The IUCN Forest Conservation Programme

Nature Conservation in Uganda's Tropical Forest Reserves

PETER C. HOWARD

Nature Conservation in Uganda's Tropical Forest Reserves

IUCN - THE WORLD CONSERVATION UNION

Founded in 1948, IUCN — The World Conservation Union — is a membership organisation comprising governments, non-governmental organisations (NGOs), research institutions, and conservation agencies in 120 countries. The Union's mission is to provide leadership and promote a common approach for the world conservation movement in order to safeguard the integrity and diversity of the natural world, and to ensure that human use of natural resources is appropriate, sustainable and equitable.

Several thousand scientists and experts from all continents form part of a network supporting the work of its Commissions: threatened species, protected areas, ecology, environmental strategy and planning, environmental law, and education and communication. Its thematic programmes include forest conservation, wetlands, marine ecosystems, plants, the Sahel, Antarctica, population and natural resources, and Eastern Europe. The Union's work is also supported by 12 regional and country offices located principally in developing countries.

THE IUCN FOREST CONSERVATION PROGRAMME

The IUCN Forest Conservation Programme coordinates and reinforces activities of the IUCN members and Secretariat which deal with forests. The Programme focuses on the conservation of species and ecological processes, and on investigating and promoting sustainable use of the resources of these forests.

The Programme includes international and national policy initiatives and strategies as well as field projects addressing selected problems in managing the world's most biologically significant tropical forests. These selected projects put the World Conservation Strategy into action by reconciling the requirements of conservation with national development and the needs of people living in forest areas. Special emphasis is given to the development of compatible uses for buffer zones around national parks and reserves.

IUCN develops its positions and policies on the basis of the concerns and information communicated by members, trends identified by monitoring activities, and the feedback from numerous field projects. Data on species of plants and animals, and on forest sites which are important for biological and ecosystem conservation, are held by the World Conservation Monitoring Centre in Cambridge, UK.

This series of publications from the Forest Conservation Programme, in conjunction with regular meetings, enables IUCN to communicate policies and technical guidance to governments, major international institutions, development planners, and conservation professionals. The Programme works closely with development assistance agencies, governments and NGO's, to ensure that conservation priorities are adequately addressed in their activities.

The Forest Conservation Programme receives generous financial support from the Government of Sweden.

THE IUCN COMMISSION ON ECOLOGY

The IUCN Commission on Ecology (COE) serves as the Union's source of technical advice for translating knowledge of ecological processes into practical action for conservation, sustainable management and restoration, in particular of areas degraded by human action. The IUCN programmes on Forest Conservation, Marine Conservation and Wetlands are under the umbrella of the Commission on Ecology. Commission members serve on advisory committees and in working groups associated with these programmes.

The IUCN Tropical Forest Programme

Nature Conservation in Uganda's Tropical Forest Reserves

by

Dr Peter C. Howard
WWF Project Leader

WWF - The World Wide Fund for Nature
IUCN - The World Conservation Union
Forest Department, Ministry of Environment Protection,Uganda

1991

Published by: IUCN, Gland, Switzerland and Cambridge, UK with the financial support of WWF-International.

Citation: Howard, P.C. (1991). *Nature Conservation in Uganda's Tropical Forest Reserves.* IUCN, Gland, Switzerland and Cambridge, UK. xvii + 313 pp.

ISBN: 2-8317-0085-X

Printed by: Unwin Brothers Ltd, Woking, Surrey, UK

Book design by: Peter Howard, with assistance from the Communications Unit, IUCN Regional Office for Eastern Africa, Nairobi, Kenya

Cover design by: James Butler

Cover photo: Chimpanzee, *Pan troglodytes* at food tree: Peter Howard

Illustrations by: Peter Howard

Available from: IUCN Publications Services Unit,
219c Huntingdon Road, Cambridge, CB3 ODL, UK
or
WWF Regional Office for Eastern Africa, P.O. Box 62440, Nairobi, Kenya
or
IUCN Communications Division, Ave du Mont Blanc, CH-1196 Gland, Switzerland

Contents

Chapter Four: Planning a System of Protected Areas

Chapter Five: Integrating Forest Conservation into District Development: A Case Study

List of Tables

List of Figures

ACKNOWLEDGMENTS

A great many people contributed to the production of this report, and to all of them I extend sincere thanks. The fieldwork was carried out over a period of 32 months from April 1985, a difficult time during which the National Resistance Army (NRA) was fighting for control of government, and subsequently consolidating its power. Without the help and support of numerous civil servants, army officers and villagers in the areas where we worked, the survey could very easily have been abandoned, and the funding withdrawn. I am especially grateful to the Regional and District Forest Officers, Foresters, Forest Rangers and other Forest Department staff who assisted the project in many ways; to the officers of the NRA who helped us continue our work 'behind the lines' in the areas they controlled prior to the establishment of the NRA government; and to the many local people living in and around the forests we surveyed who helped us cut trails, or served us as guides, porters or camp assistants. It would be impossible for me to name all these individuals, but their contribution to the work described in this report was considerable, and to them all I am most grateful. One particular problem plagued the first year of field activities - the ageing project Suzuki, which might have been retired years earlier, demonstrated a formidable repertoire of mechanical problems to test the skills of the most resourceful mechanics. The fact that any fieldwork at all was possible during the first year is in no small part due to the considerable assistance afforded the project by the Catholic Community at Virika Mission, Fort Portal, who were always ready and willing to drop everything and travel to some far-flung corner of western Uganda to recover the vehicle, and, through some mechanical wizardry, get it back on the road in the shortest possible time. I am especially grateful to Father Dick Wunsch.

In a country with relatively few trained conservation professionals, contacts with one's colleagues are particularly valuable, and I am grateful to the following for their ideas, which have inevitably shaped my own thinking, and influenced the content of this report: G.I. Basuta; A. Balmford; Ms S. Blakeman; Ms B. Bush; T. Butynski; M. Hauser; Ms J. Holmes; T. Jones; Ms J. Kalina; J. Kasenene; S. Kramer; Ms L. Leland; J. Lwanga; P. Moller; W and U Moller; R. Olivier; D. Pomeroy; Ms M. Steinbeck; T. Struhsaker; R. Wrangham and G. Yeoman. Behind the scenes, in Nairobi, Gland and New York, I have received advice, guidance and professional support from my colleagues at WWF and NYZS, for which I thank particularly: A. Carr; Ms M. Gawler; J. Hanks; H. Lamprey; Ms L. Leland; Ms C. Maina; B. Mutua; J. Sayer; Ms M. Schwartz; T. Struhsaker; R. Weyerhaueser; and E. Wilson. The inventory work was carried out by a team of five British volunteers and one Forest Department professional who kept me on my toes for four busy months, providing congenial company as well as useful new data. To them I offer my thanks; P. Buckley; J. Foord; F. Kigenyi; A. McNeilage; S. Trewick; and C. Walker. Last, but by no means least, I thank Alphonse Kisubi, my counterpart, for his company, friendship and hard work through the project.

An earlier draft of this report aroused considerable interest when it was released for comment in July 1988. I consider it an honour that so many people took the time and trouble to read and comment on this draft, when most of their desks were already overflowing with papers; I am particularly grateful to the Chief Forest Officer for hosting a nine-hour meeting with his senior officers to discuss their detailed comments with me. Many of the comments were, of course, opinions which were often difficult to reconcile one with another; the gulf between those who favour exploitation of forest resources, and those advocating a strict preservationist code is indeed wide. In editing that draft, I have taken careful note of all the comments I received, and I am most grateful to the following for the time and trouble they took in making them: G.I. Basuta; J. Boshe; T. Butynski; M. Chebet; J. Carvalho; H.C. Dawkins; D. Earl; D. Etoori; A. Hamilton; J. Holmes; R. Howard; A. Johns; J. Kasenene; P. Karani; F. Kigenyi; I. Kikangi; A. Kisubi; L. Kiwanuka; S. Kramer; H. Lamprey; L. Leland; J. Mackinnon; J. Miskall; B. Munyakabere; J. Naluswa; L. Ntiru; R. Olivier; M. Oloya; H. Osmaston; D. Pomeroy; M. Rukuba; J. Rwabukuba; J. Sayer; T. Struhsaker; G. Tabor; J. Torres; F. Turyatunga; R. Wrangham and E. Wilson.

The final report has been a long time in the making, but it would certainly have taken a lot longer were it not for the efficiency of Ms C. Namirembe and Ms K.Turner who typed and re-typed the early drafts before finally transferring it to a wordprocessor. Many hours of work have been undertaken on the maps and figures, and I am grateful to Ms E. Jarvis, H. Kiwalazi, G. Mubiru and G. Otieno for assisting with these. I am also indebted to H. Mulira for advice on statistical procedures, and assistance with running the SPSS statistical package at the Makerere University computer centre.

I am grateful to the World Wide Fund for Nature (WWF) and New York Zoological Society (NYZS) for financial support, and the use of facilities at the former Kibale Forest Project. The Forest Department provided accommodation and other facilities at various rest houses, and I was always made welcome at Bugombwa Parish in Bundibugyo, and at D. Pomeroy's house in Kampala, for which I am most grateful.

Finally, the Forest Department, National Research Council and President's Office provided permission for this work to be carried out.

Chapter One: Introduction

1. Preamble

This report arises from a three-year survey of the status of Uganda's twelve principal tropical high forest reserves, carried out between 1985 and 1988 for the Uganda Forest Department (FD), with financial support from the World Wide Fund for Nature (WWF-International), and the New York Zoological Society (NYZS). It presents the results of this survey, and attempts to:

- describe the present status of the principal forest reserves in terms of the type and extent of recent human disturbance;
- review their importance as a renewable natural resource, and the ways in which present management practices may affect their long-term ability to provide mankind with a range of useful goods and services;
- describe the wildlife communities that are characteristic of these forest reserves; and show how they are important to national and international species conservation efforts;
- review the need to set aside areas of relatively undisturbed natural forest as strict nature reserves, and provide guidelines for the selection of appropriate areas; and
- provide specific recommendations on forest management aimed at ensuring sustainable methods of exploitation,

The project began as a one-year survey of six forests in western Uganda, but was extended at the request of the Minister of Environment Protection to include major forests elsewhere, so that ultimately all of Uganda's closed canopy forests exceeding 100 km^2 were included (11 forests), together with one smaller forest (Itwara) which had been included in the original project proposal. These are the principal forest reserves referred to in this text.

The report is written for a diverse readership. It is intended primarily for those who are involved most directly in the management of Uganda's forests, including politicians and forestry officials, representatives of international aid and financial institutions, and those who carry out day-to-day management activities in the field. It is also intended for members of the international wildlife conservation and scientific community, and members of the general public who are seeking up-to-date information on the scientific importance of Uganda's forests, and their present status. Thus the report is written in a manner that is unlikely to be wholly acceptable to any one group of readers, but which will, I hope, succeed in its objective of generating awareness and initating action in all appropriate quarters towards the wise use of Uganda's unique tropical forest resource.

The fieldwork on which this report is based was carried out by two full-time personnel, myself and a local counterpart, Alphonse Kisubi. We spent the first six months in the field together, conducting general survey work in a number of forests, and developing primate censusing and vegetation sampling techniques. Alphonse Kisubi then registered at Makerere University for a Master's degree in wildlife biology, and subsequently concentrated on primate censusing and vegetation work, using the techniques we had developed together. Meanwhile, I continued with additional survey work, and the development of further activities. Five expatriate volunteers (bioscience graduates from the United Kingdom) and a Forest Department research officer conducted fourteen man-months of wildlife inventory work under this programme during 1987. In addition, three seconded government officers worked (one full-time, two part-time) on the Bwamba Natural Resources Development Project (discussed in Chapter Five) for eighteen months from late 1986 to early 1988. Thus, although this report appears in my name, it is very much a collaborative effort.

In conducting this work I have been very conscious of how little we know about the ecology of these forests, and how much work would need to be done in order to redress the situation and provide the information required for proper planning and management. Clearly a three-year, low-budget survey such as this, covering such a wide geographical area, can do little more than provide a framework for future action. In this report I present a lot of new baseline data which I believe to be useful and relevant, but which, taken out of context, could be misleading. It is therefore appropriate that I record this note of caution in the opening paragraphs to sensitize the reader to some of the report's inherent shortcomings.

2. Country setting

Uganda is a rather small landlocked country lying astride the equator in east-central Africa. It occupies about 236,000 km^2 of the central African plateau, north of Lake Victoria, between Zaire in the west, Kenya in the east, the Sudan in the north, and Rwanda and Tanzania in the south (Fig. 1.1).

The central part of the country is characterised by a gentle topography of flat-topped hills and broad, often swampy, valleys lying at an altitude of 1,000-1,500 m. More spectacular scenery is to be found in the west where the landscape is dominated by the Rift Valley and its associated mountains and lakes; and in the east where the international border follows a line of raised land associated with the large Miocene volcanoes of Mounts Elgon, Kadam and Moroto (Fig. 1.1). Most of Uganda lies on very ancient sandy clay, loamy soils. These are reasonably fertile, although they represent one of the final stages in tropical weathering and possess little or no reserve of weatherable minerals. Some better soils (ferrisols, lithosols and eutrophic soils), richer in plant nutrients and with a higher reserve of weatherable minerals, are associated with the more recent land forms along the western rift, and the volcanoes of the eastern border areas (Atlas of Uganda, 1967; Varady, 1982).

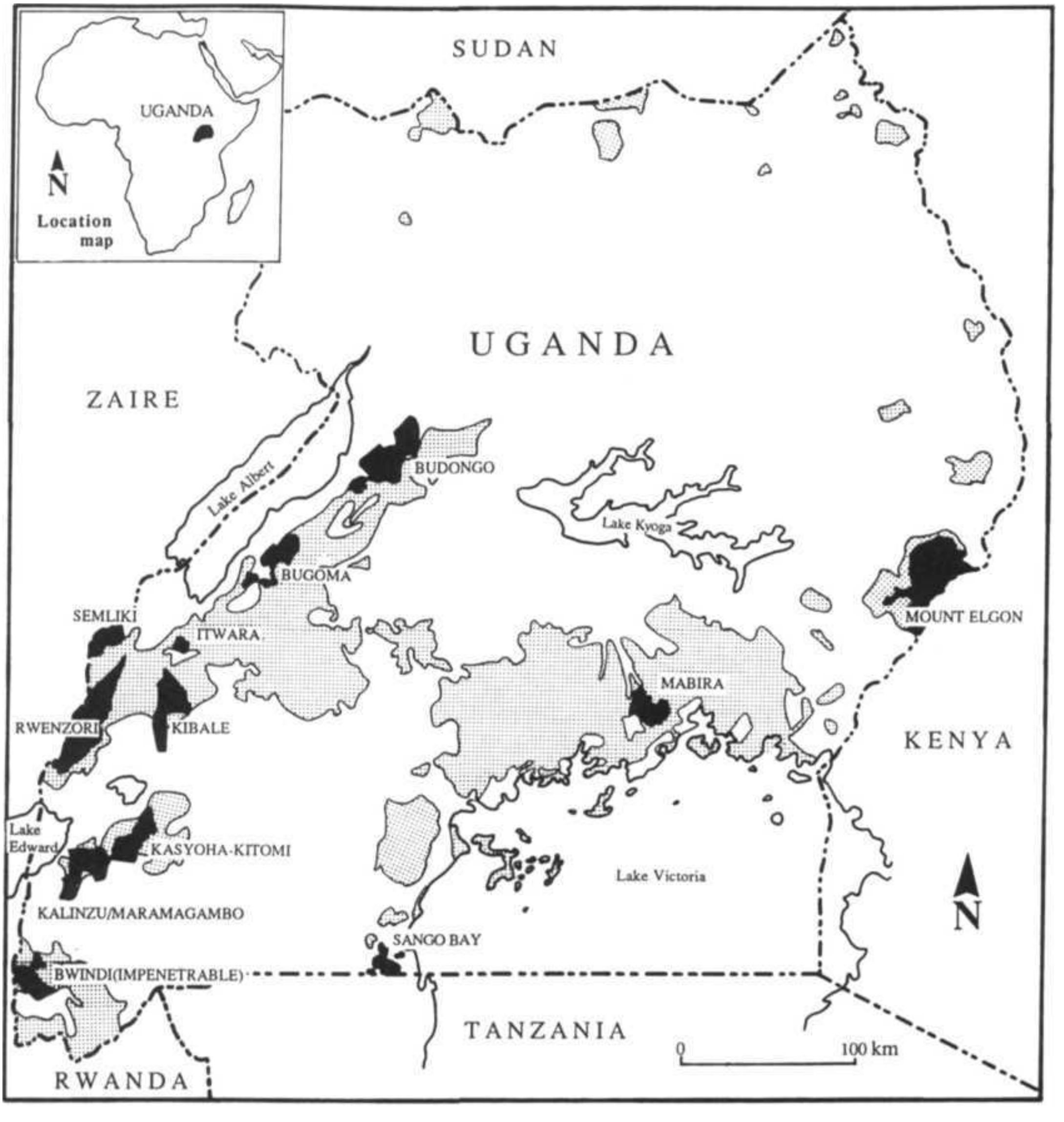


Fig. 1.1 *Map of Uganda showing the locations of the principal forest reserves (black), and areas of the country where relict forest occurs (stippled), which were presumably once forested.*

Uganda has a diverse climate, influenced by the country's latitudinal position between 1°S and 4°N, and by altitude and topography. Seasonal movements of the Inter-Tropical Convergence Zone (ITCZ) determine the general pattern of rainfall, with rainy seasons during April-May and October-November around the equator, and a weakly bimodal rainfall pattern in the north with a rather prolonged dry season between December and February. Much of the country receives 1,000-1,500 mm of rain per annum, the driest parts being in the north-east where Karamoja receives less than 750 mm, and the wettest parts being in the high mountains of Rwenzori and Elgon and the islands of Lake Victoria, which receive more than 2,000 mm (Atlas of Uganda, 1967). Mean temperatures are influenced mainly by altitude, the warmest areas lying in the Rift Valley and the plains of northern Uganda, and the coolest being the highlands of the southwest and eastern border areas. Climatic conditions favourable to the formation of forest are found in parts of the southern half of the country where rainfall exceeds about 1,150 mm p.a., evenly distributed throughout the year; and on the Karamoja mountains where low temperatures associated with altitude serve to moderate water loss during the long dry season (Hamilton, 1984).

Ecologically, Uganda is exceptionally diverse. This is largely due to its location in east-central Africa, in a zone of overlap between ecological communities characteristic of the dry East African savanna, and those of the West African rainforests. It is also partly the result of the country's great topographical diversity, with a range of altitude from below 600 m in the bottom of the Rift Valley, to over 5,000 m at the top of the Rwenzori, Africa's third highest mountain range. The UNESCO vegetation map of Africa (White, 1983) shows that seven of mainland Africa's 18 phytochoria (plant 'kingdoms') are represented in Uganda: more than in any other single country. Uganda contains vegetation (and associated animal communities) characteristic of habitats as diverse as glacier-topped mountains, lowland rainforests, *Butyrospermum* woodland savanna, and deciduous *Acacia-Commiphora* bushland and thicket (White, 1983).

3. Man and resources

Uganda is a well-watered country, richly endowed with renewable natural resources, including areas of highly productive agricultural land, forests, fisheries and grazing lands. These resources support the Ugandan people, and represent their prospects for economic development. If managed properly they can provide for greatly improved living standards for all the country's people; if squandered, the consequences would be devastating since Uganda has few mineral resources as an alternative basis for economic development (Hamilton, 1984).

Man has been a major influence on the natural environment in Uganda for a very long time. Analysis of pollen core samples from Kabale district provides evidence of forest clearance and cultivation dating back about 2,000 years (A. Hamilton, pers. comm., c.f. 1986). For at least five hundred years there have been a number of well organised kingdoms in the area, notably those of Bunyoro and Buganda, with elaborate procedures designed to administer their agricultural economies (Varady, 1982).

Uganda is still a predominantly agricultural nation, and 83% of its labour force is engaged in agriculture. Agricultural products, especially coffee and cotton, but also tea, tobacco, beans, groundnuts, simsim, and other crops account for nearly all of the country's export earnings and contribute 60% to GDP (World Bank, 1986).

According to the United Nations' Food and Agriculture Organisation (FAO) about a quarter of Uganda's area was under cultivation in 1977, 21% was classified as permanent grazing land, 12% covered by forest and woodland, and 15% occupied by open water. The remaining 28% included unused but potentially productive land, parks, roads, built-up areas and other land-use categories (FAO, 1979). Nearly three quarters of the country receives sufficient rainfall to permit intensive agriculture, and although large areas of the country are presently tsetse infested, there is thought to be scope for agricultural expansion (Varady, 1982).

In common with other African nations, Uganda's human population has risen sharply during this century. By 1985 the country supported an estimated population of 15.7 million, up from 3.0 million in 1921, and with an annual growth rate of 2.8% between 1969 and 1980. The latest population census was carried out in 1980 and shows that the population is predominantly rural, with only 8.7% of the people living in urban centres (Anon, 1982). Uganda is Africa's fourth most densely populated country, after Rwanda, Burundi and Nigeria (World Resources Institute, 1986). Ethnically, it is exceptionally diverse, with 36 tribal divisions recognised (Atlas of Uganda, 1967). The southern half of the country is occupied by Bantu, who together constitute about two thirds of the country's population and are primarily agriculturalists. In the north, most groups are pastoralist, and are of Sudanic, Nilotic and Nilo-Hamitic origin.

The area of present-day Uganda was first visited by European explorers in the 1860s, and became a British Protectorate in 1894. Under Protectorate administration, a sound basic infrastructure was developed and modest industrial development achieved. Uganda gained political independence in 1962, and enjoyed a decade of unparalleled prosperity until soon after Idi Amin took power in a military coup in 1971. The seventies was a period of severe economic recession, exacerbated by the expulsion of all 'Asians' in 1972, economic mismanagement, high rates of inflation, political suppression and widespread abuse of human rights. Amin was finally ousted in 1979 with the help of the Tanzanian army, and after two short interim governments, Milton Obote was returned to power in disputed 1980 elections. Two years later, Yoweri Museveni and other disillusioned political leaders went to the bush to fight a guerilla war against the government. The next four years was a period of continued widespread human rights abuse as the government attempted to suppress opposition by force; and, as the war became more and more desperate, achievements in the field of economic recovery became increasingly elusive. Per capita GDP fell by almost a third to US$ 240 between 1972 and 1983, a figure somewhat below the average of US$ 280 for low income sub-Saharan African countries (World Bank, 1986).

The National Resistance Movement (NRM) government of President Yoweri Museveni took power in Kampala in January 1986. It quickly restored security to many parts of the country, and embarked upon a renewed programme of economic recovery. A National Rehabilitation and Development Plan was launched in March 1987, which focusses on 'the reconstruction of economic and social infrastructure in order to restore the productive capacity of the economy in key sectors' (MPED, 1987).

Administratively, Uganda is divided into 33 districts. The district is the primary administrative unit for development, administered by a District Administrator (DA) appointed by the President. Each district is subdivided into counties, subcounties, parishes and subparishes, where locally elected Resistance Committees are responsible to the DA for coordinating local development projects, distributing food, essential commodities and agricultural inputs, and adjudicating in local disputes. It is the intention of the NRM government to establish a hierarchical system of Resistance Committees, each of which nominates one representative to the next higher committee, such that representatives from all districts are ultimately represented on the National Resistance Council, the country's supreme legislative body.

4. The role of forestry in the national economy

Forests, and trees growing on agricultural and pastoral land, play a crucial role in the national economy, both in satisfying energy and industrial product needs, and in providing essential environmental services that support Uganda's agriculture, sustain her water supplies and protect her soils. There are few recent figures available to demonstrate the value of the forest resource, but in terms of satisfying energy requirements it is estimated that 96% of Uganda's current energy consumption is provided by woodfuels, equivalent to 18.3 million m^3 of wood per annum (World Bank, 1986). This is by far the greatest pressure on the forest resource, and the greatest challenge to those responsible for forestry planning. Woodfuels are used domestically in most rural and urban homes, and they provide the primary source of energy in the tea, tobacco and brick-burning industries. In 1985, commercial woodfuels (which represent about 15% of total woodfuel demand) generated over 3 million man-days of employment and the equivalent of about US$5 million in rural incomes (World Bank, 1986).

By the time Idi Amin came to power in 1971, Uganda had developed a thriving forest industry which employed some 3,000 people and processed 170,000 m^3 of timber worth US$8 million at 1985 prices (World Bank, 1986). However, most of the industrial plant has subsequently broken down, and the country's sawn-timber requirements are today satisfied largely by an estimated 3,000 pitsawyers, many of whom are probably cutting illegally within the forest reserves.

The social role of forests is frequently overlooked or undervalued, but they do nevertheless contribute substantially to rural communities living in their vicinity. Construction poles are used for rural dwellings throughout the country, and may account for as much as 400,000 m^3 of timber annually (World Bank, 1986). Forests also provide a wide range of other minor products including roofing materials, natural fibres, medicines and foods. Furthermore, they often satisfy important ritual and cultural needs, and provide important wildlife refuges where hunting is carried out. These values are difficult to quantify in cash terms, yet they represent a significant contribution to community welfare, and the national economy.

Equally difficult to quantify, but of no less importance, is the role forests play in providing irreplaceable environmental services that support other sectors of the economy. By protecting water catchments, forests ensure supplies of domestic water, maintain downstream fisheries, and, in some cases, sustain hydro-electric power generation. In a country so heavily dependent on agriculture, the role of forests in ameliorating local climatic conditions is also likely to be vitally important, though as yet little understood.

5. The distribution and extent of forest cover

Uganda's tropical high forest occurs in three distinct geographical zones where its formation is supported by favourable rainfall regimes. These zones lie along the eastern rim of the Rift Valley escarpment in the west of the country, in a broad belt around the north-western shores of Lake Victoria, and on scattered mountains in the east of the country (Fig. 1.1) (Langdale-Brown *et al.*, 1964; Atlas of Uganda, 1967). If it were not for extensive disturbance by man, most of these areas, representing about 20% of Uganda's land surface, would probably be covered by closed canopy forest (Langdale-Brown, 1960; Hamilton, 1984). However, they have been subjected to extensive forest clearance, particularly during the past half century, to make way for agricultural settlement, and today little forest remains outside government forest reserves (Struhsaker, 1987). An excellent recent review of deforestation in Uganda has been written by Hamilton (1984).

There are approximately 14,900 km^2 of gazetted forest reserve in the country (Aluma, 1987), of which some 7,500 km^2 is savanna woodland and forest plantation, 5,900 km^2 is tropical high forest, and 1,500 km^2 montane catchment forest. Thus, reserved tropical high forest covers only 3.0% of Uganda's land surface, whilst 7.7% is gazetted for forestry use. This report is concerned specifically with the status of the twelve principal forest reserves shown in Fig. 1.1, which together cover approximately 4,000 km^2 of tropical high forest and 1,500 km^2 of montane catchment forest (Table 1.1).

Table 1.1 *The location and areas (km^2) of the twelve principal Forest Reserves reviewed under this project.*

Forest Reserve	Location (District)	Area (km^2)
Budongo	Masindi	793
Bugoma	Hoima	365
Bwindi (Impenetrable)	Kabale/Rukungiri	321
Itwara	Kabarole	87
Kalinzu-Maramagambo	Bushenyi/Rukungiri	580
Kasyoha-Kitomi	Bushenyi/Mbarara	399
Kibale	Kabarole	560
Mabira	Mukono	306
Mount Elgon	Kapchorwa/Mbale	1,145
Rwenzori	Kasese/Kabarole/Bundibugyo	996
Sango Bay	Rakai	151
Semliki	Bundibugyo	212

6. Forest types

The tropical high forests vary considerably in structure and composition from one area to another. To a large extent these differences can be related to the altitude at which the various types occur, but climatic, edaphic and historical factors are also important. Langdale-Brown *et al* (1964) have classified the tropical high forest into three broad forest types of which two occur in suitable areas below 1,500 m:

<u>Medium altitude moist evergreen forest</u>. In many ways this type is similar to true lowland 'tropical rain forest', being structurally complex and rich in species including many epiphytes, lianes and large trees with impressive buttressing; but differing on account of the greater altitude, lower temperature and lower rainfall characteristic of the areas in which it

occurs. Three sub-types are recognised, each being named after characteristic trees. These are the *Piptadeniastrum-Uapaca* type which occurs on Lake Victoria's Sese Islands, the *Piptadeniastrum-Albizia-Celtis* type characteristic of the slightly drier lake-shore forests of the Mengo-Masaka area, and the *Parinari excelsa* type characteristic of forests at 1200 m-1500 m, especially along the western rift.

Medium altitude moist semi-deciduous forest. The distinction between this and the evergreen type is somewhat arbitrary, but serves to recognise that an increasing proportion of the forest trees are deciduous, and remain leafless for longer periods in areas where the dry season is longer and more severe. Four sub-types are recognised, the older of these being the *Celtis-Chrysophyllum* forest characteristic of drier areas to the north of Lake Victoria, and the *Cynometra-Celtis* forest of lower altitude zones along the western rift. Two younger semi-deciduous sub-types, which may represent earlier seral stages in the development of the sub-types mentioned above are the *Albizia-Chlorophora* forest of areas to the north of Lake Victoria, and the *Albizia-Markhamia* forest which occurs in the mid-west of the country at altitudes of 1,200-1,500 m.

High altitude forest. This type occurs in suitable areas above 1,500 m, and tends to be less species-rich than those found at lower altitudes, with a very broken and irregular canopy, characterised by trees of generally low stature. In the moist conditions characteristic of southwestern Uganda, and much of Mount Elgon, *Prunus* moist montane forest is the recognised sub-type. It merges into an *Arundinaria* montane bamboo forest zone at 2,300-2,750 m, and/or a *Hagenia-Rapenea* forest zone of low trees above 2,750 m. On the drier northern slopes of Mount Elgon and the Karamoja mountains between 1,500 m and 2,750 m, the forest is a *Juniperus-Podocarpus* dry montane sub-type.

In addition to differences in forest type associated with altitudinal and climatic factors, there is considerable local variation related to site factors such as past management, soil type and drainage conditions. This variability in forest types within comparatively small areas is a characteristic feature of many Ugandan forests. The factors involved are poorly understood, but one of the more important is past human activity.

Many areas presently designated as Forest Reserve have a long history of human occupancy. Old cultivation plots and fire-maintained grazing lands have been colonised by forest comparatively recently, and so many of the forest types seen today are young colonising types. Many forests have grown up or expanded considerably in areas that were abandoned early this century as a result of rinderpest, sleeping sickness or tribal strife (Dale, 1954; Langdale-Brown *et al.,* 1964; Hamilton, 1984). This applies particularly to the forests of the Lake Victoria region, and to areas such as Kibale and Kasyoha-Kitomi along the western rift (Fig. 1.1). There is evidence of large-scale human activity in the area now covered by the Bugoma forest, dating back about 300 years, at which time the area was probably open grazing land (Osmaston, 1959b; 1965).

Eggeling (1947) has described the process of community succession, by which grassland is overtaken by colonising forest which eventually gives rise to a mature climax type. The whole process probably takes several hundred years, so details of the succession have to be inferred from the appearance of the forest and the size-class structure of different species of tree. Eggeling (1947) worked in the Budongo Forest, where he described three main stages in the succession. The first involves the colonisation of the savanna by one of two types of colonising forest, dominated either by *Maesopsis eminii* (on better soils) or by an irregular mixture of species including *Olea welwitschii*, *Sapium ellipticum* and *Phyllanthus discoideus* (on the poorer soils). This stage lasts for only one generation because the main constituent species will not regenerate under shade, and it is replaced by a mixed forest, rich in species of large tree including mahoganies *(Entandrophragma* spp. and *Khaya anthotheca),* and ironwood *(Cynometra alexandri).* The mixed forest stage may last for several generations but under the conditions found in Budongo, it is gradually replaced by a climax type in which three quarters of the large trees are ironwood *(Cynometra alexandri).*

Ironwood dominates large areas of climax forest throughout the lower altitude forests of western Uganda, including Bugoma, Kibale, Maramagambo and Semliki. Evidence from the Bugoma and Semliki forests suggests that, contrary to Eggeling's interpretation, it becomes the climax dominant only on poor soils with impeded drainage, whilst mixed forest may represent a climax type on the better soils (Osmaston, 1959b; Langdale-Brown *et al.,* 1964). Laws *et al.* (1970) have made the alternative suggestion that ironwood forest may represent an elephant-induced climax type.

In many cases it is not clear what exactly represents a 'climax' community. *Parinari excelsa,* for example, tends towards single species dominance of mature forest at around 1,500 m in the Impenetrable (Bwindi), Kalinzu, Kasyoha-Kitomi, Kibale and (formerly) Namatale forests, in much the same way as ironwood does at lower altitudes. However, examination of its size-class distributions in three of these forests shows an acute shortage of small trees, and it seems unlikely that the present mature populations of trees can be maintained (Osmaston, 1959a, 1960). Similar situations occur in West Africa, and possibly arise as a result of non-uniform rates of growth, various forms of mosaic or cyclical regeneration, or changes in the climate which have resulted in changes of the climax (Langdale-Brown *et al.,* 1964).

Climatic change is an important factor influencing the extent of forests and their species composition. Dale (1954) has presented some evidence of climatic changes over the last two millenia which leads him to suggest that the 'over-mature mahogany and mixed forests' found in Uganda today are largely the result of wetter conditions about 400-600 years ago when forests were probably spreading. The next two and a half centuries were relatively dry, but forest spread has continued spectacularly wherever human populations have allowed it since the beginning of another wetter period in the mid-nineteenth century.

Over the longer term, the climate of tropical Africa has undergone much more severe fluctuations than any experienced during the past 1000 years. At the time of the last Ice Age (which ended about 12,000 years ago), the whole of tropical Africa was very much drier than it is today, and few areas were climatically suitable for the formation of forest. The extensive rainforests which today cover most of the Zaire river basin were reduced to a fraction of their present size, and occupied a few isolated areas in west and central Africa (Kingdon, 1971; Hamilton, 1974) (Fig. 1.2). Only in these forest refugia could plant and animal species dependent on the rainforest environment survive during this arid period of the Pleistocene. Subsequently, as the climate became wetter and other areas became suitable for colonisation by forest, the animals and plants dispersed from these refugia. Some species were much better adapted for rapid dispersal and colonisation, and were able to extend their ranges quickly, whilst others were less successful. As a result, the richest rainforest communities today are those that served as Pleistocene refugia. The further a forest lies from one of these areas, the poorer it is in terms of species diversity. The Pleistocene forest refugium closest to Uganda lay in eastern Zaire and western Rwanda and may have extended into the extreme southwest of Uganda. Consequently the Bwindi (Impenetrable) forest in Kabale, and the Bwamba (Semliki) forests in Bundibugyo, which lie on the fringes of this refugium, are especially rich in species, and progressively fewer species are found in comparable forests further to the east and north (Kingdon, 1973; Hamilton, 1976, 1984).

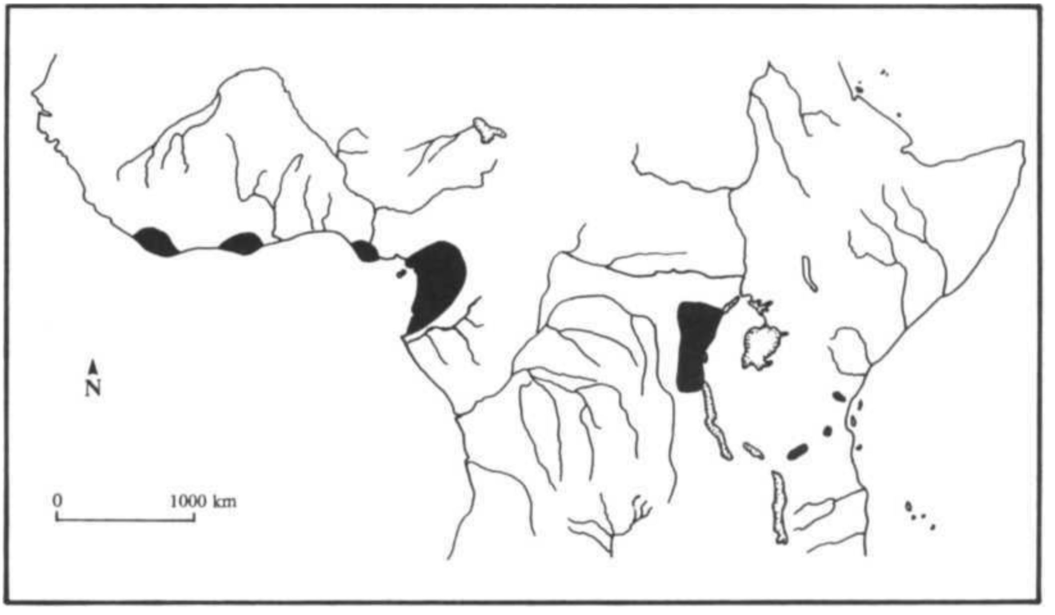


Fig. 1.2 *The probable locations of principal forest refugia in tropical Africa about 18.000 years B.P. (after Hamilton. 1981)*

7. Forest policy

The government of Uganda first adopted a Forestry Policy in 1929, one which placed emphasis on the role of forestry in the protection of the environment (Forest Department, 1951, 1955). There have subsequently been several revisions of the original Policy that have tended to place progressively greater emphasis on the realisation of short-term economic benefits from timber extraction activities (Hamilton; 1984). For example, the policy recommended over the period 1973-1978 stated that one of the primary objectives was 'to capture the returns to the nation from the natural forest resource resulting from the utilization of the remaining natural forest areas' (Forest Department, 1980). Early in 1988, the NRM government revised the Forest Policy to re-emphasise the importance of protective forestry (Table 1.2).

Table 1.2 *The Forest Policy**

1) To maintain and safeguard enough forest land so as to ensure that:
   - i) sufficient supplies of timber, fuel, pulp, paper and poles and other forest products are available in the long-term for the needs of the country, and where feasible for export;
   - ii) water supplies and soils are protected, plants and animals (including endangered ones) are conserved in natural ecosystems, and forests are also available for amenity and recreation.

2) To manage the forest estate so as to optimise economic and environmental benefits to the country by ensuring that:
   - i) the conversion of the forest resource into timber, charcoal, fuelwood, poles, pulp and paper and other products is carried out efficiently;
   - ii) the forest estate is protected against encroachment, illegal tree cutting, pests, diseases and fires;
   - iii) the harvesting of timber, charcoal, fuelwood, poles and other products applies appropriate silvicultural methods which ensures sustainable yields and preserves environmental services and biotic diversity;
   - iv) research is undertaken to improve seed sources for planting stock and the silvicultural and protection methods needed to regenerate the forest and increase its growth and yield. Research is also carried out into new and existing forest products including tourism and education with the object of maximising their utilisation potential. Research is undertaken to monitor and promote the preservation of environmental services and conservation of biotic diversity.

3) To promote an understanding of forests and trees by:
   - i) establishing extension and research services aimed at helping farmers, organisations and individuals to grow and protect their own trees for timber, fuel and poles and to encourage agro-forestry practices;
   - ii) publicising the availability and suitability of various types of timber and wood products for domestic and industrial use, and publicising the importance of environmental services provided by forests;
   - iii) holding open days at regular intervals in all districts to demonstrate working techniques and bring attention to the positive benefits of forestry.

* The Uganda Gazette 81(2). 15th January 1988

8. Forest protection and the regulation of resource use

The Forest Department is the government agency responsible for the implementation of national forestry policy. It is responsible for the selection and management of forest reserves, the protection of reserved trees outside forest reserves, research, and extension work. The Department's mandate has also periodically included the exploitation of forest products and the management of related industries (Hamilton, 1984).

The establishment of forest reserves in Uganda dates back to around the turn of the century when the British Protectorate government signed agreements with the authorities of the ancient kingdoms of Buganda, Toro, and Ankole whereby all forest land became the property of the Protectorate government. Unfortunately, no formal reservation and demarcation of the forest estate was undertaken until 1932, by which time much had apparently been lost. In Buganda, for instance, the Agreement of 1900 stipulated that 1500 square miles (3900 km^2) of forest would come under the Protectorate Government, yet only 504 square miles (1300 km^2) were finally gazetted (Forest Department, 1951). Most of the country's principal forest reserves were formally gazetted in 1932 as undemarcated Crown forests, totalling 3657 km^2 (Forest Department, 1951). It took a further two decades before the boundaries, more or less as they are today, were finally consolidated. During this period a large number of additional smaller areas were gazetted as Local Forest Reserves, under district administrations, in order to cater for local demands. These were later brought under centralised Forest Department control in 1967 (Hamilton, 1984).

The relevant legislation regulating the use of forest products is contained in the Forests Act of 1964 and a number of subsequent statutory instruments. There are some local variations in the rules governing different areas of the country but the following important legal provisions are widely applicable (Government of Uganda, 1964):

- Nobody may reside, cultivate or graze livestock in a forest reserve without written authority from a Senior Forest Officer.

- Certain species of tree are designated as reserved forest produce and may only be cut with Forest Department permission, both within forest reserves, and on public land elsewhere.

- Local people enjoy special privileges in the use of unreserved forest produce, which they may take from reserved or public forest land without a permit or the payment of fees in reasonable quantities for their own private domestic use.

- Any other form of forest resource use within forest reserves requires the issue of a permit from a Senior Forest Officer, and usually involves the payment of stipulated fees.

At a departmental level, the efficient management and control of individual forest reserves is facilitated by the use of Working Plans, which set out the objectives of management, and the methods to be employed in achieving those objectives over any given period. The first Working Plan for a natural forest area was prepared for Budongo in 1934, and by 1950 most of the principal reserves had come under planned management. Unfortunately, none of the Working Plans has been revised or replaced since the early 1970s and all are now out-of-date.

The preparation of the Budongo Forest Working Plan marked the beginning of a period of some 35 years during which a great deal was achieved in the evolution of methods used in natural high forest management in Uganda. Indeed, Uganda came to be known as a leader in this field (Hamilton, 1984). Forest Department staff became involved in a wide range of forestry activities, including the assessment and mapping of timber resources, the control of forest resource exploitation, silvicultural operations, boundary demarcation and maintenance, and research.

Although all Forest Reserves come under the administration of the Forest Department, forestry personnel have no jurisdiction over the wild animals in these areas. This is the responsibility of the Game Department, which maintains field staff in some of the larger reserves. At present there is a ban on the killing of all wild vertebrate animals throughout Uganda except (i) in self-defence, (ii) in the protection of crops or personal property on private land, (iii) by Game Department staff under certain other circumstances, and (iv) for tsetse fly control purposes under the authority of the Chief Game Warden (Government of Uganda, 1984). Thus the vertebrate animals living within the country's forest reserves are given full legal protection under existing legislation, and no hunting is permitted. As will be shown later in this report, these legal provisions are not widely recognised in the rural areas.

Several of the country's principal Forest Reserves carry dual status as Game Reserves, Animal Sanctuaries or National Parks (i.e. Maramagambo, Mgahinga, Bwindi and part of Kibale forests), and these are subject to additional regulations contained within the Game (Preservation and Control) Act, 1964, and the National Parks Act, 1964. These regulations make it an offence to reside in, cultivate or graze livestock in any of these areas, or to hunt any animal. Game Reserves and Animal Sanctuaries may be declared or abolished by the responsible Minister, and the Chief Game Warden is able to issue special permits to authorise activities otherwise prohibited by the Act. National Parks are areas declared or abolished only by an Act of Parliament, and administered by a Board of Trustees appointed by the responsible Minister. The Board has wide-ranging powers and may 'take such steps as will ensure the preservation of the animal and vegetable life in a natural state' (National Parks Act, 1964). Any exploitation of forest products within a National Park would require the authority of the National Parks Board in addition to that of the Forest Department.

9. Present status of forest management

Forestry has suffered alongside other sectors of the economy during Uganda's recent turbulent history. In particular, the effectiveness of the Forest Department has been seriously eroded as a result of low levels of funding and a general decline in law and order (Hamilton, 1984). By 1986, the Department had only 13 serviceable vehicles to support a technical and professional staff of over 600. The purchasing power of staff salaries has continued to decline steeply since the early 1970s, and today a District Forest Officer with 10 years service receives about 1,200 Uganda shillings per month-only enough to purchase 10 kg of maize flour, or four loaves of bread (Fig. 1.3). Under such circumstances, staff find it impossible to remain committed fully to their jobs, and most are obliged to spend the majority of their time earning a real living elsewhere. Inevitably, there have been many cases where forestry officials have administered the resources under their charge for personal gain. As a result of these severe constraints on the Forest Department, forest management activities have become very limited and inefficient since the mid-1970s. The problems will be given more detailed consideration later in this report, but a number of the more important ones deserve mention at this stage:

- the Department lost control of some areas of the forest estate to agricultural encroachment;

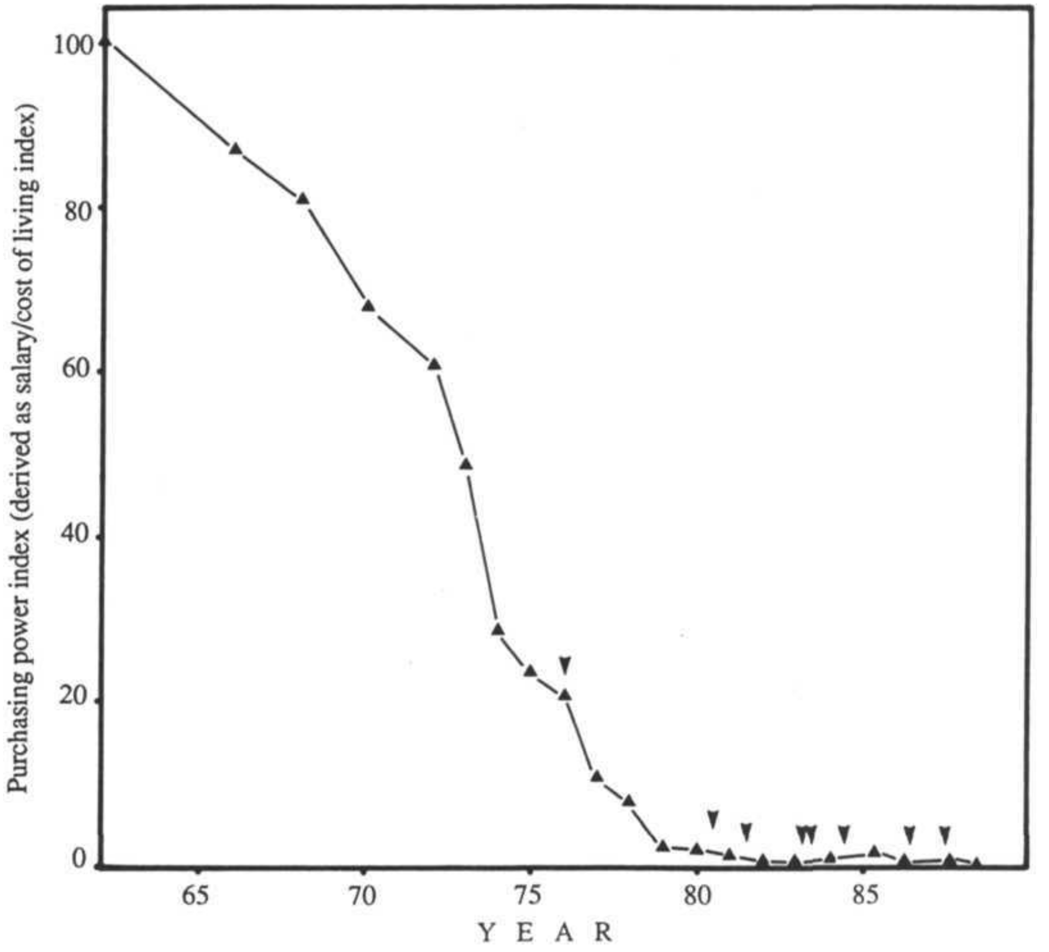


Fig. 1.3 *The purchasing power of a forest officer's salary over the period since Independence (1962 = 100). Figures are based on the starting salary of a U5-3 grade officer (data from Ministry of Agriculture salaries section; Tumisiime. pers. comm.), and on the Kampala cost of living index (data for the 1962-81 period based on the low income index; World Bank. 1982. Data for the 1981-88 period based on the middle income index; Anon, 1987: S. Morris, pcrs.comm.). By June 1988 the purchasing power of a forest officer's salary stood al 0.4% of its 1962 level, 0.6% of its 1970 level, or 16% of its 1980 level. Arrows indicate salary increases, obscured by the effects of inflation.*

- the regulation of timber cutting, charcoal production, and other forms of forest resource exploitation became erratic;
- royalties and fees payable to the Forest Department were rarely collected, and submitted to the appropriate authorities;
- little or no silvicultural work was undertaken to ensure the satisfactory regeneration of forests after logging;
- forest management systems that require close supervision and control collapsed, with resultant degradation of the forest land in many areas;

- Departmental infrastructure and facilities received little or no maintenance and have fallen into a state of disrepair; equipment has been damaged or looted during periods of civil unrest;

- the country's softwood plantations have not been tended, maintained, protected, harvested or replanted, and timber quality has deteriorated as a result;

- extension services stagnated and rural householders were given no encouragement to plant trees to meet their own domestic requirements for fuelwood and building poles.

Despite these problems it should be said that the Forest Department employs many well trained, enthusiastic and highly dedicated people who have struggled on with their jobs with enviable tenacity. Were it not for their efforts the forestry situation in Uganda would undoubtedly be very much worse than it is today.

10. Chapter summary

1. This report describes the results of a three-year survey of Uganda's twelve principal tropical high forest reserves, carried out by two full-time ecologists from 1985-1988. The surveys were aimed at evaluating the present status of the reserves through assessments of human activities and wildlife characteristics; and the production of specific recommendations to enhance their nature conservation value.

2. Uganda is a small land-locked country in east-central Africa, which enjoys a favourable tropical climate and supports an exceptionally diverse flora and fauna. This is due to the country's great topographical diversity and its location in a zone of overlap between ecological communities characteristic of the dry East African savanna, and those of the West African rainforests.

3. Uganda is rich in renewable natural resources, and has a long history of human settlement. It is the fourth most densely populated country in Africa, with a 1985 population of 15.7 million, growing at 2.8% p.a. The period from 1971-86 was one of the most turbulent in Uganda's history, characterised by severe economic recession, the breakdown of law and order, and widespread civil strife.

4. Forests make a crucial contribution to the Ugandan economy, providing most of the people's energy needs as well as construction materials and environmental services. Reserved closed canopy forests cover approximately 3.0% of the country's land surface, and can be broadly classified as medium altitude moist evergreen forest, medium altitude moist semi-deciduous forest and high altitude forest. Many seral stages are represented, and substantial areas are dominated by single characteristic species. The most species-rich forests occur in the west of the country close to former Pleistocene refugia.

5. Uganda has had a Forest Policy since 1929, the latest revision taking place in 1988 . The present policy emphasises the importance of protective forestry. Policy implementation is the responsibility of the Forest Department, which manages the Forest Reserves under established Working Plan guidelines. Several Forest Reserves carry dual status as Game Reserves, Animal Sanctuaries or National Parks.

6. Forestry has suffered alongside other sectors of the economy during Uganda's recent turbulent history. Reserves have been encroached, silvicultural operations abandoned, extension services allowed to stagnate, and facilities and equipment have fallen into a state of disrapair through lack of maintenance. The situation would undoubtedly have been considerably worse were it not for the dedication of forestry staff.

Chapter Two: Forest Wildlife Resources

1. Introduction

Tropical forest destruction has recently aroused considerable international concern. It has been the subject of numerous popular writings (e.g. Myers, 1984; Caufield, 1986) and has become the focus of several major international conservation programmes. There are many reasons for this growing concern over the future of the world's tropical forests, one of the more important being an awareness of their value as home to the greatest wealth of life forms to be found anywhere on Earth. It is estimated that between two and four million of the Earth's five to ten million species live in the rainforest, which covers only seven percent of the planet's land surface (Myers, 1984). Most of these species are insects and plants which, although less obvious than the larger mammals and birds, are nevertheless important members of the complex rainforest ecosystem, and part of its exuberant wildlife. In this report, I am concerned with all wild species, including the less obvious members of the fauna and flora, and I use the term 'wildlife' to cover them all.

The purpose of this chapter is to describe the wildlife communities of Uganda's twelve principal forests; to provide an evaluation of which forests, and which particular communities within these forests, are of most importance for wildlife conservation; and to compare the wildlife of Uganda's forests with that of tropical forests elsewhere in the world. This information can then be used, later in the report, to help formulate plans for an appropriate programme of conservation action.

My approach is to evaluate the importance of different areas on the basis of their biological richness, and the rarity of the species present, using certain taxa of the flora and fauna as indicator groups. It must be stressed that this approach is taken for practical reasons, and represents the most viable option in seeking a scientific basis for management decisions, given the limitations of time and funding available for this activity. A lot more research needs to be done (as recommended in Chapter Six) to provide the sort of detailed information that should ideally be evaluated when considering management options for the natural forest. Some of the more serious limitations of the methods described below are outlined in Appendix Q.

In selecting the groups I use as indicators of biological richness and rarity, I considered the need to ensure the representation of plants and animals that are as taxonomically different from one another as possible, so that my overall evaluation was not biased too much by any one particular group. I wanted to include, for example, animals that fly and those that don't, for the two types might demonstrate quite different patterns of distribution on account of their different dispersal abilities. Likewise I wanted to include both vertebrate and invertebrate representatives in my evaluation. In addition to these scientific criteria for the selection of indicator groups, there were compelling practical considerations which meant that only groups for which reasonably complete species lists could be compiled with the resources available to the project could be included.

Two further important considerations in conservation planning that are discussed in this chapter are the general patterns of species' distributions, and the occurrence of species which are under global threat of extinction.

2. Research Methods

2.1 Country-wide comparisons of the importance of different forests for wildlife conservation

As a basis for evaluating the relative importance of the country's twelve principal forest reserves for species conservation, the following four groups of animals and plants were selected as 'indicator groups'.

- **forest trees** (427 species);
- **forest birds** (329 species);
- **diurnal forest primates** (12 species);
- **forest butterflies** (71 species) of the swallowtail family (Papilionidae), and the *Charaxes* genus of the Nymphalidae. (The 'black Charaxes' *(C. ethalion, C. etheocles, C. cedreatus, C. viridis and C. catachrous)* were excluded on account of the difficulty in distinguishing between these species.)

Each group includes species whose survival I consider to be closely linked to the existence of natural forest habitats. The distinction between these 'forest species' and 'non-forest species' of the same taxa (which I did not consider) is somewhat arbitrary, since many species are adapted to forest-edge habitats and survive quite well in heavily degraded forests. In my selection of 'forest species' I tended to include all forest and forest-edge species, excluding only those members of a particular group which obviously favour non-forest habitats. Initially, species lists were compiled from the literature for each group and each forest. The following publications were consulted:

- **for forest trees:** Eggeling (1947), Eggeling and Dale (1951), Forest Department (1955), Osmaston (1959a, 1959b, 1960), Leggat and Osmaston (1961), Hamilton (1969, 1974, 1981), Wing and Buss (1970), Synnott (1971, 1985), and Hamilton and Perrott (1981).
- **for forest birds:** Jackson and Sclater (1938), Van Someren and Van Someren (1949), Weekes (1949), Friedmann (1966), Williams (1967), Keith *et al.* (1969), Friedmann and Williams (1968, 1969, 1970a, 1970b, 1971, 1973), Hamel (1972, 1980), Britton (1980), Williams and Arlott (1980), Skorupa (1983), Butynski (1984a) and Carswell (1986).

- **for diurnal forest primates:** Kingdon (1971), Struhsaker (1981).
- **for butterflies:** Carcasson (1960), and Williams (1969).

In addition, species locality records were obtained from tree specimens held at Makerere University herbarium (which now includes the Forest Department collection), and butterfly specimens held at the National Museums of Kenya, the Kawanda Agricultural Research Station near Kampala, the British Museum of Natural History (Van Someren collection only), and in the private collections of Mr Steven Collins, (P.O. Box 14308, Nairobi) and Dr David Pasteur (Stoke Pound, Bromsgrove, England).

The preliminary species lists derived from these various scattered sources were supplemented with additional records made during the course of fieldwork conducted under this programme. Inventory activities were the primary focus of a volunteer programme which involved fourteen man-months of work in the seven least-known forests during 1987. In planning this exercise, sampling effort and study sites were selected so as to ensure as complete a listing of indicator species as possible from all forests, taking into account work done previously, by other workers or ourselves. Inevitably, however, certain groups of species and certain forests are better known than others, as indicated in Table 2.1. The primate lists, for example, are probably complete, whereas the butterfly fauna of several forests is still very imperfectly known.

Table 2.1 The extent of existing knowledge of the flora and fauna of Uganda's principal forest reserves. * denotes species lists (Appendices A-D) thought to record 40-70% of the total species likely to be found in a given forest, ** denotes lists which probably include 70-90% of a forest's total list, and *** denotes lists considered to be at least 90% complete. Estimates are based on personal experience of 'species accumulation rates' when conducting fieldwork in each forest.

	FOREST RESERVE											
Indicator Group	Kibale	Semliki	Budongo	Kalinzu/ Maramagambo	Bugoma	Bwindi (Impenetrable)	Kasyoha-Kitomi	Itwara	Sango Bay	Mabira	Mount Elgon	Rwenzori
Trees	**	*	**	**	*	*	**	*	***	**	**	*
Birds	***	***	**	***	**	***	*	*	***	***	**	**
Primates	***	***	***	***	***	***	***	***	***	***	***	***
Butterflies	***	***	***	**	***	***	*	*	***	**	***	*

The species lists were then used to derive a score for each forest representing its 'importance for species conservation'. The score was taken as the mean importance for plants and importance for animals, where the latter represents the mean of importance for primates, birds and butterflies. This method has previously been used by Mackinnon and Mackinnon (1986). The importance scores for each indicator group in each forest are derived by allocating each species a total value of one, to be divided by the number of forests in which the species occurs, and then adding all the individual species scores for each forest. The highest scoring forest is awarded a final score of 100, and the other forests are scaled down accordingly. The method thus takes into account both the richness of each forest, and the 'rarity value' of the species represented there.

2.2 Patterns of species distribution

The species lists were also used to identify groups of forests which support a similar flora and fauna, using a technique known as cluster analysis. This method generates data that can be represented visually (by means of 'dendrograms') to show 'clusters' of ecologically similar forests on different branches of a diagramatic 'tree'. Four separate analyses were carried out, one for each of the species indicator groups, using the Makerere University computer to execute the appropriate routines from a standard computer software package known as SPSS (Statistical Package for the Social Sciences). For the benefit of the scientifically-minded reader the details of this analysis are as follows:

1. Each of the species lists was transferred to the computer as input data, scoring species presence as 1, absence as 0.

2. Correlation coefficients (r) between each pair of forests were computed separately with respect to trees, birds, primates and butterflies.

3. The input data were used to perform an agglomerative hierarchical cluster analysis in which forests were clustered into progressively bigger groups starting with the most similar and finishing with the least similar. In forming clusters, the method of average linkage (between groups) was used, in which a correlation coefficient (r) between any two clusters was calculated on the basis of the total species list of each cluster, or group, of forests.

4. Dendrograms were produced, in which the correlation coefficients (r) between forests, or groups of forests were re-scaled to fall in the range of 1 to 25. Thus, in the case of the dendrogram relating to trees, a dissimilarity score of 1 corresponds to a correlation coefficient (r) between Kalinzu and Kasyoha-Kitomi forests of 0.57 (the two most similar forests), and a score of 25 corresponds to a correlation coefficient (r) of 0.01 between the two least similar clusters of forests.

2.3 Community-level work on tree species richness

Tree species-area relationships were examined in small plots (0.2-1.2 ha) at a total of 27 sites representing a variety of forest communities in eight forest reserves. Twenty of these were obtained along line transects used for censusing primates, whilst the remainder were plots established specifically for the purpose of examining tree species-area relationships. Vegetation sampling along primate census routes involved the identification, measurement and enumeration of all trees exceeding 10 cm diameter at breast height (dbh) in plots 20x20 m at 200 m intervals along transects 4-6 km in length. The transects were all located in areas considered to be homogeneous with respect to forest type, but, because most forests occupy undulating or hilly terrain, they often traversed catenary gradients and sampled the range of associated habitats. Most of the vegetation sampling along primate census routes was carried out by Alphonse Kisubi, although I worked with him on the first six transects. The other vegetation sampling plots were located in homogeneous areas of forest selected to avoid sampling across catenary gradients. Sampling was carried out within an area of 500x100 m by establishing a transect line 500 m in length and then enumerating all trees exceeding 10 cm dbh within 5 m of ten 50 m cords placed at right angles to the transect, and at 50 m intervals along it, alternately to the left and right (thus sampling a total of 0.5 ha).

2.4 Evaluation of the status of threatened species

Throughout the course of fieldwork carried out under this programme, data were collected opportunistically on the status of species which are considered internationally to be threatened with extinction. Such species are listed and described in the well-known Red Data Books of threatened species published by the World Conservation Union, IUCN. Records were made of direct sightings of threatened animals as well as indirect evidence of their occurrence such as spoor or reports from local people. Four of the country's threatened species are primates, two are other mammals, six are birds and two are butterflies (see Appendix R). The primates were given special consideration by Alphonse Kisubi, who conducted line transect censuses at 20 sites in six forests. The censusing method described by Struhsaker (1975) was used, with each 4-6 km transect traversed at about 1 km/h on 6-7 consecutive mornings.

3. Results and Discussion

3.1 Indicator species and their distributions in Uganda's forests

Species lists for Uganda's forest trees, forest birds, diurnal forest primates, and 'indicator' butterflies are included as Appendices A, B, C and D respectively. Table 2.2 shows the number of species of each of these groups so far recorded from the country's twelve principal forest reserves. Although these figures should be interpreted with caution on account of the incompleteness of some of the species lists, it is worth noting that with only one exception (butterflies in the Bwindi Forest), no forest is known to support more than two thirds of the country's species of any particular indicator group. On average, each forest is known to support 41% of the country's forest trees, 45% of its forest birds, 46% of its diurnal forest primates and 54% of its butterflies. This has obvious and far-reaching implications for the conservation of species because it means that it is quite impossible to preserve the country's full complement of species by protecting any single forest.

3.2 The relative importance of different forests for species conservation

Scores for the species conservation importance of different forests are presented in Table 2.3. Overall, the Bwindi (Impenetrable) and Semliki forests are shown by this analysis to be of outstanding importance, followed in second place by the Budongo, Kalinzu-Maramagambo and Kibale forests, and close behind them the Sango Bay and Mount Elgon forests. The low scores recorded for the Kasyoha-Kitomi and Rwenzori forests are probably the result of incomplete species lists from these forests, particularly for birds and butterflies in Kasyoha-Kitomi and for trees in Rwenzori (Table 2.1).

Table 2.2 The number of species belonging to four 'indicator groups' of flora and fauna, recorded from Uganda's twelve principal forest reserves. Full species lists are provided in Appendices A,B,C, and D.

	FOREST RESERVE												
INDICATOR GROUP	Max. possible No. of species	Kibale	Semliki	Budongo	Kalinzu-Maramagambo	Bugoma	Bwindi (Impenetrable)	Kasyoha-Kitomi	Itwara	Sango Bay	Mabira	Mount Elgoa	Rwenzori
Trees	427	209	168	240	242	158	163	204	143	170	202	112	75
Birds	329	177	216	159	181	144	214	104	87	119	151	144	89
Primates	12	8	8	5	6	6	7	6	6	6	2	2	4
Butterflies	71	45	51	42	40	42	57	21	25	45	39	36	15

Table 2.3 Scores for the importance of different forests for the conservation of bird, primate, butterfly and tree species. For method of derivation, see text.

	FOREST RESERVE											
INDICATOR GROUP	Kibale	Semliki	Budongo	Kalinzu/Maramagambo	Bugoma	Bwindi (Impenetrable)	Kasyoha-Kitomi	Itwara	Sango Bay	Mabira	Mount Elgon	Rwenzori
Birds	45	100	41	43	33	86	20	16	25	34	47	38
Primates	85	100	23	31	32	76	31	31	68	14	9	39
Butterflies	43	70	40	41	40	100	20	21	48	36	36	27
ANIMAL GROUPS AVERAGE SCORE	58	90	35	38	35	87	24	23	47	28	31	35
Trees	71	77	100	94	53	84	71	46	76	76	86	42
OVERALL SPECIES IMPORTANCE SCORE	64	83	67	66	44	85	47	34	61	52	58	38

This ranking replicates the intuitive priorities of Kingdon (1973) who wrote that 'the forests of the greatest significance are the Bwindi-Kayonza (formerly known as the Impenetrable), Semliki, Ruwenzori, Kibale and Malabigambo (Sango Bay) forests', and of Hamilton (1981, 1984) who wrote 'For species conservation it is particularly important to place nature reserves in the species-rich forests of the west, especially Bwindi-Kayonza (Impenetrable) and Bwamba (Semliki), but also Kalinzu, Kibale and Budongo'.

3.3 Relationships between forests

The dendrograms which illustrate the relationships between forests on the basis of their tree flora and bird, primate and butterfly fauna are shown in Fig. 2.1. The most similar of these relate to tree flora and bird fauna. In both these cases the separation into clusters of similar forests seems to reflect altitudinal differences, with the forests of 'high intermediate' altitudes (i.e. Kalinzu, Kasyoha, Kibale and Itwara) being clustered together and those of 'low intermediate' altitudes (i.e. Budongo, Bugoma and Mabira) being clustered together. The montane forests of Bwindi (Impenetrable), Mount Elgon and Rwenzori, and the low-lying Semliki forest are all quite distinct from one another and from other forests. The only significant difference in the dendrograms for trees and birds is in the placing of the Sango Bay forests which cluster with the 'low intermediate' altitude group on the basis of bird fauna, but stand alone on the basis of their tree flora. This is explained by the fact that Sango Bay's trees include a number of montane species considered indicative of a relict community, whereas its bird fauna includes no such anomalies (see Sango Bay forest profile, Appendix M).

The dendrogram for butterflies shows very much the same pattern, except that members of the 'high intermediate' altitude group have been scattered. In particular, Itwara and Kasyoha-Kitomi forests have been 'misplaced' because their butterfly faunas are so imperfectly known (only 50-60% of the butterfly species expected in these forests have so far been recorded). Otherwise the clusters are similar to those for birds and trees with a 'low intermediate' altitude group comprising Bugoma, Budongo, Mabira, Sango Bay (and Kibale), and with each of the montane forests (Impenetrable, Mount Elgon and Rwenzori) and the low-lying Semliki forest isolated as quite distinct from one another.

The dendrogram for primates again isolates the montane forests of Mount Elgon and Rwenzori, and the low-lying Semliki forest as quite distinct from one another and from other forests. However, in this case the Bwindi (Impenetrable) forest is grouped with those of 'high intermediate' altitudes (Kalinzu, Kasyoha and Itwara)), which are quite closely related to a sub-group of 'low intermediate' altitude forests (Budongo and Bugoma). Kibale forest is somewhat distinct on the basis of its primates, as are the Sango Bay forests and Mabira (Fig. 2.1).

In practical terms, this analysis provides us with some useful guidelines for establishing conservation priorities. In order to protect the full range of species represented in Uganda's forests we need to ensure the survival of forests representing each 'cluster' of similar forest wildlife communities. Thus, for sake of argument, if a political decision was taken to establish three forest nature reserves, the dendrograms show us that it would be inappropriate to locate them in the Mabira, Budongo and Bugoma forests, because these

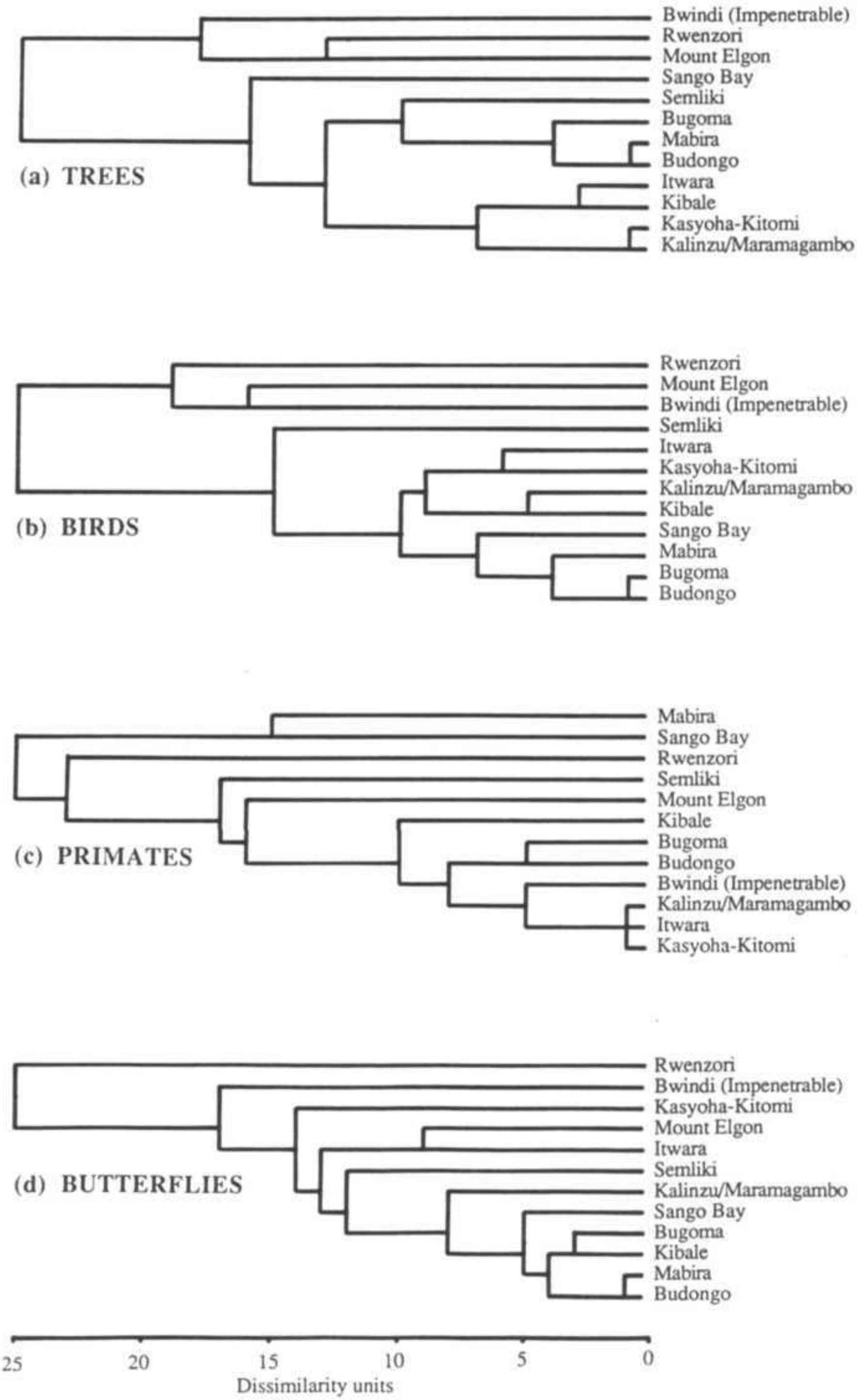


Fig. 2.1 Dcndrogams of relationships between different forests, based on their tree flora (top ofpage), bird fauna (below), primate fauna (below) and butterfly fauna (bottom ofpage). Forests that support similar communities of species are clustered on the same 'branch' of the dendrograms.

three forests belong to the same 'cluster', with similar wildlife communities. Similarly, if there were demands to exploit a particular forest, reference to that forest's position on the dendrograms would indicate the extent to which its wildlife communities were adequately represented elsewhere, so providing insight into the conservation implications of the proposed exploitation.

3.4 Community-level tree species richness

Twenty-seven tree enumeration plots were examined, and the resultant species-area curves are provided in the appropriate forest profiles (Appendices E-P). The number of tree species exceeding 10 cm dbh per hectare ranges from 11 to an estimated 67. For the sake of this discussion I have classified rich forest types as those with more than 50 species per hectare; medium-rich forest types as those with 30-50 species per hectare; and poor types as those with fewer than 30 tree species per hectare. Table 2.4 lists the various enumeration plots and their characteristics by this classification. Examination of this Table reveals that:

1. Most of the forests in which vegetation sampling was carried out include species-rich and species-poor communities.

2. The species-rich plots all represented swamp or mixed forest communities, some of which had been mechanically harvested, but not in the recent past.

3. The medium-rich plots were mostly those from single-species dominant communities, particularly *Parinari*-forest. They included most of the plots enumerated in forest that has been mechanically harvested in the past 20 years. They also included the only example of *Cynometra*-forest that had been harvested (37 years previously).

4. The species-poor plots were characteristic of *Cynometra*-forest, semi-deciduous forest, montane forest or single-species dominant communities. Four of the five poorest plots were from *Cynometra*-forest.

These results illustrate very clearly the great differences that are to be found between different communities, even within a single forest. These differences are of practical importance when deciding upon the siting of nature reserves, and will be discussed further in Chapter Four.

3.5 Some international comparisons

It is of interest in the context of establishing conservation priorities to compare the wildlife of Uganda's forests with that of forests elsewhere. This can be done most meaningfully by examining species richness, and levels of endemism in different areas of the world. Richness can be measured at a community level, in terms of the number of species of a selected group of organisms found within a relatively small homogeneous habitat (a measure known as alpha-diversity), or it can be measured over a wider area which may include a number of different habitats or communities (beta-diversity). In the context of this study, small plot tree enumeration data provide a useful basis for comparisons of alpha-diversity whilst species lists from different forest reserves are useful measures of beta-diversity. Some international comparisons follow.

Table 2.4 List of tree enumeration plots examined under this project and their characteristics. Data are for trees exceeding 10cm diameter at breast height (dbh), arranged in order of decreasing species-richness.

Category	Forest	Enumeration Code*	Plot size	No. of species	Estimated No. of Species/ha	Description of forest type
Rich	Kalinzu	D	0.80	63	67	Mixed forest, mechanically harvested 22-36 years previously
	Kasyoha-Kitomi	D	0.88	63	66	Mixed forest, lightly pitsawn
	Sango Bay	b	0.25	30	65-70	Swamp forest, mechanically harvested more than 35 years previously
	Budongo	1	1.00	64	64	Swamp forest, undisturbed
	Semliki	a	0.22	24	60-65	Mixed forest, undisturbed
	Bugoma	a	0.50	41	55-60	Mixed forest, undisturbed
	Sango Bay	a	0.45	39	55-60	Mixed, seasonally flooded forest, mechanically harvested more than 35 years previously
Medium-Rich	Kalinzu	A	1.00	49	49	*Paritiari*-forest, lightly pitsawn
	Budongo	2	1.00	49	49	Mixed forest, undisturbed
	Itwara	A	1.00	48	48	*Oleo*-dominated mixed forest, mechanically harvested 14 years previously
	Kalinzu	C	1.00	46	46	*Parinari*-forest lightly pitsawn
	Kasyoha-Kitomi	C	0.80	44	46	Mixed forest, lightly pitsawn
	Bugoma	b	0.50	36	43-47	*Cynometra*-forest, mechanically harvested 37 years previously
	Bwindi		0.80	43	45	Mixed lower montane forest, lightly pitsawn
	Kalinzu	a	0.50	33	40-45	*Parmari*-forest, lightly pitsawn
	Kibale	A	0.80	42	44	*Pterygota*-mixed forest, undisturbed
	Kibale	C	0.84	41	43	*Parinari*-forest, mechanically harvested 15 years previously
	Kalinzu	B	1.00	39	39	*Parinari*-forest, mechanically harvested 4-12 years previously
	Kibale	D	1.00	35	35	*Parinari*-forest, mechanically harvested 10 years previously
	Kibale	B	0.80	31	33	*Parinari*-forest, undisturbed
	Budongo	3	1.00	32	32	Colonising forest, undisturbed
Poor	Semliki	b	0.27	14	27-33	*Cynometra*-mixed forest, undisturbed
	Itwara	B	1.00	30	30	*Olea*-dominated mixed forest, undisturbed
	Kasyoha-Kitomi	B	1.16	33	30	Poor mixed, semi-deciduous forest, undisturbed
	Kasyoha-Kitomi	A	1.00	30	30	Poor mixed, semi-deciduous forest, undisturbed
	Kibale	E	1.20	29	28	*Parinari*-forest, mechanically harvested 18-20 years previously
	Maramagambo	E	1.04	27	27	*Cynometra*-foresl, undisturbed
	Maramagambo	F	1.04	27	27	*Cynometra*-forest, undisturbed
	Bwindi		1.00	20	20	Montane mixed forest, undisturbed
	Budongo	4	1.00	17	17	*Cynometra*-forest, undisturbed
	Semliki	A	1.10	11	11	*Cynometra*-forest, undisturbed

Note: * Enumeration codes are those used in Appendices E-P, where individual species-area curves and study plot locations are shown. Upper case letters denote enumerations along primate census routes, lower case letters denote other vegetation plots enumerated under this programme and figures denote enumerations reported by Eggeling (1947).

Species-area relationships for trees exceeding 10 cm dbh have been examined at a number of sites throughout the tropics. Table 2.5 summarises a selection of these data, from which it can be seen that Uganda's forests are relatively poor. The richest Ugandan sites support about a quarter as many tree species per unit area as the world's richest sites (in Amazonian Peru; Gentry, in press), and about half as many as the richest African sites (in the Korup Forest, Cameroon; Gartlan, 1987): This is not surprising since all of Uganda's forests exist at the lower limit of annual precipitation (1,200-1,500 mm) necessary to maintain forest vegetation (Richards, 1952), and there is a strong positive correlation between precipitation and community-level plant species richness (Gentry, 1982). In the neotropical lowlands richness is greatest in areas receiving at least 4,000 mm of rainfall (Gentry, in press), more than twice that of the wettest parts of Uganda.

This study has shown that Uganda's forest reserves individually support up to 242 species of forest tree, 216 species of forest bird, 8 species of diurnal forest primate and 57 species of swallowtail and *Charaxes* butterfly (Table 2.2; see Appendices A, B, C, D for full lists). Some comparative data from reserves elsewhere in Africa are available for bird and primate fauna and tree flora (see below), but none are available for butterflies.

The forest avifauna of West Africa has recently been reviewed by Thiollay (1985), and that of the Albertine Rift forests by Prigogine (1985). Further useful comparative data are provided from the forests of East Africa by Stuart (1981). The most diverse forest bird faunas appear to be those of West Africa where, for example, 233 species have been recorded from the 3,300 km^2 Tai National Park, Ivory Coast; 250 species from the Makokou-Belinga area of NE Gabon (Thiollay, 1985); and about 186 from the 1,200 km^2 Korup forest in Cameroon (Gartlan, 1987). This compares with figures of only 45-98 forest species from seven isolated forests near the East African coast (Stuart, 1981).

Table 2.5 Some international comparisons of tree species richness for trees exceeding 10cm dbh in small enumeration plots.

Region	Site		No. of tree species/ha	Source
Africa	Uganda:	- various (27 sites)	11-70	This study (Table 2.4)
	Nigeria	- mixed forest (2 sites)	38,59	Richards, 1939
		- swamp forest (1 site)	34	Richards, 1939
		- Usonigbe F.R. (1 site)	c. 73	Baur, cited by Hall & Swaine, 1981
	Sierra Leone	- mixed forest (6 sites)	53-76	Davies, 1987
	Ghana	- Kade (1 site)	c. 85	Hall and Swaine, 1981
	Mauritius	- upper climax forest (135 sites)	52	Vaunga and Wiehe, 1941
	Cameroon	- Korup forest	75 per 0.64ha	Gartlan, 1987 (mean value)
			101 per 0.64ha	(richest site)
SE Asia	Sarawak	(7 sites)	73-223	Whitmore and Sidiyasa, 1986
	Papua New Guinea	(4 sites)	120-150/0.8ha	Cited by Whitmore, 1975
	Malaya	(1 site)	c. 120	Cited by Whitmore, 1975
America	Costa Rica	- Corcovado (1 site)	110	Cited by Whitmore, 1984
	Brazil	(2 sites)	65,80	Cited by Whitmore, 1984
	Peru	- Amazonian forest (6 sites)	155-283	Gentry, submitted
	Suriname	(2 sites)	116, 120	Schultz, 1960, cited by Gentry, 1982

There are a number of problems in comparing these figures, mainly because different workers adopt slightly different criteria in their definitions of what constitutes a forest species. Nevertheless, it appears that Uganda's forests are amongst the richest areas on the continent for forest birds. They are also important for the conservation of species restricted to the Albertine Rift area, being home to 25 (69%) of the 36 endemic species listed by Prigogine (1985). About 7.6% of Uganda's forest bird species are Albertine Rift endemics.

As with birds, the continent's richest forests for primate species are in West Africa, where it is not uncommon to find 7-10 sympatric monkey species together with 1-2 apes and 2-5 prosimians (Oates, 1985). Such species assemblages are typical of the forests of the Upper and Lower Guinea area, including reserves such as the Tai National Park in Ivory Coast (12 diurnal forest species), Outamba-Kilimi National Park in Sierra Leone (12 diurnal forest species) and the Douala-Edea and Dja reserves in Cameroon (each with 14 diurnal forest species; Mackinnon and Mackinnon, 1986). By comparison, Uganda's forests are rather poorer (the best forests, Semliki and Kibale, supporting 8 diurnal forest species), but important as home to a number of highly localised subspecies (Oates, 1985). In an East African context, the forests of western Uganda are exceptionally rich, since very few sites elsewhere in the region support more than three diurnal forest species (Kingdon, 1971). None of Uganda's primates are endemic species although one *(Cercopithecus l'hoesti)* occurs only on Mount Cameroon and Bioko Island outside the Albertine Rift area.

Comparative data for tree species diversity within African protected areas comes from the Korup forest of Cameroon (Gartlan, 1987), the Gola forests of Sierra Leone (IUCN, 1987), and the forests of the Usambara mountains of eastern Tanzania (IUCN, 1987), in which about 400, at least 180, and 276 tree species respectively, have been recorded. Assuming that many of the tree lists for Uganda's principal forests are now 70-90% complete (Table 2.1), the richest of these areas probably supports 270-340 tree species, substantially fewer than Korup forest, but rather more than recorded at either of the other sites for which comparative data are available. Levels of tree species endemism are low: the total flora of Uganda probably includes about 5,000 species, of which only an estimated 30 (0.6%) are endemic (Davis *et al.*, 1986). Few, if any, of these are trees, a situation very different from neighbouring Tanzania, where 79 (18%) of the country's 433 tree species are probably endemic (Lovett, 1985).

3.6 Status of threatened species

Fourteen of Uganda's forest animals are considered by IUCN to be globally threatened with extinction, and are listed in the Red Data Books. These include four primates, two other mammals, six species of bird and two swallowtail butterflies. The information available on each of these species is reviewed in Appendix R. The most seriously threatened animal is the mountain gorilla, which is considered by IUCN to be 'endangered', meaning that it is unlikely to survive unless the factors causing its decline can be brought under control. Six species are described as 'vulnerable', a status category used to denote animals that could soon become 'endangered' if the factors threatening them continue operating; these are the chimpanzee, l'hoest's monkey, elephant, leopard, Grauer's rush warbler and the cream-banded swallowtail butterfly. Four birds (Nahan's francolin, African green broadbill, Chapin's flycatcher and Forest ground thrush) and a butterfly (the African giant swallowtail) are classified as 'rare', meaning that they have small world populations and are at risk of becoming 'endangered'. The Uganda red colobus monkey and the Kibale ground thrush are categorised as 'indeterminate' because they are considered to be either 'endangered', 'vulnerable' or 'rare', but not enough information is available about them to say which of these categories is most appropriate.

Table 2.6 The occurrence of threatened animals in the twelve principal forest reserves.

	FOREST RESERVE											
Threatened Species	Kibale	Semliki	Budongo	Kalinzu-Maramagambo	Bugoma	Bwindi (Impenetrable)	Kasyoha-Kitomi	Itwara	Sango Bay	Mabira	Mount Elgon	Rwenzori
Mountain gorilla	-	-	-	-	-	+	-	-	-	-	-	-
Chimpanzee	+	+	+	+	+	+	+	+	-	-	-	+
L'Hoest's monkey	+	-	-	+	-	+	+	+	-	-	-	+
Red colobus	+	-	-	-	-	-	-	-	-	-	-	-
Elephant	+	+	+	+	+	+	+	+	+	-	+	+
Leopard	+	?	+	+	?	?	?	?	?	+	+	+
Nahan's francolin	+	+	+	-	+	-	-	-	-	+	-	-
African green broadbill	-	-	-	-	-	+	-	-	-	-	-	-
Grauer's rush warbler	-	-	-	-	-	+	-	-	-	-	-	-
Chapin's flycatcher	-	-	-	-	-	+	-	-	-	-	-	-
Kibale ground thrush	+	-	-	-	-	-	-	-	-	-	-	-
Forest ground thrush	-	+	-	-	-	-	-	-	-	-	-	-
African giant swallowtail	+	+	+	+	-	+	+	-	-	-	-	-
Cream-banded swallowtail	-	-	-	-	-	+	-	-	-	-	-	-
TOTAL NO. SPECIES	8	5	5	5	3	9	4	3	1	2	2	4

+ denotes species present
- denotes species not yet recorded and probably absent
? denotes species not yet recorded but possibly present

Table 2.6 shows the distribution of these threatened species in Uganda's twelve principal forest reserves. The two most important forests for the conservation of these are the Bwindi (Impenetrable) forest (which supports nine threatened species) and the Kibale forest (which supports eight threatened species). Three forests (Semliki, Budongo and Kalinzu/Maramagambo) support at least five threatened species, while seven support four or less (Table 2.6).

The results of primate censuses are provided in the 'profiles' of the Kibale, Semliki, Kalinzu/Maramagambo, Bwindi (Impenetrable), Kasyoha-Kitomi and Itwara forests (Appendices E, F, H, J, K, and L respectively). Data are presented to show the mean (± SE) number of groups of primates of each species seen per kilometre of census route; and to enable comparisons between forests; an estimated census strip width (based on observed sighting distances along each route) is used to calculate a population density estimate for each species in each area. These results may be useful as indices of abundance for between-forest comparisons, but as real density estimates they are too high, possibly by a factor of two (for a discussion of this see Appendix Q; Skorupa, 1987 and Struhsaker, 1975).

Table 2.7 provides a summary of these primate census data (after Kisubi, in prep.). They suggest that different forests, and even different areas within the same forest, support very different primate densities. In terms of the total number of primate social groups, the highest densities are recorded in the Kibale, Kalinzu/Maramagambo and Kasyoha-Kitomi forests (all intermediate-altitude forests), whilst the lowest are found in the high altitude parts of the Bwindi (Impenetrable) forest and the Itwara forest (a high-intermediate altitude forest). In terms of biomass densities, it is likely that some areas of the Kibale forest support significantly more primates than any of the other forests in which censuses were carried out, because of the large numbers of red colobus social groups each of which includes a large number of individual animals (Struhsaker and Leland, 1979).

4. Chapter Summary

1. Four indicator groups of plants and animals (forest trees, birds, diurnal primates, and selected butterflies) are used to compare the importance of the country's principal forest reserves for species conservation, on the basis of the number and rarity of the species which occur in each forest. Species lists were compiled from the literature and supplemented with records made during the course of fieldwork on this programme. The forests support very different wildlife communities, and (with one exception) no single forest is known to harbour more than two-thirds of the country's species of any particular group. The analysis suggests that the Bwindi (Impenetrable) and Semliki forests are of greatest importance for species conservation, followed by the Budongo, Kalinzu-Maramagambo and Kibale forests.

2. The degree of similarity in the flora and fauna of different forests is examined by means of cluster analysis. It is shown that, in general, the forests of high intermediate altitudes (i.e. Kalinzu, Kasyoha-Kitomi, Kibale and Itwara) support similar communities of species as each other, as do those of low intermediate altitudes (i.e. Budongo, Bugoma and Mabira). The montane forests of Bwindi (Impenetrable),

Mount Elgon, and Rwenzori, and the low-lying Semliki forest are shown to be quite distinctive in terms of the flora and fauna they support.

Table 2.7 Estimated primate population densities (number of social groups/km2), calculated from line transect census data from six forests in western Uganda. Full data are provided in Appendices E,F,H,J,K and L; after Kisubi, in prep. Extreme caution is necessary in the interpretation of these data: for discussion see Appendix Q.

		PRIMATE SPECIES							
FOREST	TRANSECT (for location see Appendices)	Black & white colobus	Red colobus	Mangabey	Baboon	Redtail	L'hoest's	Blue	TOTAL NO. PRIMATE SOCIAL GROUPS/KM2
Kibale	A	1.0	4.5	5.7	3.0	11.2	1.0	1.0	27.4
	B	1.3	11.5	1.1	0.1	6.6	0.0	3.9	24.5
	C	7.1	7.8	1.7	0.0	7.8	0.7	3.1	28.2
	D	4.8	4.6	0.2	0.4	2.8	0.0	2.2	15.0
	E	7.2	4.1	0.2	0.0	5.1	0.0	2.7	19.3
Semliki	A	1.6	0.0	3.8	0.0	4.3	0.0	0.5	10.2
Kalinzu/ Maramagambo	A	2.3	0.0	0.0	0.0	1.2	0.7	4.5	8.7
	B	3.3	0.0	0.0	0.0	4.1	0.9	5.3	13.6
	C	2.7	0.0	0.0	0.3	1.0	0.7	4.7	8.4
	D	2.3	0.0	0.0	0.8	6.8	2.7	2.9	15.5
	E	3.8	0.0	0.0	0.5	4.3	0.5	0.0	9.1
	F	11.8	0.0	0.0	3.8	5.7	1.5	5.7	28.5
Bwindi Impenetrable	A	0.0	0.0	0.0	0.0	0.0	0.4	1.5	1.9
	B		0.0	0.0	0.0	0.0		1.7	
Kasyoha-Kitomi	A	11.0	0.0	0.0	1.0	11.8	0.0	0.5	24.3
	B	18.5	0.0	0.0	1.2	13.5	0.0	0.5	33.7
	C	7.0	0.0	0.0	0.0	6.5	0.7	1.8	16.0
	D	5.5	0.0	0.0	0.0	13.0	0.0	4.8	23.3
Itwara	A	0.3	0.0	0.0	0.5	1.3	0.0	0.8	2.9
	B	0.0	0.0	0.0	0.5	1.2	0.0	1.7	3.4

3. Trees exceeding 10 cm diameter at breast height (dbh) were enumerated at 27 sites in eight reserves, and species-area relationships examined. The number of tree species per hectare varies widely between sites, the richest communities being those of swamps and mixed evergreen forest (with up to 67 species), and the poorest being those of ironwood forest (with as few as 11 species per hectare). The richest of Uganda's forests examined so far supports about a quarter as many tree species per unit area as the world's richest sites, and about half as many as the richest known African sites.

4. In an East African context, Uganda's forests are exceptionally rich in species, although the limited data available from elsewhere on the continent suggest that the forests of West and Central Africa are even richer. Uganda's forests are internationally important as home to 69% of the birds that are restricted to the Albertine Rift area of Africa; as home to several distinctive subspecies of primate, and to 14 species of animal considered to be under global threat of extinction.

Chapter Three: Forest Management and its Impact on Wildlife

1. Introduction

The purpose of this chapter is to review the ways in which Uganda's forest resources have been used over the past few decades, and the impact of man's activities on the forests as functioning ecosystems. This information can then be used to examine whether existing management systems achieve conservation objectives, where conservation is understood as 'the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations' (IUCN, 1980).

The chapter is divided into three main sections. The first provides an evaluation of the extent to which Uganda's twelve principal forest reserves have been subjected to timber harvesting activities and agricultural encroachment. The second section examines the ways in which Uganda's forest resources are harvested and managed, describing the methods used, the controls imposed, and the problems encountered. The final section then looks at the effects of these forest management activities on wildlife communities.

2. Present status of the principal reserves

Four methods were used to evaluate the present status of the country's twelve principal forest reserves:

- **Aerial surveys.** A light aircraft was used to overfly the Mabira, Bwindi (Impenetrable), Maramagambo, Rwenzori and Semliki forest reserves at low altitude and slow speed, looking for obvious signs of agricultural encroachment, settlement and timber harvesting activities.

- **Ground surveys.** All of the reserves were visited and surveyed on foot from tented camps. In conducting these surveys, I followed existing footpaths, or took compass bearings through areas where no paths existed, so as to cover each forest as thoroughly as possible. In some cases, I passed within 1 km of most points in a reserve (e.g. the surveys of Itwara and Kalinzu), whereas in others it was impractical to do more than follow a survey route network designed to pass within 5 km of all points (for survey route maps of each forest see Appendices E - P). Typically, the ground survey of one of the larger forests would involve several weeks' work, and include a series of all-day excursions from several strategically located base camps, followed by some longer overnight trips into the more remote areas. During ground survey walks I recorded signs of human activity, including timber harvesting, agricultural encroachment, and hunting, as well as evidence of wildlife.

- **Reference to Forest Department records.** Forest Department records were used as a source of information regarding legitimate timber harvesting activities in several forests.

- **Reference to the work of others.** Wherever recent ground surveys of particular forests have been undertaken by others I have relied heavily on their information in compiling this report (for example, Van Orsdol's (1983a) survey of Kibale; Butynski's (1984a) survey of the Bwindi (Impenetrable); and Kramer/Holmes' (in prep., a) survey of Mabira).

The information gathered by these four methods is presented in the series of Forest Profiles appended to this report (Appendices E-P). Maps are included to show the ground survey routes followed in each case, and the locations of human activities recorded during the surveys. This basic information has been used to derive a map of each forest which shows, as accurately as possible, the areas which have been affected by various human activities. Seven status categories are used:

- **severely encroached:** areas in which more than 31% of the land is presently under cultivation or has been cultivated at some time within the past ten years.

- **lightly encroached:** areas in which 4-30% of the land is presently under cultivation or has been cultivated at some time within the past ten years.

- **intensively pitsawn:** areas where more than 70% of prime timber trees above the specified minimum harvestable size have been cut *in situ* by pitsawyers.

- **selectively pitsawn:** areas where 6-70% of prime timber trees above the specified minimum harvestable size have been cut *in situ* by pitsawyers.

- **mechanically harvested post-1950:** areas that have been harvested by means of heavy machinery, the logs being skidded out of the tree-felling locations and transported whole to a sawmill for processing. Areas felled since 1950 (harvesting intensity not considered).

- **mechanically harvested pre-1950:** as above, but felled before 1950 and now in an advanced state of regeneration (except where re-cut in Budongo).

- **essentially undisturbed:** areas that have never been mechanically harvested; where pitsawing, if evident, affects at most 5% of prime timber trees of harvestable size; and where no more than 3% of the land is (or was in the past ten years) under cultivation. Note that although the forest vegetation in this category is essentially unaffected by recent human activity, no distinction is made between areas that support undisturbed animal populations, and those that do not.

A summary of the status of all twelve forests is provided in Table 3.1 and Fig. 3.1. Overall, about 53% of the forested land within these reserves remains essentially undisturbed. There are only five reserves (probably six) in which more than 100 km^2 of forest remains relatively unaffected by timber harvesting, agricultural encroachment, or both. Two of these are montane forests - the Mount Elgon reserve, where an estimated 340 km^2 of forest remains essentially intact; and the Rwenzori reserve, where approximately 230 km^2 of undisturbed forest remains. The other three (probably four) are intermediate altitude forests: the Kalinzu/Maramagambo reserve (450 km^2 of undisturbed forest remaining), the Kasyoha-Kitomi reserve (260km^2 remaining), the Bugoma reserve(210km^2)

Table 3.1 Areas (km2) of the country's twelve principal forest reserves that have been affected by various types and degrees of human disturbance. Only the forested portions of reserves are considered here.

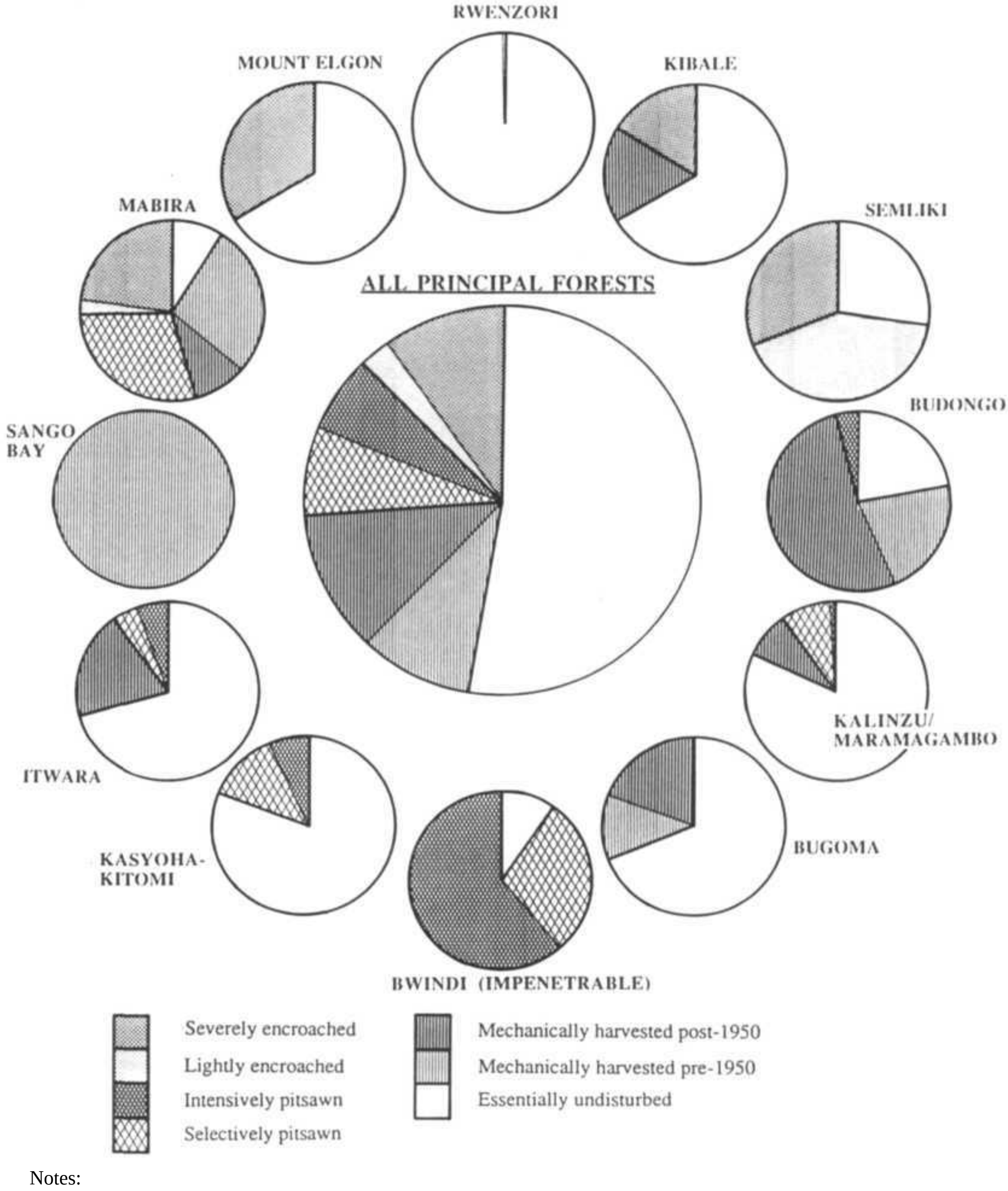
	FOREST RESERVE												
Type of Disturbance	Kibale	Semliki	Budongo	Kalinzu-Maramagagambo	Bugoma	Bwindi (Impenetrable)	Kasyoha-Kitomi	Itwara	Sango Bay	Mabira	Mount Elgon	Rwenzori	TOTAL
Mechanically harvested pre-1950	0	0	90	0	35	0	0	0	151	84	0	0	360
Mechanically harvested post-1950	74	0	223	47	58	0	0	13	0	29	0	0	444
Intensively pitsawn (> 20% of trees exceeding 50 cm dbh exploited)	?	0	16	4	0	197	24	4	0	0	0	0	245
Selectively pitsawn (5-20% of trees exceeding 50 cm dbh exploited)	?	0	0	50	0	93	40	3	0	88	0	0	274
Severely encroached (> 30% canopy cover removed)	70	65	0	0	0	0	0	0	0	71	175	0	381
Lightly encroached (5-30% canopy cover removed)	0	87	0	0	0	0	0	0	0	8	0	1	96
Essentially undisturbed	288	57	95	452	207	31	264	48	0	26	340	234	2042
TOTAL (Forested portion only)	432	209	424	553	300	321	328	68	151	306	515	235	3842

remaining), and, probably, the Kibale reserve (which is known to have 290 km^2 unaffected by encroachment or mechanised harvesting, but a large part of this is thought to be affected by pitsawing). Five of the country's principal reserves have been heavily utilized, with at least 70% of their forested area affected by timber harvesting operations, agricultural encroachment, or both: these are the Semliki, Budongo,Bwindi (Impenetrable), Sango Bay and Mabira reserves (Table 3.1; Fig. 3.1).

Mechanized timber harvesting has affected about 21% of the total forest area contained within these reserves. Prior to 1950, felling operations were restricted to the Sango Bay, Mabira, Budongo and Bugoma reserves, but sawmills were later installed in the Kibale, Kalinzu and Itwara forests, and significant areas of these forests have now been harvested. In the last 38 years, almost half the forest area harvested by mechanized methods has been in the Budongo forest. Mabira has also been extensively harvested although here much of the utilized forest has later been encroached, and appears as 'encroached forest' in Table 3.1. Extensive areas of the Kibale, Kalinzu and Bugoma forests have also been mechanically harvested since 1950 (Table 3.1; Fig. 3.1).

Approximately 14% of the forested land within the principal reserves has been exploited by pitsawyers, more than half of that area being in the Bwindi (Impenetrable) forest. There has been widespread pitsawing activity in Kibale (J. Kasenene, pers. comm.), although no survey data are available here; and large areas of the Kalinzu, Kasyoha-Kitomi and Mabira forests have been exploited by pitsawyers, especially in the last ten years.

Four of the principal reserves have suffered from serious agricultural encroachment during the past fifteen years. Altogether about 12% of the forested land is affected by encroachment, including 73% of the Semliki forest, 34% of the Mount Elgon forest, 26%



Notes:

1. Much of the undisturbed forest occupies sleep, mountainous terrain that is unsuitable for timber harvesting.
2. Pitsawing activity was not assessed in the Kibale and Budongo forests, but is thought to be widespread, at least in Kibale (J. Kasenene. pers. comm.).

Fig. 3.1 *Status of Uganda's twelve principal Forest Reserves* of Mabira, and 16% of Kibale. Fortunately, the other eight principal reserves have suffered little or no encroachment (Table 3.1; Fig. 3.1).

3. Forest resource utilization

The purpose of this section is to review the variety of ways in which Uganda's forests are used. Earlier, I showed that large areas of forest reserve land have been felled to provide timber, or cleared to make way for agriculture, so it is my intention here to describe the methods used in carrying out these activities, and the justification or reasons for them. In addition to timber harvesting and the conversion of forest land to agricultural use, forests are widely used by hunters as a source of wild animal meat, and by local people as a source of many other minor forest products. These forms of resource use are reviewed before discussing their impact on wildlife communities in the final section of this chapter.

3.1 Timber harvesting

One of the primary functions of the natural high forest reserves has been to satisfy the country's domestic wood requirements, and most of them have been used for this purpose. By the early 1970s, sawmills had been established in most of the principal reserves, and others, considered too inaccessible or steep for mechanized felling, were harvested by pitsawyers.

Up until the early 1970s, timber extraction from the natural forest was relatively well organised and controlled by the Forest Department. Forest areas were divided into management compartments, each of which was harvested in an orderly manner. No felling was allowed in any area prior to systematic stock mapping by Forest Department staff, and only trees marked for felling could be cut. Minimum girth limits were enforced. After cutting a tree, a concessionaire or pitsawyer was not allowed to remove any timber before Forest Department staff had marked it and the tree stump, and assessed the royalties payable.

The quantity of roundwood extracted from the natural forest for sawn timber rose steadily throughout the period to 1970, and was projected to increase to 460,000 m^3 by 1990 (Fig. 3.2). However, the political upheavals which overtook Uganda in the early 1970s brought about a period of severe economic decline which affected the forestry sector as badly as any. Most of the sawmills were Asian owned, and when Idi Amin expelled all Asians in 1972 the management of the mills was brought under the Forest Department, and later transferred to a new parastatal body, the Wood Industries Corporation (WICO). For a number of reasons, this body failed to keep the mills running, and by 1980 only two of the original 21 sawmills it took over were operating at anything like full capacity (Hamilton, 1984). The result was a rapid decline in recorded roundwood consumption, which fell by more than two thirds between 1970 and 1977 (Fig. 3.2). Thus this period of rapid economic decline resulted in a slow-down in the rate at which undisturbed natural high forest was being affected by the sawmilling industry. Whether or not actual roundwood consumption declined over this period is, however, questionable since much of it may have gone unrecorded, the result of illegal pitsawing activity. Certainly, the number of pitsawyers has risen sharply in recent years and by 1986, 500 were registered and a further 2,500 thought to be operating illegally in the forest reserves (World Bank, 1986). As a

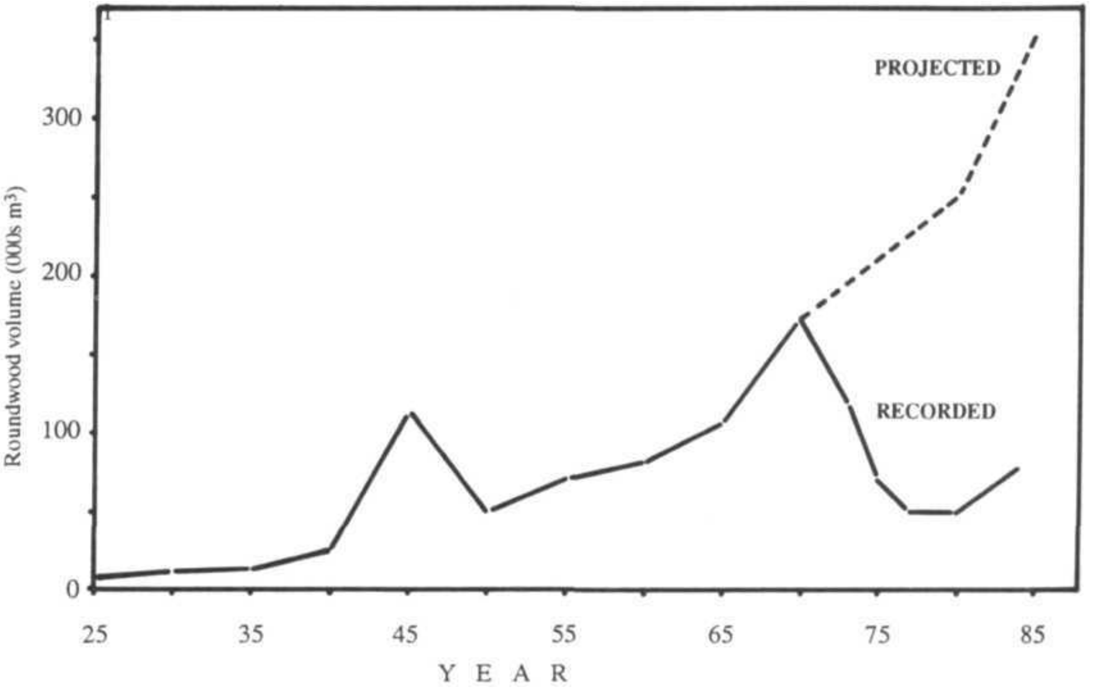


Fig. 3.2 *The recorded (and projected) use of roundwood from the natural forest by the sawmilling industry from 1925 to present. Records of past use are taken from Atlas of Uganda, 1967, and Forest Department, 1980. 1985. Projections of demand are based on those of Lockwood Consultants, 1973, assuming a 40% conversion of roundwood to sawn-timber.*

consequence of this shift in timber harvesting practice from sawmillers to pitsawyers, harvesting is now more species-specific than it was previously.

Mechanical harvesting methods

Approximately 21% of the forest within the principal reserves has been mechanically harvested (Table 3.1), a little over half of it since 1950. In the early years to the mid 1950s, a polycyclic felling system was used, designed to create a two-tier or three-tier multi-aged forest from which trees exceeding a specified minimum girth were harvested about every 30 years, on a 60-90 year rotation. This system was favoured at the time because it interfered relatively little with the natural state of the forest, and was relatively inexpensive because each subsequent crop was provided by natural regeneration rather than enrichment planting.

However, in the mid 1950s, this system was replaced by a monocyclic, uniform one involving as complete a felling as possible with a lower limit on the size of trees cut (usually 30-50 dbh depending on the species; Dawkins, 1958). A rotation of 60-80 years was envisaged. The monocyclic system came into favour because it overcame some of the perceived disadvantages of the polycyclic one, namely:

- in the polycyclic system only relatively slow-growing shade-tolerant trees are able to regenerate, because the forest canopy is insufficiently opened up by harvesting operations to encourage the faster growing (light-demanding) colonising species. Thus the polycyclic system is thought to be relatively unproductive of useful timber.

- in the polycyclic system, each harvesting operation is associated with serious damage to a large proportion of the younger stock so that, after several felling cycles, the net harvest becomes unacceptably low.

- the volume of timber cut per unit area at each felling cycle in a polycylic system is often too small to make mechanized harvesting operations economic.

- the polycyclic system was thought to require greater expertise and manpower to achieve effective management.

- harvesting under a polycyclic system inevitably removes the larger and faster growing trees causing a deterioration in productivity, and ultimately in the genetic composition of the forest.

Although the monocyclic system was adopted in the mid 1950s there has been very little subsequent effort to determine whether its perceived advantages have actually been realised. However, there is some evidence that (i) regeneration in some areas has not been as good as expected (Wood, 1978); and (ii) the system has a far more deleterious impact on wildlife communities and ecological processes than a polycyclic one (Struhsaker, 1975; 1987).

In order to ensure adequate regeneration after timber harvesting, and a satisfactory subsequent crop, various silvicultural operations have been applied in the felled areas. These are aimed at removing unwanted trees that would otherwise over-shadow the desirable seedlings and inhibit their growth, and ensuring that the young desirable trees are not smothered by climbers and herbaceous growth. The post-harvest silvicultural treatments applied in Uganda have evolved over the years as a result of experience, and changes in forest management policy, as well as social and economic conditions. The four main ones are listed below, in chronological order.

- **Enrichment planting.** This technique, which involves planting nursery-grown seedlings of commercially important trees in the gaps created by timber harvesting operations, was widely used until the mid-1950s. After planting, the seedlings generally need to be weeded several times until they are large enough to overcome the smothering effects of herbaceous plants. Another of the problems associated with this technique was that some of the tree species used had very limited habitat tolerance (J. Kasenene, pers. comtn.).

- **Arboricide treatment.** This technique involves poisoning unwanted trees in order to open up the canopy and stimulate the growth of young commercially important seedlings and adolescents. It was applied over wide areas of Uganda's forests between 1956 and the mid-1970s. There was a lower limit on the size of trees poisoned (50 cm in the case of *Cynometra*, but as little as 10 cm for certain others). The poisoned trees are left standing, and gradually die, rot and fall.

- **Charcoal refinement.** This technique involves felling unwanted trees and converting the wood, together with the lops and tops of trees that are cut for timber, into charcoal. This opens the canopy considerably, stimulating the growth of the desirable seedlings and adolescent trees that are left at the time of felling, and others that are planted shortly afterwards. This system was developed in the 1960s (Earl, 1968).

Unassisted regeneration. Over the past fifteen years or so, no post-harvest silvicultural operations have been applied in most areas, and the forest has been simply abandoned. As a result, some areas that have been heavily logged over this period are now characterised by a low tangle of herbaceous vegetation, limiting regeneration severely (Wood, 1978).

In summary, mechanized timber harvesting is presently carried out without any systematic prior evaluation of timber stocking or regeneration potential; it is carried out on the basis of a monocyclic system in which all commercially valuable trees are felled, subject to a lower girth limit; and post-harvest silvicultural operations are rarely applied, so potential regeneration is often smothered by herbaceous growth. By 1978 it was estimated that at least 20,000 ha of mechanically harvested forest was in need of silvicultural treatment before it could be regarded as usefully productive (Wood, 1978), a figure which has increased since.

Manual (pitsawing) methods

Pitsawing was recorded in all but two of the forest reserves covered by this programme, and is the main timber extraction method in many areas, including all the less accessible reserves. It is thought likely that about 3,000 pitsawyers are operating at present (World Bank, 1986), a figure considerably higher than at any time in the past.

Pitsawing is extremely labour intensive. A tree is felled by hand and cross-cut into lengths that are rolled onto a platform made of poles cut nearby. The log is then cut length-wise into boards using a long cross-cut saw that is pulled by two men, one standing above the log, and one below. The boards are then head-loaded by porters out of the forest.

Each pitsawyer is required to register with the Forest Department and may only cut a tree once it has been allocated to him. Different minimum girth limits apply to each species, as do the royalties payable. Regulations require that tree stumps and boards be stamped by a Forest Department staff member with the sawyers registered letter die before they can be removed from the forest.

Unfortunately, these regulations are not adhered to at present. Most of the forestry staff who are charged with the control of pitsawing lack the letter dies necessary to mark legitimate timber and distinguish it from that which is felled illegally. This leaves the system open to abuse. I have come across widespread evidence of direct involvement of forestry staff in pitsawing activity, and it seems very likely that much of the royalties payable to government are never officially receipted or declared. As Fig. 3.3 illustrates many trees are cut below the minimum permissible size. In Kasyoha-Kitomi forest 57% of the stumps I measured were from trees cut undersize. Similar discrepancies were found in other reserves, for example Itwara, where 48% of trees were cut undersize, and Kalinzu, where 57% were undersize (unpublished data).

Pitsawing has a number of possible advantages over mechanized timber harvesting methods, which include:

- it provides more rural employment, and local benefits to communities living in the vicinity of forest lands, than does mechanized harvesting;

- it is much less damaging environmentally than mechanized harvesting methods, because it avoids the problems associated with the introduction of heavy machinery into the forest, and creates forest gaps which are similar to those that arise from natural tree-falls (Struhsaker, 1987);

- it requires very little capital investment and provides a very high benefit to cost ratio compared with mechanised harvesting operations;

- it enables trees that are inaccessible to mechanized harvesting operations to be harvested;

- it enables forest that is otherwise 'uneconomic' to be utilised, and provides a more ecologically acceptable way of harvesting forest areas that would have to be virtually clear-felled in order to provide the sort of cash returns necessary to justify capital-intensive harvesting methods.

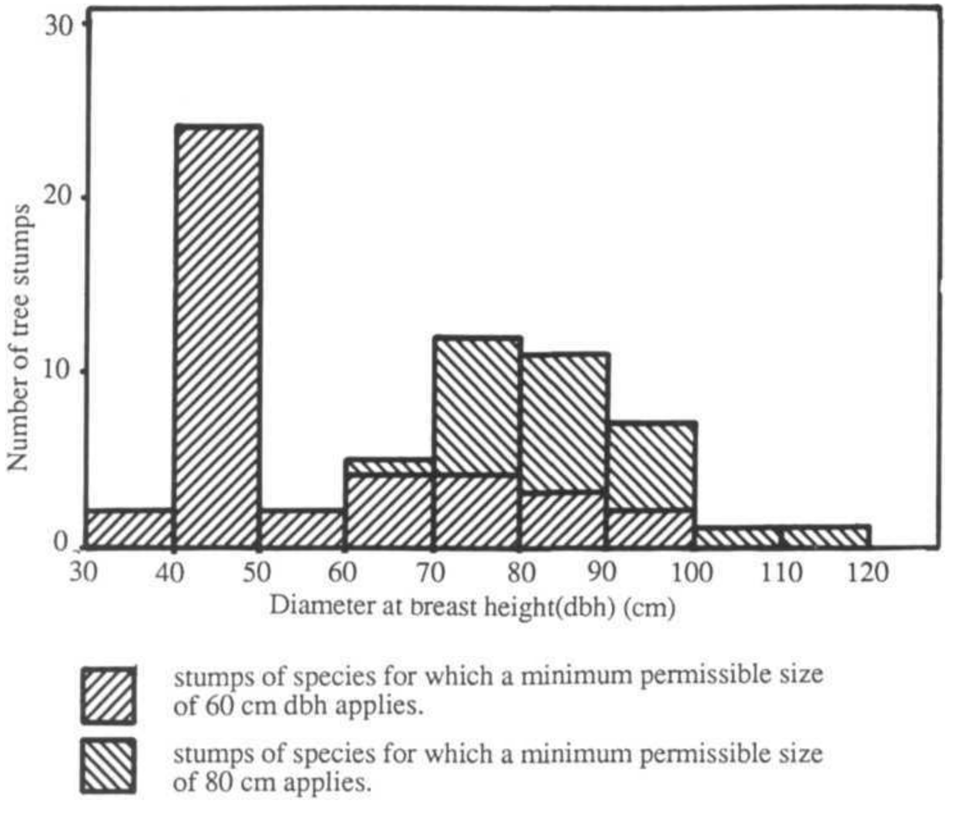


Fig. 3.3 *The size class distribution of the stumps (cm dbh) of trees felled by pitsawyers in the Kasyoha-Kitomi forest within the twelve month period October 1984 - September 1985. The measurements were made during the course of project fieldwork.*

There are, of course, a number of important disadvantages, mainly associated with the difficulties of regulating pitsawing activity. These include:

- it is difficult to control the activities of large numbers of people who enter the forest as sawyers and woodcarriers;
- it requires a more complicated system of management, involving more field staff to allocate trees and assess the royalties payable by different individuals, and more office staff in support;
- pole-class trees, which should be allowed to grow into merchantable timber trees are cut unnecessarily by pitsawyers for the construction of pitsawing platforms and temporary shelters:
- pitsawing, as currently practised in Uganda, is wasteful and achieves a much lower conversion efficiency than mechanized timber harvesting, because large offcuts are left unutilized;
- the quality of most pitsawn boards is inferior to those produced by an efficient sawmill;
- pitsawyers are more selective than sawmill operators in the species they will cut, which leads to the genetic impoverishment of the forest and a decline in the numbers of prime timber trees available.

Fuelwood harvesting and charcoal burning

By comparison with the national demand for sawn-wood, the requirements for fuelwood are enormous. The World Bank (1986) estimates that 1985 demand stood at 18.3 million m^3 or about 60 times the sawn-wood demand. Current annual production of woody biomass in Uganda may be around 15.6 million m^3 of fuelwood equivalent, in which case demand already exceeds the sustainable supply by around 17%. The situation is expected to worsen considerably over the coming years as population and industrial growth increase demand to a level that, by the year 2000, may exceed the 1985 sustainable supply by 80% (World Bank, 1986).

Most fuelwood and charcoal is taken from public land outside the forest reserves, so the direct impact of demand for these products has not resulted in the loss or conversion of large areas of reserved forest. Fuelwood plantations, small remnant patches of natural forest, and woodland on public land have so far been able to meet the demand for fuelwood, but the situation is clearly changing, and Uganda has now become wood deficient. In the long term, this must surely create additional pressures on the natural high forests, and the wildlife communities they support.

The charcoal refinement system of natural forest management developed in the 1960s was an early attempt to help satisfy the growing demand for fuelwood by integrating charcoal production into natural forest management systems. After felling a management compartment, young desirable timber trees would be marked for retention, and all remaining woody biomass including weed trees that had not been felled by the concessionnaire, and the lops and tops of trees that had, would be converted to charcoal. Nursery grown desirable tree seedlings would then be used to enrich the area with 100-150 seedlings per hectare (Earl, 1968). Such a system could produce considerable extra revenue by converting an additional 90 m^3 per hectare of wood to charcoal; provide additional employment; and create a uniform stand of young fast-growing trees. Against these obvious benefits a number of possible disadvantages with the system are apparent:

- although regeneration of most naturally occuring species is likely to continue for several felling cycles, one would expect the forest to become progressively richer in the number of desirable timber species, and correspondingly poorer in non-timber trees, so that in the long-term it becomes biologically less diverse;

- there may be some deleterious long-term effect on nutrients cycling processes, since some plant nutrients are removed from the forest as charcoal;

- the removal of such a large proportion of above-ground biomass may expose the forest to invasion by non-woody weeds which are expensive to control, and result in changes in animal populations that result in excessive predation on tree seedlings and saplings (J. Kasenene, pers. comm.).

Cutting of building poles

There is a substantial demand for building poles, which the World Bank (1986) estimated at 4-5 million poles, enough to build 100,000 new rural dwellings each year (figures from Bundibugyo suggest this is an under-estimate - see Chapter Five). This is equivalent to 300,000-400,000 m^3 of wood, somewhat more than the national demand for sawn-timber. This demand is met largely by small private plantation owners, natural forest remnants on public land, and trees retained or planted on agricultural land. Poles are also taken from all the forest reserves by people living nearby, although this is rarely evident further than 1 km from the boundary (pers. obs.). No commercial harvesting of building poles from the natural forest was noted during my fieldwork. Large numbers of bamboo poles are cut from the montane forests of south-western Uganda, the Rwenzoris and Mt Elgon, and used for a variety of construction purposes.

3.2 Conversion to agricultural use

The results of my surveys revealed that about 12% of the forested land within the country's principal reserves has been affected by agricultural encroachment (Table 3.1; Fig. 3.1). Four reserves (Kibale, Semliki, Mabira and Mount Elgon) have been badly affected, whilst eight have suffered little or no encroachment. The conversion of forest land to agricultural use is of particular concern because it leads to the complete destruction of the forest ecosystem in the areas affected - an ecosystem which is irreplaceable except over very long periods of time.

Encroachment may involve the settlement of forest land by people practising subsistence agriculture, or the production of cash crops by people living outside the reserve. Both types are widespread, and commonly practised alongside each other. However, in general terms, the encroachment of Kibale and Semliki can be regarded as predominantly subsistence farming, whilst that of Mabira and Mount Elgon involves cash-crop production.

Agricultural encroachment became a serious problem in Uganda's forests during the 1970s (Hamilton, 1984). Before this, there had been a period just prior to Independence when encroachment affected the forests of Buganda and Mount Elgon (M. Rukuba, pers. comm.), but these and a few isolated cases subsequently were generally resolved satisfactorily, with the eviction of those involved. It is important to examine why the problem has recurred at this time, and why certain forests should have been so badly affected whilst others have remained intact. Six key factors seem to be involved and Table 3.2 summarises the importance of each in contributing to the incidence of agricultural encroachment in the four worst-affectd reserves covered by this programme.

Table 3..2 The relative importance of different factors in contributing to the encroachment of four of the country's principal forest reserves

FOREST	1 Breakdown of law	2 Population pressure	3 Failure of taungya	4 Economic constraints	5 Political instability	6 Tribal conflict
Kibale	***	***	-	*	*	-
Semliki	*	***	***	*	**	-
Mabira	***	-	-	**	***	-
Mount Elgon	***	***	***	**	*	**

*** denotes primary factor responsible for initial encroachment problem
** denotes secondary factor which has exacerbated the encroachment problem, and contributed to the spread of cultivation, but which would not have been a strong enough factor alone to cause encroachment.
* denotes an important contributory factor
- denotes an unimportant factor

- **Breakdown of law and order.** There has been a general deterioration in the maintenance of law and order in Uganda since the early 1970s, and a growing disregard for the authority of Forest Department staff. This has made it difficult for departmental staff to assert control over the forest estate, particularly when other government bodies have encouraged or condoned encroachment by providing facilities (such as schools and clinics) to illegal settlers (Van Orsdol, 1986). Many encroachers, particularly in Kibale and Mabira, are said to have been misled by the Government's drive to double agricultural production in the early 1970s, coupled with President Amin's declaration at about the same time that every Ugandan is free to settle in any part of the country (Hamilton, 1984)

- **Population pressure.** The pressure of high, rapidly increasing human populations in areas adjacent to forest reserves has been a major factor influencing encroachment. Forests which lie in densely populated regions, such as Mount Elgon and Semliki, (where populations exceed 300 persons/km^2 in neighbouring lands) are especially vulnerable; but encroachment can also be the result of immigration from densely populated regions elsewhere. Kibale forest, for example, has been settled by immigrants from densely-populated Kabale District some 200 km away (Van Orsdol, 1986). Freshly cleared forest soils, capable of yielding several bumper harvests, are particularly attractive to people coming from densely populated areas, because the soils in their areas are generally overworked and low in plant nutrients. Indeed, in the

Mount Elgon area it is quite common to see forest land under cultivation whilst adjacent areas outside the reserve are abandoned, presumably because the soils there have become so degraded that their continued cultivation is no longer worthwhile.

- **Failure of the *taungya* forest management system.** The *taungya* system was introduced as a cost-effective method of forest plantation establishment. The system uses unpaid local people to clear forest land, by granting them temporary cultivation rights. Trees are planted in the freshly cleared lands, alongside the farmer's crops, and they eventually grow up to overshadow the crops, at which time the farmer is supposed to move on. The system has been used widely throughout the tropics because of the obvious benefits of using free labour, and increasing agricultural production.

  The *taungya* system was first introduced into Uganda in the early 1940s, to help with the establishment of peri-urban plantations, and later (in 1957) extended to the natural forest to facilitate the establishment of softwood plantations on Mount Elgon (Synnott, 1968). Its use has subsequently been extended to a number of other reserves. In 1971, a decision was taken to develop the western two-thirds of the Semliki forest reserve using this system (Kingdon, 1971a). Despite some degree of early success with the Mount Elgon plantations, the system has proved disappointing on account of three main problems, namely (i) the Forest Department has failed to meet its planting targets, (ii) departmental staff have been unable to control the spread of cultivation and the destruction of forest in areas where the *taungya* system has been introduced, and (iii) trees planted by the Forest Department have been deliberately killed or uprooted by the cultivators. In general the system requires a level of supervision, enforcement and commitment that the Forest Department has been unable to provide. The present encroachment of the Semliki and Mount Elgon reserves is in large part due to the failure of the *taungya* system.

- **Economic constraints.** The severe economic difficulties facing the Forest Department over the past fifteen years have undoubtedly contributed to the loss of forest land to encroachment in a number of ways. Foremost amongst these has been the marked decline in the Department's ability to undertake any active protection measures such as boundary maintenance and patrols; and the fact that a few Forest Department staff supplement their meagre salaries by accepting payment for cultivation rights. This, local reports indicate, applies particularly to the Mount Elgon area.

- **Political instability.** Since the early 1970s forest reserve land has frequently been used to buy political allegiance, particularly during periods of greatest instability. Most recent changes of government in Uganda have been accompanied by widespread civil unrest, and many people have taken advantage of these situations to encroach on forest land, knowing that neither outgoing nor incoming regimes would consider it to be in their immediate political interests to take a firm stand against such encroachment. Much of Mabira, for example, was lost to encroachment after Amin's overthrow, and the situation there worsened as a result of party politics and the adoption of a populist line 'the land is for the people; trees don't vote'. It is estimated that some two thirds of the area presently under cultivation in Mabira was lost in the 1980-83 period, condoned by the politicians of local constituencies for fear of losing popularity (S. Mpangire, pers. comm.). Likewise, during the latest war, the National Resistance

Army officially permitted residents of Bundibugyo to cultivate temporary crops in the Semliki forest reserve after they had liberated the district in July 1985; a move no doubt intended to help them gain popularity and recruit additional soldiers for their ongoing struggle against the government of the day.

- **Tribal conflicts.** A significant factor in the encroachment of the Mount Elgon reserve has been tribal conflict. There have been numerous long-standing conflicts between neighbouring tribes in this region, but two recent events have been particularly important in exacerbating the encroachment problem. In 1979, all non-Sabiny people were expelled from the northern slopes area of Sebei by the Sabiny who have traditionally occupied this region. Amongst those who fled were large numbers of Bagisu, who returned to their traditional area on the western slopes of the mountain. This influx of people to an already overpopulated area resulted in a considerable increase in the incidence of encroachment (Hamilton, 1984). A more recent factor has been the incidence of cattle-raiding between the Sabiny and the Karamajong and Pokot people to the north. As a result of frequent raiding and counter-raiding the Sabiny have abandoned much of their traditional land on the lower slopes of the mountain, and moved up into the higher-lying areas, including the forest reserve.

3.3 Hunting

Hunting was recorded in all of the forests covered by the survey, and is clearly having a major impact on populations of many of the larger mammals (see below). The animals taken vary from place to place (Table 3.3): ungulates, particularly larger ones such as buffalo, giant forest hog, bushbuck and bushpig, but also various species of duiker and other antelopes, are avidly hunted in all forests, by people of all ethnic groups. Primates, on the other hand, are hunted only by the Batwa, Baamba, Bakonjo and Bagisu, and only in the forests found in their traditional areas, namely Semliki, Rwenzori and Mount Elgon respectively. Ground-dwelling birds, including guineafowl and francolins are commonly trapped in the Rwenzori and Bwindi forests but rarely elsewhere, and I have found several traps intended for songbirds in the Rwenzori forest.

There is a considerable degree of local variation in the hunting methods used in different areas. Six techniques are distinguished in Table 3.3. In many areas, parties of between 5 and 40 men use dogs to drive forest ungulates into long walls of coarse net, where they are speared to death. Poison-tipped arrows are used by the Batwa and Baamba who hunt primates and a wide range of other species in the Semliki forest reserve. They are not used elsewhere, except possibly by the Bakonjo and Bagisu. Triggered snares are very widely used to capture forest ungulates; animals are trapped by the leg or neck, by means of a noose that is tightened by the release of tension in a bent-over sapling attached to the end of the noose. Snares made of a simple loop of wire or bushrope placed in an animal path, are also extremely common and widespread. Two other kinds of trap are the pitfall - a tapered pit normally two metres deep, the top of which is concealed by sticks and leaves, into which a passing bushpig or antelope may fall; and the deadfall trap, in which an animal (anything from the size of a hyrax to that of a bushpig) is crushed by the weight of several large stones or logs suspended over a baited triggering mechanism (further description of trapping methods is provided by Butynski, 1984). It is of considerable significance that guns are

Table 3.3 The types of animals taken by hunters, the methods used, and the proportion of 1 km2 survey compartments in which hunting was recorded during ground survey work in the principal forest reserves.

	ANIMALS TAKEN			HUNTING METHODS USED						
Forest	Ungulates	Primates	Birds	Nets/Dogs	Bows/Arrows	Triggered snares	Simple snares	Other traps	Guns	% of survey compartments in which hunting activity was recorded
Kibale	*	-	-	**	-	*	**	*	-	?
Semliki	*	*	?	-	**	-	*	*	-	4
Budongo	*	-	-	?	?	?	?	?	?	?
Kalinzu/Maramagambo	*	-	-	**	-	**	*	*	-	8
Bugoma	*	-	-	**	-	*	*	-	*	7
Bwindi (Impenetrable)	*	-	*	-	-	**	*	*	-	12
Kasyoha-Kitomi	*	-	-	**	-		*	-	-	10
Itwara	*	-	-	**	-	**	**	*	-	35
Sango Bay	*	-	-	?	?	?	?	?	?	0
Mabira	*	-	?	?	?	?	?	?	?	0
Mount Elgon	*	*	?	*	?	?	**	*	-	4
Rwenzori	*	*	*	*	?	*	**	*	-	30

** denotes hunting method of primary importance
* denotes animal taken/hunting method of secondary importance
\- denotes animal not taken or rarely taken/hunting method never, or rarely used
? denotes no information available

rarely used for hunting in Uganda's forests: the only exception to this being instances in which military rifles have been used for ivory poaching. Shotguns and other similar weapons, so commonly used for hunting purposes in the forests of West Africa (Davies, 1987; Gartlan, 1987) are unheard of here.

A considerable amount of variation was recorded in the incidence of hunting activity in the different forests covered by ground survey work (Table 3.3). Taken at face value the data would seem to indicate that hunting activity is particularly intensive in the Itwara and

Rwenzori forests, and relatively slight in Semliki, Sango Bay, Mabira and Mount Elgon. However, this may not be the case since hunting methods vary between forests, and some of the evidence (e.g. snares) is easily detected and persists for long periods, while others (e.g. a man with a bow and arrows) are unlikely to be recorded during ground survey work. It is therefore necessary to interpret such data with caution, realising that animals living in forests where a high incidence of hunting activity was recorded may be at no greater risk than those living in other areas where hunting is carried out by less obvious methods.

3.4 Harvesting of minor forest products

Timber harvesting, agricultural encroachment and hunting are undoubtedly the three activities which have the greatest impact on wildlife in the natural forest. There are, however, a few other products which are harvested in sufficient quantity or in such a way as to have some significant impact, at least locally.

- **Bamboos.** Bamboos grow in all the montane forests between about 2,400 and 3,000 m, and are cut in considerable quantities in the Rwenzori, Mount Elgon, Mgahinga, Echuya and Bwindi (Impenetrable) forests for use as building poles, fencing materials, roofing materials, and water piping.

- **Palm nuts.** The West African oil palm *(Elaeis guineensis)* occurs naturally in the Semliki forest and bunches of palm nuts are collected by local people, sometimes by cutting down the fruiting tree.

- **Rattan canes.** Canes from a rattan palm, *Calamus deeratus* are cut by hand from the lower altitude forests including Budongo, Bugoma and Semliki, for use in furniture making.

- **Other minor products.** A wide range of other products is harvested on a small scale from forests throughout the country. This often involves damage to forest tress, as for example when a tree is cut to collect honey; when bark is cut for medicinal use; when a rubber tree is tapped; or when a coffee bush is cut to harvest its berries.

4. The impact of resource exploitation on wildlife communities

Little is known about the ways that forest management activities affect wildlife communities and ecosystem function in the natural forest. It is only possible to speculate on their likely impact, based on an understanding of ecological principles. Broadly speaking, management activities affect wildlife communities either by changing the physical and biological environment in a way that favours the survival of certain species at the expense of others (habitat alteration), or by altering the balance of species by removing particular plants or animals which then become less abundant or extinct. In the discussion that follows I describe these two types of impact and provide examples of their effect.

4.1 Habitat alteration

Mechanized timber harvesting, and other less intensive forms of timber extraction, bring about far-reaching changes in the physical and biological conditions prevailing in the natural forest. Prior to felling, a mature forest is in a state of equilibrium with its environment: the growth of trees is matched by the losses suffered through death and decomposition. The large, mature trees of the forest canopy have reached their maximum size and are investing some of the resources at their disposal in reproductive activity, producing flowers and fruits that will ensure the survival of their species. The saplings of the canopy trees are overshadowed, and their growth is suppressed until the death of a larger tree nearby opens up a gap in the canopy that allows light to reach the forest floor and release their growth. The gap is soon filled by whichever sapling has been able to compete most effectively with the others in capturing the light, and growing as fast as possible to occupy the gap.

The character of a forest after felling is dramatically different. The young forest vegetation is not in a state of equilbrium with its site conditions, but is changing to regain that equilibrium. The mature trees have been removed by the logging operation, so there are few flowers and fruits in the canopy. Instead, the young forest is characterised by exuberant vegetative growth, stimulated by the abundant light and warmth. Species characteristic of the mature forest are unable to establish themselves under such conditions, so the forest is quickly dominated by far-growing species that are adapted to colonising such areas. Eventually the colonising trees create enough shade for the species characteristic of mature forest to become re-established. If the forest is left for long enough a succession of different communities of plants and animals takes over one from another until eventually (perhaps after several centuries) a mature forest, with all the characteristics outlined above, is re-established. This mature forest, although theoretically in a state of equilibrium with a stable environment, may be perpetually changing, chasing a changing environment.

The process of community succession from grassland, and the characteristics of the forest at each seral stage, have been described for the Budongo forest by Eggeling (1947), and have been summarised in Chapter One. Of course, they vary from place to place, but the principles are the same. The trees of logged forest habitats tend to be species that are fast growing, light demanding and which produce abundant small seeds that are dispersed by the wind or small animals; whereas those typical of mature forest communities tend to be slower growing, shade-tolerant trees that produce relatively small numbers of large seeds that are dispersed by larger animals (Table 3.4). It is also important to note that the more useful timber species are generally not those of climax forest, which means that setting the succession back is advantageous for timber production. In fact, Uganda has a lot more valuable timber on account of the past few centuries of forest expansion than would have been the case if all the forest had reached its climax.

This provides a theoretical framework for examining the impact of habitat disturbance on forest wildlife communities. A summary of the main concerns is provided in Table 3.5. In general, animal communities are closely dependent on plants, and the ways in which they respond to habitat disturbance are similar. Certain species are able to adapt to the new conditions, and may even benefit from them, whilst others are unable to do so and may be eliminated.

Obviously, the impact of habitat disturbance on wildlife is closely linked to the nature of the management activity that has brought it about. In the most extreme case, the conversion of forest to agricultural use eliminates most of the species characteristic of mature forest. The impact of mechanized timber harvesting on a monocyclic felling system followed by charcoal refinement and enrichment planting is likely to be far more severe than that of a selective pitsawing system in which only trees exceeding a specified minimum girth are felled. This can be illustrated by reference to recent studies of the impact of habitat disturbance on wildlife communities (see below).

Table 3.4 Characteristics of trees typical of colonising (logged) and mature (unlogged) forest

Trees of colonising forest	Trees of mature forest
Fast growing - often useful timber trees	Slow-growing - often non-timber trees
Need light-abundant conditions to become established	Need humid, shady conditions for seedlings/saplings to become established
Produce large numbers of small seeds that are dispersed by the wind or by small animals	Produce small numbers of large seeds that are dispersed by large animals
Seedling/sapling stages relatively successful at competing with herbaceous growth and climber tangles	Seedling/sapling stages unable to compete with dense herbaceous growth and climber tangles

Table 3.5 Some wide-ranging effects of forest management practices on forest ecology and wildlife communities

Management Activity	Impact on forest wildlife communities and related ecological concerns
1. Intensive mechanised logging	1. Introduction of heavy machinery causes widespread destruction of vegetation cover, soil compaction and erosion; and results in poor forest regeneration in the most disturbed areas.
	2. Removal of logs carries away scarce nutrients and may lead to long-term ecological change.
	3. Opening of the canopy results in changed physical conditions which favours the regeneration of 'colonising' trees to the exclusion of species characteristic of mature forest.
	4. Populations of animals that are dependent on mature forest habitats are reduced or eliminated by the reduction in fruit supplies available as food, the loss of dead trees used by hole-nesting birds, the disruption of aerial pathways used by primates, etc.
2. Refinement systems (e.g. liberation thinning, arboricide treatment, climber cutting, charcoal refinement)	1. The selective removal of non-commercial ('weed') species in order to promote the growth of 'desirable' trees threatens to impoverish the forest through species extinction. It is likely that many of today's 'weed' species will assume commercial importance in future; and all should be regarded as functioning components of the complex rainforest ecosystem even if their precise role is not presently understood.
	2. The use of arboricides and the burning of charcoal has an unknown impact on soil structure and decomposition cycles.

(a) Impact of habitat disturbance on primate communities

A number of studies to investigate the effects of habitat disturbance on primate populations have been conducted in Uganda's Kibale Forest (Struhsaker, 1975; Skorupa, 1987; Kisubi, in prep.), and elsewhere (a useful review is provided by Johns and Skorupa, in press). These studies show that primates respond to habitat disturbance in many ways, with some populations declining as a result of disturbance, whilst others increase. In general terms, small species are better able to adapt to moderate levels of disturbance than larger ones, and frugivorous (i.e. fruit-eating) species suffer rather badly as a result of habitat disturbance (Johns and Skorupa, in press).

One of the most exhaustive recent studies was carried out by Skorupa (1987) in the Kibale forest. He found that population densities of five out of seven primates were significantly lower in an area that had been heavily logged 12-14 years previously, compared with an adjacent area of undisturbed forest. In another adjacent area, where logging had been comparatively light, only one of the primates showed significantly reduced population densities. One species (black and white colobus) is favoured by intensive logging, and severely disturbed areas may support populations five times as high as those in adjacent undisturbed areas (Fig. 3.4).

Primate population densities have been monitored in three heavily logged compartments of Kibale forest (namely compartments 12, 13 and 17) over a period of about seventeen years (Struhsaker, 1975, unpublished data; Skorupa, 1987, un-published data; Kisubi, in prep.; P. Howard, unpublished data),. from a time two years post-felling to nineteen years post-felling. The results of these studies indicate that all but one of the seven resident primates have remained at post-logging population densities, without any significant return to densities characteristic of undisturbed habitat. In other words, there has been no 'recovery'

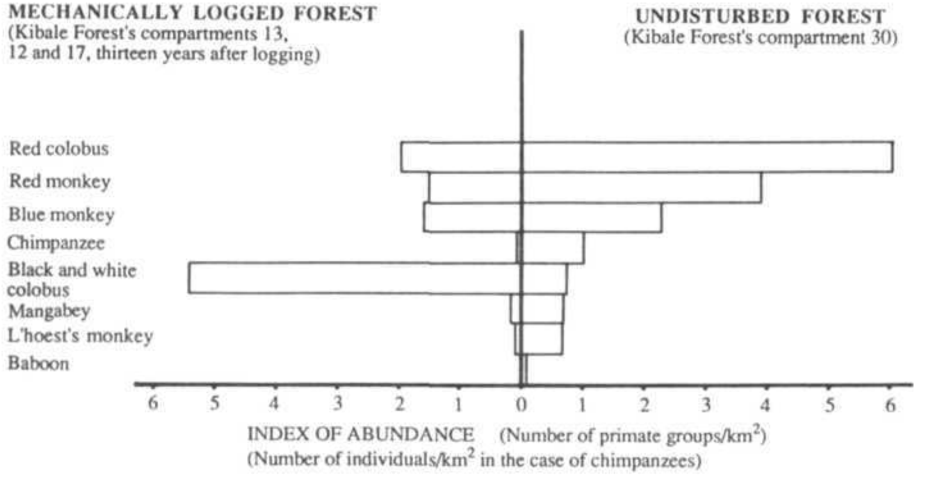


Fig. 3.4 *The relative abundance of eight primates in adjacent areas of mechanically logged and undisturbedforest at Kibale. Data arefrom Skorupa. 1987.*

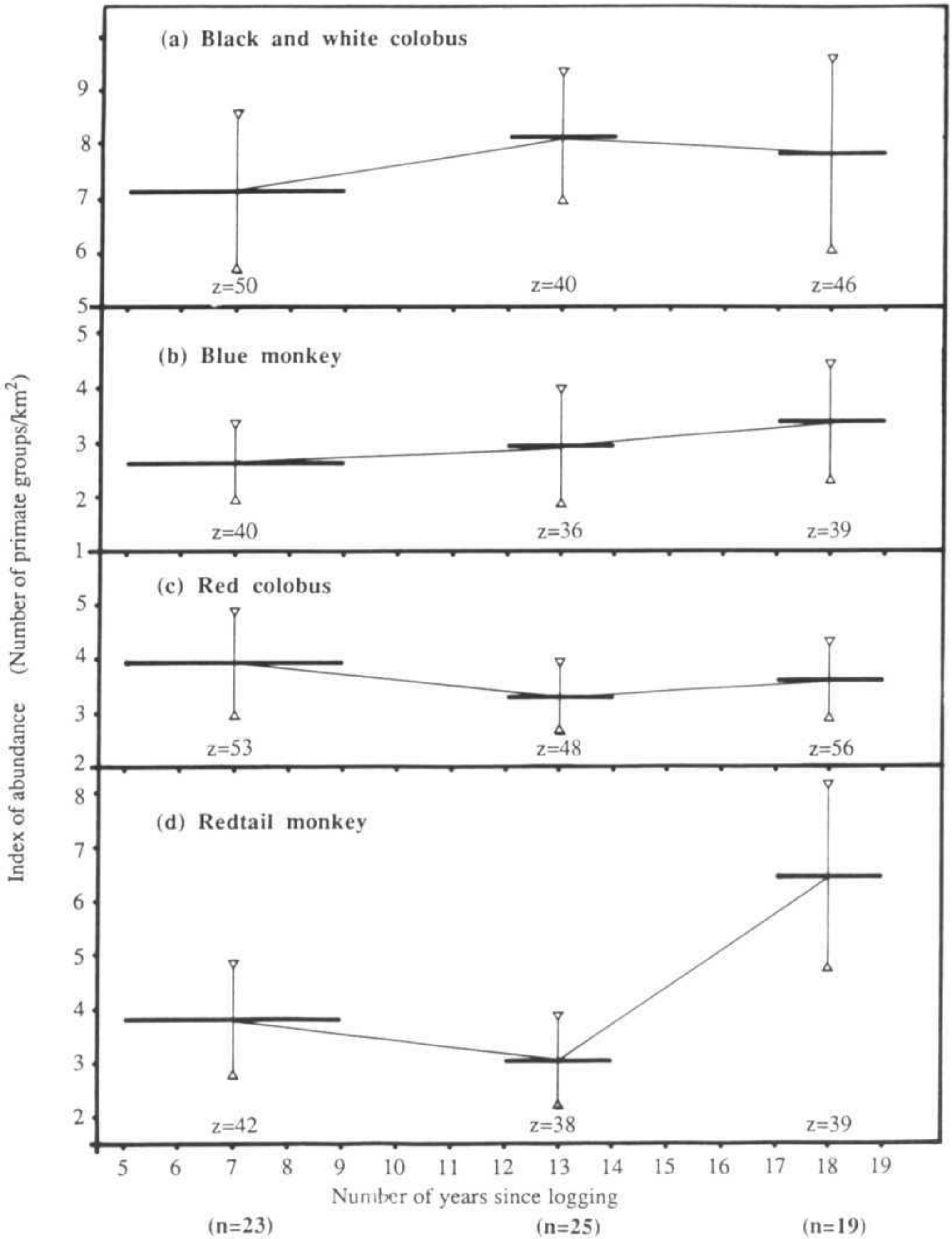


Fig. 3.5 *The relative abundance of the four commonest primates in an area of logged forest (Kibale Forest's compartments 13, 12 and 17) over a period 5-19 years after logging. Data are from line transect censuses conducted by Struhsaker (unpublished), Skorupa (1987) and Kisubi and Howard (Appendix E; unpublished data), n refers to the total number of censuses conducted over any given period: z refers to the mean (observer - first animal seen) sighting distance for single species groups; horizontal bars represent the period over which each scries of censuses was conducted; vertical bars represent 95% confidence limits either side of the mean.*

of the primate community nineteen years after logging, except in the case of redtail monkeys (Fig. 3.5). This particular study area did not benefit from any post-harvest enrichment planting.

(b) Impact of habitat disturbance on bird communities

Tropical forest avifaunas are characteristically rich and many of their species show a high degree of habitat specialisation. Logging, and other forms of disturbance, may alter the environment to such a degree that the more specialised birds are eliminated from disturbed sites. At the same time, disturbed forest may offer new habitat opportunities for forest edge colonisers which are not normally found in the forest interior. Johns (1983) recorded 22 species from a primary forest in West Malaysia that were not found in adjacent logged forest, whilst another 17 species were restricted to the logged forest. Thus, whilst the avifaunas of logged and undisturbed forests may contain similar numbers of species, they differ markedly in species composition (Johns, 1985).

There are a number of possible reasons to account for the elimination of forest interior species from logged forest habitats. One of these is the inability of birds of the forest understorey to cope with the relatively harsh conditions (higher light intensity, higher ambient temperature and lower humidity) of logged forest habitats. Many rainforest species become heat-stressed very easily (Johns, 1983); others that feed on litter arthropods may be affected by the widespread drying and hardening of the soil under disturbed habitat conditions. Other species may be dependent upon the availability of over-mature trees, as foraging substrates (e.g. for woodpeckers) or nesting sites (e.g. for hornbills). These are commonly eliminated from intensively managed forest.

Holmes and Kramer (in prep., b) have recently completed a study in which they examined the avifauna of five different management compartments in the Kibale Forest, representing two undisturbed natural forest communities, heavily exploited and lightly exploited natural forest and pine plantation. The study involved mist-net sampling in gridded plots and line transect censusing of bird populations over a period of 18 months. The preliminary results indicate (J. Holmes, pers. comm.):

- That there are considerable differences in the avifaunas of adjacent management compartments that can be attributed to management history and resultant habitat differences.

- In the most heavily exploited habitats the avifauna is characterised by a large number of species, most of which can be regarded as opportunistic, adaptable birds with broad ecological requirements.

- In the undisturbed forest habitats, there is a greater diversity of true forest-dependent species, including many not found in the disturbed forest, such as the white-tailed ant-thrush *(Neocossyphus poensis)*, brown-chested alethe *(Alethe poliocephala)* and blue-breasted kingfisher *(Halcyon malimbica)*.

- A higher proportion of the birds captured in the undisturbed habitats are in breeding condition, and more birds are re-captured here than in the disturbed habitats. In the most heavily exploited forest, many of the birds are juveniles. These observations indicate that the disturbed habitats are serving largely as foraging areas for itinerant, immature and non-breeding birds, whilst the undisturbed forest represents optimal habitat for breeding. In other words, even if a species is found to occur in the disturbed habitats its populations there may not be self-sustaining.

(c) Impact of habitat disturbance on rodent communities

As with other groups of plants and animals, rodent densities and community species composition are altered by habitat disturbance. Undisturbed forest at Kibale supports a community of seven ground-living rodent species that can be live-trapped, of which two do not occur in an adjacent lightly felled area. The disturbed forest, on the other hand, supports a richer community of ten species, and overall rodent densities are significantly higher than in the undisturbed forest (Fig. 3.6; Kasenene, 1984).

(d) Impact of habitat disturbance on plant communities

The impact of management activities on plant species composition is usually less obvious than their impact on the forest's physical structure. Nevertheless most management activities bring about significant changes in species composition, either by converting a mature forest community to an earlier seral stage, or through deliberate silvicultural

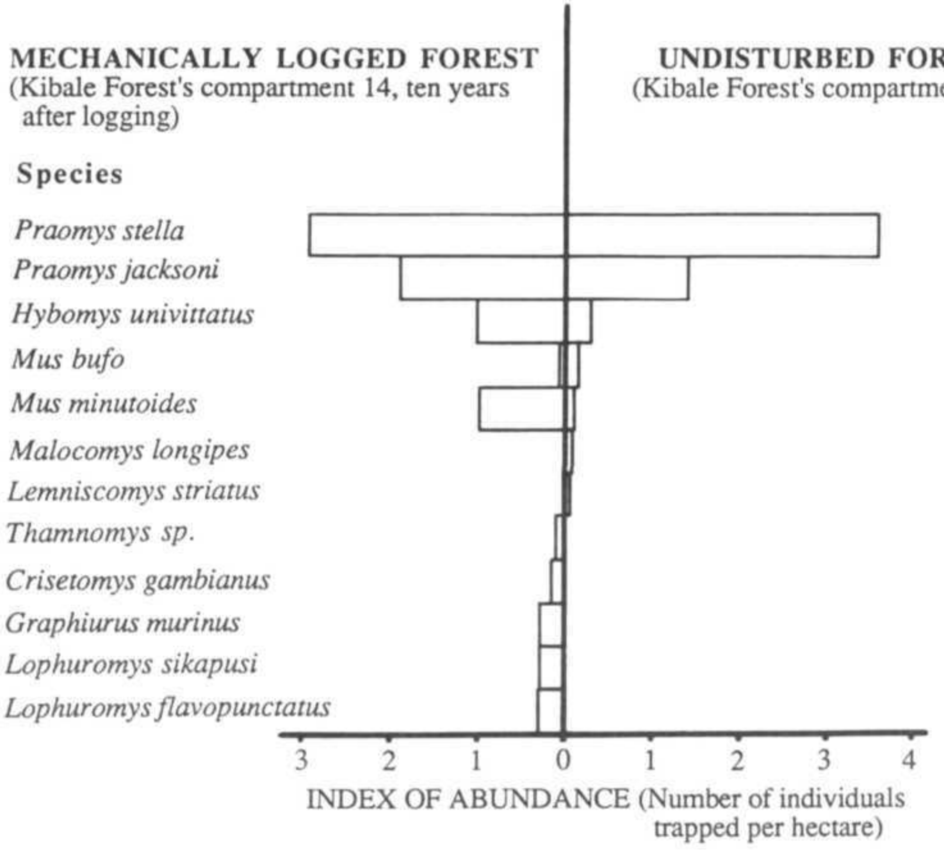


Fig. 3.6 *The relative abundance of twelve species of rodent in adjacent areas of mechanically logged and undisturbed forest at Kibale. Data are from Kasenene, 1984.*

measures aimed at increasing the representation of a few commercially important timber species at the expense of others. Thus these activities threaten to impoverish the forest plant communities through the elimination of late-successional species, and non-merchantable ones.

Logging changes the species composition of forest by creating conditions favourable to the establishment of colonising species, which inhibit the shade-loving trees characteristic of mature undisturbed forest. The extent of this change depends on the intensity of the logging operation, and on the nature of the forest before it was logged. In many Ugandan forests single-species dominance is a characteristic of the most mature (climax) communities, and when these are cut, the forest that replaces them is generally expected to be more mixed and species-rich, although lacking some of the mature forest elements (Eggeling, 1947). Some of the rarer species may be eliminated. Logging also influences the composition of epiphyte communities and the original components of the herbaceous flora since these plants are especially sensitive to the unfavourable microclimatic conditions created by opening the forest canopy (Davidson, 1985).

In order to illustrate the types of changes which occur in trees species composition following logging some enumeration data for two 1 ha plots representing adjacent areas of logged and unlogged *Parinari* forest at Kalinzu are included as Appendix S and summarised in Fig. 3.7. The enumerations were carried out along primate censusing routes which ran through areas originally mapped as *Parinari* forest (Fig. H1, Appendix H), and both sampled ridge-top, midslope and valley bottom communities. Thus they are considered to be directly comparable. A comparison of the two enumerations reveals that:

- in terms of the total number of species recorded, the two plots are similar, the unlogged plot being only marginally richer (48 species exceeding 10 cm dbh per hectare) than the logged plot (42 species per hectare).

- the total number of individual trees enumerated is almost identical (354 and 355 stems), although those of the logged forest are generally smaller.

- there are considerable differences in species composition. Twenty-seven (56%) of the species recorded in the unlogged forest were absent from the logged forest; these no doubt include uncommon species that were not recorded from the logged forest simply because the samples were inadequate, but probably includes a number of species that have been eliminated from the logged forest plot as a result of logging. On the other hand, the logged forest supports 21 species (50% of the total) not found in the unlogged plot; these include some uncommon species that occur in both areas but happen to have been sampled in the logged plot, and others that are colonising, forest edge species that do not normally occur in the forest interior, such as *Trenta orientalis, Musanga leo-errerae, Polysciasfulva* and *Croton macrostachyus.*

- the logged forest tends to be characterised by many individuals of a few species; seventy-five percent of the trees belong to just eight species. By comparison, three-quarters of the unlogged forest trees belong to 13 species.

- in terms of numbers of individuals, four of the six most important trees in the unlogged forest are different from the six top-ranking trees in the logged forest (Fig. 3.7). Since the top six species represent 53% and 66% of the total number of trees in unlogged and logged plots respectively, these differences are highly significant, and represent a fundamental change in the forest's status. One of the unlogged forest's

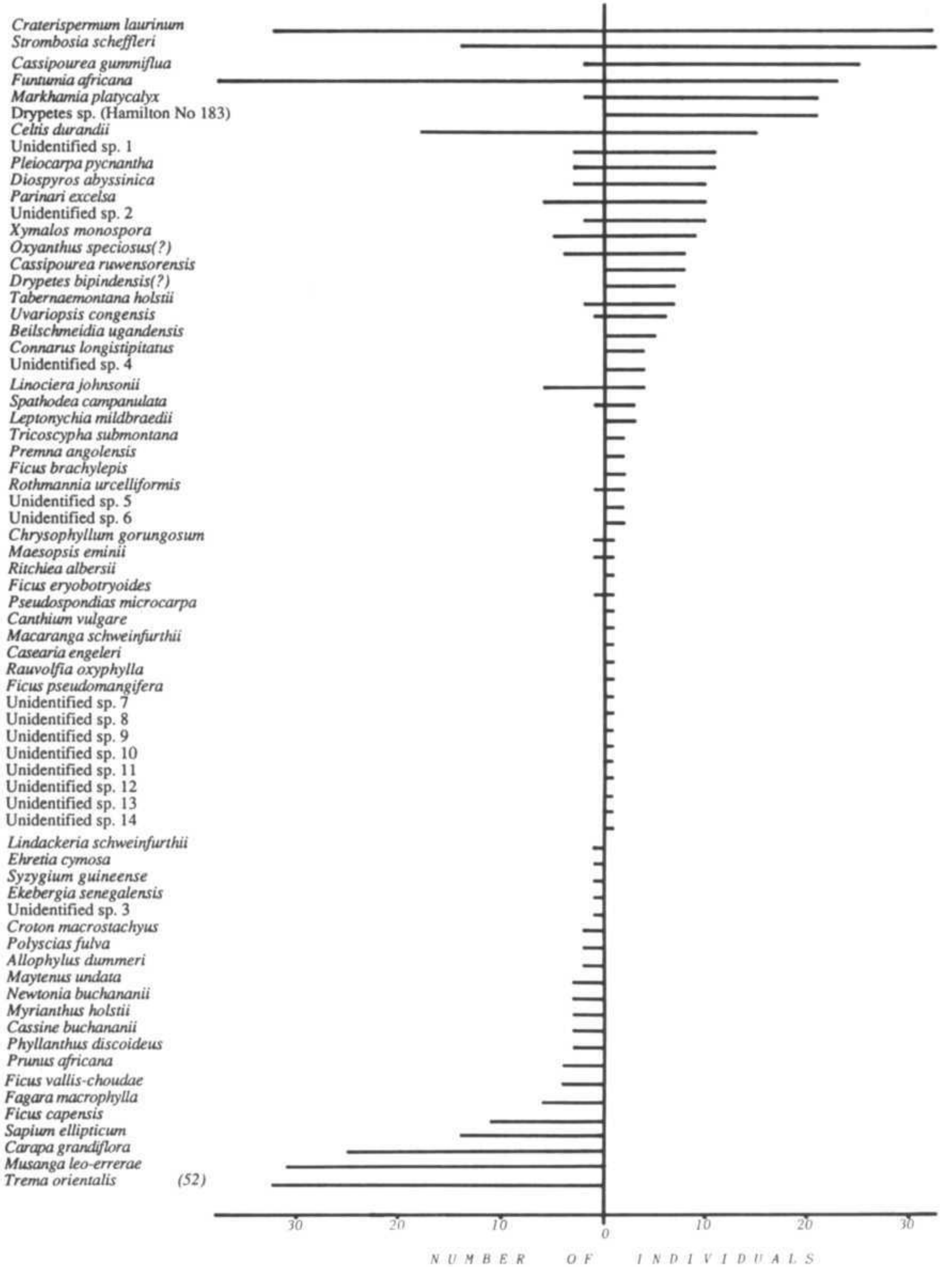


Fig. 3.7 *The number of individual trees of 69 species enumerated in 1 ha plots in adjacent areas of mechanically logged and relatively undisturbed Parinari forest in Kalinzu. Full enumeration data are provided in Appendix S. Data are from A. Kisubi (unpublished).*

'top 6' *(Drypetes sp.)* was not found in the logged forest plots, and another *(Cassipourea gummiflua?)* was rare. Three of the logged forest's 'top 6' are not found in the unlogged forest, including two particularly abundant colonising species, *Trema orientalis* and *Musanga leo-errerae* (Fig. 3.7).

Intensive forest management, if strictly applied, could threaten the existence of a great many species, because it sets out to maximise the stocking of commercially important timber species, at the expense of others. Treatments such as 'liberation thinning' and 'charcoal refining' could remove all non-commercial trees unless provision is made for the retention of ecological keystone species; climber cutting could eliminate a great many species including most of the figs (important food sources for many animals); and enrichment planting would help ensure that only commercially important trees found a space in the canopy. If intensive forest management systems of this kind were applied over a period of several felling cycles, they could lead to a considerable impoverishment of the plant communities characteristic of undisturbed natural high forest.

4.2 Selective removal of single species

Hunting, pitsawing and the harvesting of 'minor' forest products are very species-specific in their impact, threatening particular target species of animals and plants, rather than whole communities. The loss of these target species is particularly regrettable because, of all the species represented in the natural forest, these are the ones that have already proved their direct economic value.

(a) Effects of pitsawing

Pitsawyers tend to be very selective when, as is presently the case in Uganda, their activities are not adequately controlled, (i.e. they are not restricted to particular forest management compartments; seed-bearers are not retained; lower girth limits are not enforced). Trees yielding good quantities of high value timber are cut preferentially, even if they are situated as much as 5-6 km from a road, and considerable effort is required to head-load the timber out of the forest. The results of this highly selective removal of trees are twofold. First, it may lead to the complete elimination of particular target species in places where they occur as rare trees. An example is provided by the cutting of the mahogany *Entandrophragma excelsum* in many forests, including Kalinzu, Kasyoha-Kitomi and Itwara where most sizeable individuals have now been removed. Several other members of the family Meliaceae are similarly threatened elsewhere (see also Knees and Gardner, 1983). The second consequence of highly selective pitsawing activity is that it may lead to genetic impoverishment of the target species by removing only the biggest trees with sound straight boles, leaving the commercially inferior stock as a seed source (Davidson, 1985).

(b) Effects of hunting

It is difficult to assess the impact of hunting activity on populations of wild animals, since there is very little information available on the abundance of these animals at different sites in the past. However there are a number of indications that it is resulting in drastic reductions in many large mammal populations, and has already resulted in the extinction of certain species from some forests.

- There have already been a number of species extinctions attributed to hunting in the recent past. Buffalo have probably disappeared from the Bwindi, Rwenzori, Mabira, Kasyoha-Kitomi and Itwara forests during the past twenty years, and populations elsewhere appear to be very low (Appendices E-P). Elephants have been almost eliminated from Bugoma, Mabira and Itwara, and only small remnant populations exist in other forests.

- The results of ground survey work indicate considerable differences in the abundance of ungulate signs (e.g. footprints, faeces etc) in different forests, which presumably reflects differences in ungulate population density (Appendices E-P). When these data are plotted against the mean human population densities in the subcounties bordering each reserve, it is found that ungulate population densities are inversely proportional to human population densities (Fig. 3.8). This seems to provide strong circumstantial evidence that ungulate populations are being reduced by hunting pressure, and that this pressure has a more severe impact in areas of high human density (where more people have been hunting, over longer periods of time) than in less densely populated areas.

- Wherever active measures are taken to reduce hunting pressure, forest ungulate populations achieve much higher densities than they do in areas that are not so well protected. For example, the Mount Elgon National Park in Kenya supports large populations of bushbuck, waterbuck, buffalo and elephant, which may be living at close to carrying capacity. The Ugandan portion of the mountain supports relatively very few of these animals, even in the less disturbed parts of the reserve (Appendix O), and the difference is almost certainly the result of hunting pressure. Similarly, part of the Kibale forest is protected from hunting activity by Game Guards supported by the Kibale Forest Project, and forest ungulates appear to be considerably more abundant here than in most similar forests in western Uganda (pers. obs.).

- Local people in the vicinity of most forests commonly report that populations of many forest ungulates and other hunted animals have been drastically reduced in recent years (see, for example, Howard, 19 88b).

5. Chapter Summary

1. Aerial surveys, ground surveys and documentary sources were used to determine the present status of Uganda's twelve principal forest reserves. Overall, 53% of the forested land within these reserves remains essentially undisturbed, 21% has been mechanically harvested, 14% has been cut by pitsawyers and 12% affected by agricultural encroachment.

2. Methods of forest exploitation are described. Mechanized timber harvesting was based on a polycyclic felling system until the mid 1950s, and thereafter a monocyclic one. Until recently a number of silvicultural operations were widely used in the natural forest, including liberation thinning, arboricide treatments, post-harvest charcoal refinement and enrichment planting. These operations have been virtually abandoned during the years of political instability since the mid-1970s. Over the same period, most of the country's sawmills have broken down, and its sawn-wood requirements have been increasingly satisfied by growing numbers of pitsawyers. Agricultural encroachment has become a major problem in four of the principal reserves, a

phenomenon attributable to political instability, a breakdown in law and order, severe economic constraints facing the Forest Department, high human population pressure in many areas, tribal conflicts and the failure of *taungya* forest management systems. Hunting is carried out in all the major forests, with some local variations in the animals taken and methods used. A number of other minor forest products are harvested locally, including bamboos, palm nuts, and rattan canes.

3. All these human activities affect wildlife communities, by altering habitat conditions, removing selected animals or plants from it, or both. The impact of logging on primate, bird, rodent and tree species composition and abundance is reviewed, showing the extent to which habitat alteration can lead to the elimination of certain species, while favouring others. Pitsawing, and hunting activity threaten particular trees and animals, and have already caused local extinctions of certain species. The impact of hunting appears to have been particularly severe in forests that lie close to densely populated human settlement areas.

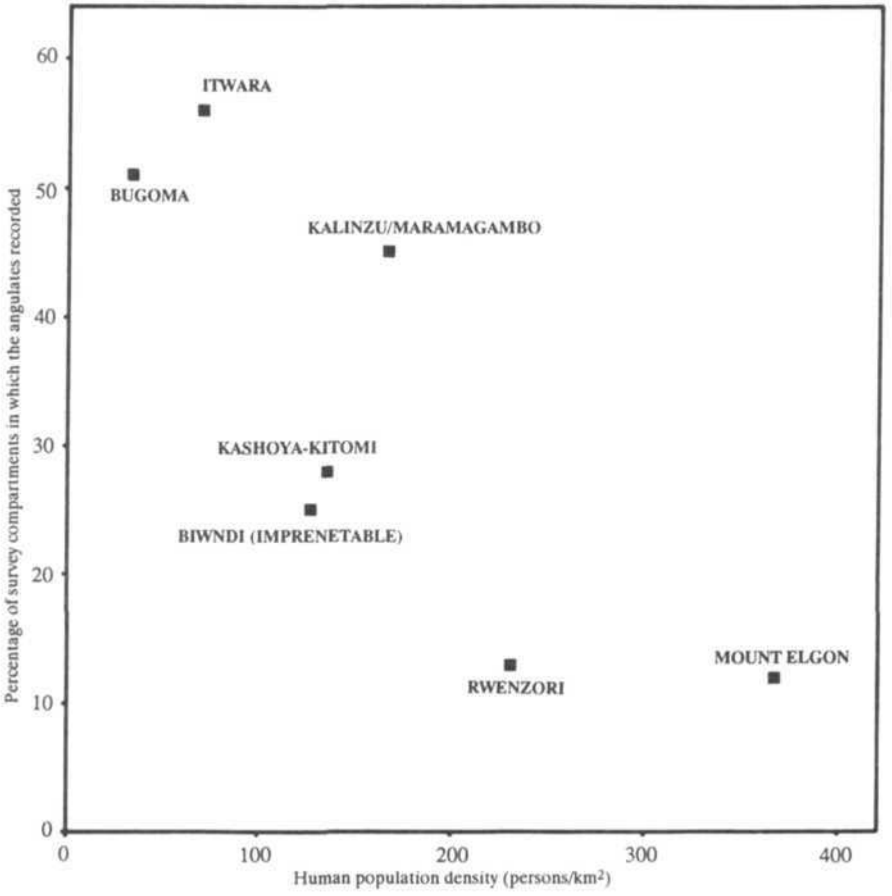


Fig. 3.8 *The percentage of 1 km² compartments covered by ground survey work in which ungulates (buffalo, antelope, pigs, etc) were recorded, as a function of mean human population density in the subcounties bordering the reserves. Forests in which fewer than 50 compartments were surveyed are considered unrepresentative, and have been excluded. Data are from Appendices E - P.*

Chapter Four: Planning a System of Protected Areas

1. Introduction

In the two previous chapters I described the wildlife communities characteristic of Uganda's forests, and illustrated how these communities are affected by timber harvesting and other human activities. It is quite clear that any successful programme to preserve biological diversity will involve the strict protection of some forest areas from extractive resource use. Indeed, many conservationists would advocate that all the remaining natural forests be set aside as strictly protected areas. However, these conservation ideals are in direct conflict with overwhelming demands to realise both short-term and maximum sustained long-term economic returns from these areas and cannot realistically be achieved. In this chapter I consider the issues involved in planning a network of protected areas, addressing the following important questions:

- How can the conflicting demands of wildlife conservation and production forestry best be reconciled?
- What is the most appropriate legal status for protected areas in the natural forest?
- Which forests are most important for wildlife conservation?
- What is the optimal size and configuration of protected areas - both in the context of individual forests, and in the context of national and regional needs?
- Within each forest, which areas are most suitable for protection?

2. Categories of protected area

There are presently three ways to increase the level of legal protection afforded to any of Uganda's reserved forests (or parts of them), namely to designate them as National Parks, Game Reserves/Animal Sanctuaries or Nature Reserves. In addition, a new category of protected area, known provisionally as a Forest Park, has recently been proposed (Kigenyi, 1988). A summary of the legal status and management objectives of each category follows, together with some comments on the advantages and disadvantages of each.

2.1 National Parks

This is the highest conservation status that can be afforded to any area, aimed at protecting outstanding natural and scenic areas of national or international significance for scientific, educational and recreational use (Mackinnon *et. al.,* 1986; Table 4.1). At present, only the

Table 4.1 International categories of protected area relevant to Uganda's forests and corresponding conservation objectives (after MacKinnon *et al,* 1986).

Primary conservation objective	International category (Ugandan equivalent) I Strict Reserve (Nature Reserve)	II National Park (National Park)	VIII Multiple Use Area (Forest Park)
Maintain sample ecosystems in natural state	1	1	2
Maintain ecological diversity and environmental regulation	3	1	2
Conserve genetic resources	1	1	3
Provide education, research and environmental monitoring	1	2	2
Conserve watershed condition	2	1	2
Control erosion, sedimentation	3	3	3
Provide animal products, permit hunting	-	-	1
Provide recreation and tourism services	-	1	1
Produce timber on a sustained yield basis	-	-	1
Protect national heritage sites	-	1	3
Protect scenic beauty and open space	3	1	3
Maintain management flexibility	-	-	3
Stimulate rational, sustainable use of marginal areas	2	1	1

Notes: 1 = Primary objective for management of area and resources;
2 = not necessarily a primary objective, but always an important objective;
3 = included as an objective whenever resources and other management objectives permit.

northern part of Maramagambo forest, contained within the Queen Elizabeth National Park is afforded this status. Under existing legislation, no extractive resource use is allowed without the approval of the National Parks Board of Trustees (Government of Uganda, 1964b).

The main advantages of protecting some of the country's forests as National Parks are:

- Uganda National Parks (UNP) may be the most effective managers of areas destined for preservation because (unlike the Forest Department) they have no (conflicting) interest in promoting consumptive forms of resource life.

- As legally constituted, National Parks can only be degazetted through an Act of Parliament, and are more secure than Forest Reserves because management decisions are made by a Board of Trustees, not a single senior civil servant.

- The National Parks Act provides for the protection of plant and animal life, whereas the Forests Act provides for the protection of plant life only. Thus, where complete ecosystem protection is the management priority, UNP is the appropriate authority. Forestry staff have no jurisdiction over animal life in the forest reserves.

- UNP has experience and expertise in tourism planning and development which the Forest Department lacks. Where strong tourism potential exists, UNP would be more capable of realising that potential and capturing the economic benefits for the nation.

- National Parks are internationally recognised and may attract international support more easily than any other type of protected area. This has been demonstrated in Uganda, where UNP has attracted (albeit modest) support from the international community throughout the 1980s, whereas significant support to the Forest and Game Departments was not forthcoming until late in the decade.

- As a parastatal, UNP management is fundamentally different from that of a government department, so by allocating responsibility for some forest protection to this body, it is possible to reduce the risk of excessive forest degradation should one or other management system fail.

Conversely, there are a number of reasons why National Park status may be inappropriate for natural forest areas:

- It may not be in the best interests of the nation to institute preservationist policies in forest areas which have always provided substantial economic and social benefits through consumptive resource exploitation. Setting aside forest areas carries very high costs (in terms of opportunities forfeited) that may not be justified by the benefits of preservation.

- Although the National Parks Act has provisions to allow for consumptive use of resources within National Parks, UNP has little experience of regulating such use.

- In many cases, local people living alongside forested areas are deeply suspicious of moves to create forest National Parks, fearing lost opportunities in the use of forest products to which they have traditionally had access. Unless the establishment of forest National Parks is socially acceptable to local people, there is a substantial risk of backlash against them, which could result in severe forest degradation, encroachment or worse (i.e. the sort of problems experienced in the establishment of Lake Mburo National Park).

- Uganda's tourist industry is not yet sufficiently strong to justify the establishment of forest National Parks in areas where this would carry high costs in terms of economic and social benefits forfeited.

- UNP is a relatively small organisation which does not possess the institutional capacity to administer properly the areas already under its jurisdiction, let alone any new ones.

- UNP and Forest Department fall under different ministries, so any transfer of custodianship between them would need to be well justified in order to overcome the professional pride of those involved.

2.2 Game Reserves and Animal Sanctuaries

The Bwindi (Impenetrable), Mgahinga, south Maramagambo and part of the Kibale and Budongo forest reserves carry dual status as Game Reserve/Animal Sanctuary and Forest Reserve. Game Reserve/Animal Sanctuary status provides legal protection to vertebrate animals, which may only be captured or killed with the permission of the Chief Game Warden (Government of Uganda, 1964a). However, this provision has been largely superseded by subsequent legislation (Government of Uganda, 1984) which out-laws hunting in all parts of Uganda. The difference between a Game Reserve and an Animal

Sanctuary is that Game Department has full jurisdiction over the land in the former, but not the latter.

The main advantages inherent in dual status as Forest Reserve and Game Reserve/Animal Sanctuary are that:

- Animals are protected, as well as plants.

- There is greater control over livestock grazing, cultivation and settlement because permission for these activities has to be obtained from senior representatives of both departments.

- The area is provided greater protection because both departments carry out patrols and management activities.

- The activities of each department are subject to scrutiny by the other, thus reducing the possibility of any environmentally damaging developments.

The main disadvantages of dual status are that:

- It is administratively inefficient and expensive to manage.

- There may be conflicts and jealousies between representatives of the two departments, especially where there is considerable difference in the level at which they are financed and equipped.

- Dual status may give rise to confusion amongst local people regarding their rights and the management objectives of the area.

2.3 Nature Reserves

Forest Nature Reserves are areas of forest reserves that are designated by the Forest Department to be protected from all forms of extractive resource use. The legal protection afforded to them is derived from paragraph 13 of the Forests Act (Government of Uganda, 1964), which provides for any forest area to be closed for the cutting and removal of forest produce at the discretion of a senior forest officer. Nature Reserves are subject to minimal management intervention, involving only boundary demarcation, the controlled burning of any grasslands, the cutting and maintenance of essential paths, and the control of any unnatural concentrations of large game animals (such as elephants displaced by disturbance elsewhere).

The objectives of maintaining undisturbed areas of forest as Nature Reserves have been described by Osmaston (1960a, 1960b) as follows. These are now somewhat out of date, and more appropriate objectives are recommended in Section 4.1 below.

- to provide areas for fundamental scientific research on the natural vegetation;

- to preserve areas unaffected by harvesting and silvicultural operations as an experimental control whereby their long-term effects may be assessed;

- to preserve plant species that, though considered weeds at present, may later be found to have special uses; and

- to preserve natural habitats for animals and birds adversely affected by developments in the rest of the forest.

As will be shown in Section 3 below, Nature Reserves as presently constituted are usually far too small to serve as effective reservoirs of plants and animals for the maintenance of biodiversity throughout a forest reserve, and they have proved highly vulnerable to degradation. Nevertheless, the establishment of new Nature Reserves, perhaps incorporating the existing ones, offers a viable option for the protection of undisturbed forest habitats within the larger production forests.

2.4 Forest Parks

The Forest Department has recently proposed the establishment of a new category of multiple-use conservation area known provisionally as a Forest Park (Kigenyi, 1988). This would be equivalent to a Category VIII Multiple Use Management Area/Managed Resource Area as defined by IUCN (Mackinnon *et al.*, 1986; Table 4.1). As proposed by a Ministry of Environment Protection select committee, Forest Parks would fall under the control of a Forest Parks Commission and be managed by the Forest Department. At least 50% of their area would be protected against extractive resource use; no mechanised exploitation would be permitted; manual harvesting of forest products would be licensed and strictly regulated within designated areas; and Park guards would be empowered to enforce regulations protecting both animal and plant life (Kigenyi, 1988).

It is difficult to comment on the possible advantages and disadvantages of this category of protected area until some firm proposals have been developed. However, on the basis of the recommendations of a Ministry select committee (Kigenyi, 1988), it would appear that Forest Parks could be developed in a way that would give them many of the advantages of National Park status whilst overcoming the more serious disadvantages mentioned under Section 2.1 above. The type of arrangements that have been proposed show considerable merit and warrant serious consideration. In particular, the development of a strong nature conservation capacity within the Forest Department (which would be necessary for Forest Park management) would facilitate the adoption of natural forest management policies that are increasingly sensitive to environmental concerns. It is the intention that the nation's timber requirements should be satisfied increasingly from softwood plantations (World Bank, 1986), so that the emphasis of natural forest management can shift from timber production to become increasingly multiple-use. But this will inevitably take time, and it may be a decade or more before the transition is completed. The development of Forest Parks would provide the Forest Department with a formal mechanism for the adoption of appropriate multiple-use management policies, without relinquishing control of them to Uganda National Parks. In time, as the nation becomes less dependent on the natural forests as a source of timber, and the national economy recovers, it is possible that many of the principal natural forests could become Forest Parks. It is quite conceivable that the two Ministries responsible for the management of protected areas might ultimately be merged, thus paving the way for subsequent rationalisation of protected areas throughout the country. In the meantime, the proposal to develop Forest Parks appears to be a pragmatic response on the part of Forest Department to present-day issues facing natural forest management.

That said, it should be noted that Forest Department is unlikely to play a major role in developing tourism, and forest areas that have high tourist potential, combined with a need for strict forest protection - as, for example, in the high mountain catchment forests of Rwenzori, Mount Elgon and Mgahinga - would more appropriately be administered by Uganda National Parks.

3. Location and status of existing Nature Reserves

During the course of fieldwork, I visited most of the existing Nature Reserves to assess their present status. Table 4.2 summarises the results of these surveys. In addition to the ten Nature Reserves listed here, eight small islands (totalling about 4 km^2) in the Sesse Islands of Lake Victoria and a part of the Mgahinga Forest Reserve have been designated as Nature Reserves.

According to the latest working plans (now all out of date) Nature Reserve establishment has been a management objective in nine of the twelve principal forest reserves covered by this programme: only in the Kasyoha-Kitomi, Itwara, and Sango Bay reserves was it not previously considered important. However, the implementation of Nature Reserve management prescriptions appears to have been rather ineffective, since little documentation exists on the location of Reserves; several proposed Reserves have never been designated; and most of those that have been designated, surveyed and documented have lacked the protection necessary to prevent timber cutting and/or agricultural encroachment. A summary of Nature Reserve prescriptions and management problems follows, for each of the principal forests.

Table 4.2 List of forest Nature Reserves, and their present status, based on field observations carried out in 1986/7

Forest Name	Location of Nature Reserve	Size(km2)	Present status
KIBALE	1. Central block (shown on FD map TO/IIIA)	59	Essentially intact (pers.obs.)
	2. North Kibale, compartment 22 (" ")	3	Heavily exploited by pitsawyers (Basuta, pers. comm.)
SEMLIKI	East of Kirimia river	84	About 10% of the area affected by agricultural encroachment - otherwise intact (pers.obs.)
BWINDI (IMPENETRABLE)	1. Ishasha river (shown on FD map SKI/20A)	3	Heavily exploited by pitsawyers (Butynski, pers. comm.)
	2.Ntendure hill (" " " " " ")	10	Heavily exploited by pitsawyers (Butynski, pers. comm.)
BUDONGO	Nyakafunjo, compartment NI5 (shown on FD map NBN/83B)	9	Essentially intact (pers.obs.)
BUGOMA	Musara block (shown on FD map BN/39A)	6	Essentially intact (pers.obs.)
KALINZU	Kasunju hill (shown on FD map AN.44: KI.49 included in the 1960-70 Working Plan)	8	'Creamed' of best timber trees by pitsawyers (pers. obs.)
MABIRA	1. Namaganda South, compartment 209 (shown on FD map EME 66).	3	'Creamed' of best timber trees by pitsawyers (pers. obs.)
	2. Musamya West, compartment 216	8	Essentially intact (Kramer, pers. comm.)

Kibale Forest Reserve: A Nature Reserve 'Working Circle' (management regime) was established for the first time in 1959, and two widely separated management compartments allocated to it (Osmaston, 1959). These were both marked clearly on management maps of the forest, so there is little confusion over their location. The 1959-65 working plan also proposed the establishment of a representative Reserve in the south of the forest (possibly part of the lower Dura valley), before any exploitation was allowed to take place in this area; and another 'provisional' Nature Reserve in the wild coffee areas. Nothing has subsequently been done about the two proposed Nature Reserves, but one of the others was enlarged substantially in the mid-1970s and the new boundaries marked on management maps of the forest. According to G.I. Basuta (pers. comm.) the smaller of the two existing Nature Reserves has been heavily exploited by pitsawyers in recent years, but the larger one (used as a study area by researchers of the Kibale Forest Project) is essentially intact.

Semliki Forest Reserve: Approximately one third of this reserve (the area east of the Kirimia river) was allocated to a Nature Reserve and Animal Sanctuary Working Circle in 1961 (Leggat, 1961). At that time, no specific management prescriptions were drawn up, pending 'an investigation by a competent authority to determine the type of forest and minimum area required to preserve the fauna and flora'. No such investigations were carried out, and no revision of the working plan was made after it expired in 1971. The Nature Reserve has suffered from agricultural encroachment, affecting an estimated 10% of its area, and several small groups of Batwa pygmies (perhaps 20-40 individuals altogether) are residing in the area. These people, and others from outside the reserve are avid hunters of the larger mammals, including primates.

Bwindi (Impenetrable) Forest Reserve: Two Nature Reserves, each about 2.5 km^2, had been provisionally selected in this forest when the latest working plan was written in 1961 (Leggat and Osmaston, 1961). It was decided that the selection should be confirmed by on-the-ground inspection before any final designation of the areas took place. No action was taken on this until long after the working plan had expired, but in 1984 two Reserves were finally designated and marked on the forest management map. However, there has been no active protection of these areas, which have suffered badly as a result of pitsawing and hunting activity (T. Butynski, pers. comm.). Butynski (1984b) has proposed a system of seven Nature Reserves for this forest, and there has been a long standing proposal to designate the whole area as a National Park (Wheater, 1971; Butynski, 1984a).

Budongo Forest Reserve: The 1945 working plan for this forest prescribed the establishment of three Nature Reserves, namely Nyakafunjo (9.2 km^2), Kenge (0.4 km^2) and Balmoral (1.1 km^2). However, none of these was apparently established until the beginning of the next working plan period (1955-64), when the Nyakafunjo Nature Reserve came into being. There is no record that either of the two smaller Reserves was ever designated, but Nyakafunjo was marked on all management maps and has subsequently received good protection. It lies at the edge of the forest, close to the Nyabyeya Forestry College, and is used as a teaching area.

Bugoma Forest Reserve: A Nature Reserve Working Circle was established for the first time in 1959, and one un-numbered management compartment allocated to it (Osmaston, 1959). The Reserve is located several kilometres from the nearest road in an area of low population pressure where it is unlikely to have suffered serious degradation. I viewed the area from a nearby hill in April 1987, and was satisfied that its integrity was under no immediate threat. Osmaston (1959) suggested that it may be desirable to establish a second Nature Reserve in the extreme south of the forest in future, but no action has been taken on this.

Kalinzu Forest Reserve: An area of about 8 km^2 to the west of Kasunju Hill was designated as a Nature Reserve in 1960, providing an unrivalled example of the transition of forest types from over 1,800 m to below 1,100 m within a small area. Although its location was clearly marked on a map included in the 1960-70 working plan, the area has received poor protection and many of the larger timber trees have been cut by pitsawyers in recent years. When I visited the area in November 1985, several pitsawyers told me that they had paid the local Forest Guard the 'necessary fees' to allow them to cut timber here, and were unaware of the area's designation as a Nature Reserve. Furthermore, several tree stumps had been stamped with a Forest Department (FD) letter die. The Forest Guard has since been dismissed.

Mabira Forest Reserve: Provision for the establishment of a 5 km^2 Nature Reserve in Mabira was made in the 1948-57 working plan (Sangster, 1948), but according to the 1961-71 plan, no action was taken, despite the identification of a suitable (2.5 km^2) area to the west of the Musamya river by the Forest Ecologist (Webster, 1961). The 1961-71 plan again prescribed the selection and designation of a (2.5 km^2) Nature Reserve in Mabira (Webster, 1961). Subsequently two areas were identified as possible Nature Reserves, but it is not clear whether they have been officially designated. No Nature Reserve is marked on the Headquarter's management map of Mabira (sheet KYA 113), although the senior cartographer informs me that the whole of management compartments 209 (3 km^2) and 216 (8 km^2) are designated as such. (G. Mubiru, pers. comm.). Compartment 209 is recognised as a Nature Reserve on management maps of the forest held in the Regional and District forest offices (sheet EME 66), and is taken by District forestry staff to be the only area in Mabira accorded this status (S. Mpangire, pers. comm.). The Senior Forest Officer-Protection is reported to recognise compartment 216 as a Nature Reserve (G. Mubiru, pers. comm.). Whatever the status of these areas on paper, it is known that compartment 209 has been exploited by pitsawyers, especially in the past two to three years (pers. obs.; S. Kramer, pers. comm.); and that compartment 216 remains essentially intact (S. Kramer, pers. comm.), probably because of its remote location.

Mount Elgon Forest Reserve: A Nature Reserve was first proposed in 1954, in the *Aningeria-Entandrophragma* forests in the vicinity of the Manafwa valley (Webster, 1954). This proposal had not been adopted by the time the first working plan revision was undertaken in 1968, and it was then suggested that it should receive 'urgent attention when any plans are formulated for exploitation or plantation' (Synnott, 1968). Three areas were subsequently proposed for reservation, one in the montane forest, one in the giant heather zone and one in the higher-lying Afro-alpine zone (Forest Department records, Mbale, 1972), but no action was taken. In addition, there has been a long-standing proposal to establish a National Park in the Mount Elgon Forest Reserve (Wheater, 1971), possibly contiguous with the one that already exists on the Kenyan side of the mountain.

Rwenzori Forest Reserve: The first proposal to establish a Nature Reserve in the Rwenzori Forest Reserve was made in 1961 (Leggat and Beaton, 1961), although the area had been proposed for National Park status long before that (R. Bere, pers. comm.). The first revision of the working plan prescribed the selection of a representative Nature Reserve before 30 June 1961 (Leggat and Beaton, 1961), and suggested the Nyamugasani valley as a possible site. However, no action was taken on this, and there is still no Nature Reserve in the Rwenzori forest.

Clearly, the Forest Department has long recognised the need to establish a system of representative Nature Reserves throughout the forest estate, but the actual designation and protection of appropriate areas has been haphazard and largely ineffective. A total of 24 Nature Reserves has been proposed at various times in the nine principal forest reserves listed here, of which only nine have been officially designated and are currently recognised, at least on paper. Of these nine, only three remain essentially intact, whilst the remainder have been seriously disturbed by pitsawyers or agriculturalists. Of the three that survive, Bugoma and central Kibale lie in very remote locations while central Kibale and Budongo have the advantage of being used for research and teaching. Of the six that are known to have suffered disturbance, all are in areas of high human activity, and have suffered from numerous small-scale incursions (pitsawing, hand-tool agriculture) rather than large-scale commercial exploitation (such as mechanised logging).

4. Expanding the protected area network

There is a widespread appreciation in Uganda of the need to expand the existing network of areas set aside to protect natural forest ecosystems, and provide effective management of these areas. This has resulted in proposals to re-gazette some of the Forest Reserves as National Parks (Wheater, 1971; Struhsaker and Malpas, 1982; Butynski, 1984; Howard, 1988a), and has given rise to the Forest Department's recent proposal to establish Forest Parks (Kigenyi, 1988). In addition, the Forest Department has undertaken to expand the forest Nature Reserve network to cover 20% of the country's reserved natural high forest estate, and protect a further 30% from intensive forms of forest management as 'buffer zones'. Clearly, the choice of an appropriate management strategy for each of the country's forests must be based on established scientific principles so I include a summary of the more important considerations in Appendix U. Further useful reviews of this subject are provided by Margules and Usher, (1981), Hall (1983/4), Mackinnon *et al.*, (1986), Usher (1986) and McNeely *et al*, (1987).

4.1 Basis of a strategy for network expansion

Many of the considerations that have to be taken into account when designing a network of protected areas (which are reviewed in Appendix U) create conflicting demands which it is difficult to reconcile. Nevertheless they must all be carefully evaluated, as objectively as possible, and a protected areas system developed that considers them all. I suggest that an appropriate strategy for Uganda's forests should adopt the following guidelines.

- The overall objectives of the protected area network should be:

  (a) to ensure the long-term survival of as many a possible of Uganda's forest species;

(b) to maintain viable, representative samples of each of the major forest types in an undisturbed state;

(c) to provide suitable areas for fundamental scientific research, education and other forms of non-consumptive use including recreation and tourism.

(d) to help sustain the productive capacity of adjacent production forests, and their role in environmental protection, by serving as a reservoir of plant and animal species able to disperse and recolonise these areas.

- The figure of 20% of the natural forest which the Forest Department has proposed for designation as Nature Reserve should be accepted, at least as a medium term (5-10 years) objective. This would be in addition to any forest area that is included within a National Park or Forest Park.

- The proportion of each forest reserve to be given higher conservation status should be decided upon according to objective criteria that take into account the number and rarity of the species it supports, the diversity of its habitats, its potential use as a timber producing area, and its potential for non-consumptive forms of use such as research, education, recreation and tourism.

- The protected area network should ensure the preservation of viable representative samples of all major forest communities and guarantee the diversity of ecological interaction contained within them. This can best be achieved by establishing several large protected areas in different geographical regions, including at least one in each altitudinal zone. These should include the greatest possible range of habitat types, the richest examples of those habitats, and the widest possible altitudinal continuum.

- The network of major protected areas should be supplemented with a larger number of smaller subsidiary ones selected to protect additional distinctive habitats and regional habitat sub-types; to protect sites of special importance to particular species (e.g. communal breeding or nesting sites, feeding areas, etc.); and provide additional areas for research, education, recreation and tourism development.

- Each area selected for upgrading should be designed as an integral component of the forest reserve in which it is located. In accordance with the principles of reserve design developed under UNESCO's Man and the Biosphere (MAB) programme (Batisse, 1982), each forest reserve should be zoned into a number of concentric resource management areas (Fig. 4.1). The objectives of management within each zone differ, as do the management practices adopted. Within a totally protected 'core area' the primary management objective is the maintenance of biotic diversity. In contrast, the outer management zone is more intensively managed for the sustained production of timber, and the maintenance of biotic diversity assumes only secondary importance. A low intensity-use zone serves to 'buffer' the totally protected 'core area' from the more intensively managed outer zone (Fig. 4.1). Wherever possible, community forestry programmes should be encouraged in the areas bordering the reserve, so as to reduce the demands of local people for forest products from within the reserve.

This model of protected area design is entirely appropriate to the situation in Uganda's forest reserves. As a broad guideline, 30% of the forested land within each of the forest reserves should be managed as low-intensity use zones. An important function of these zones would be to connect core areas within any forest, allowing the movement of animals and dispersal of seeds between them and

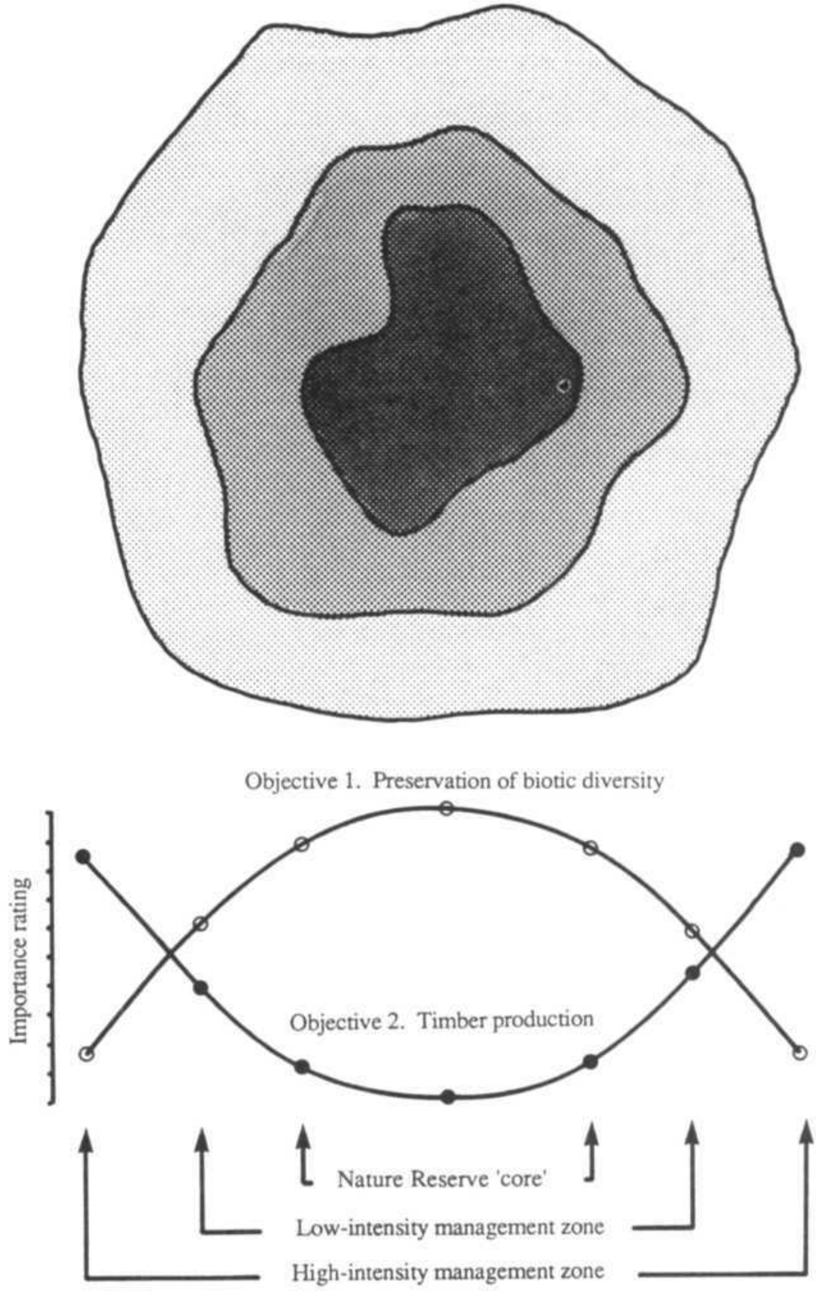


Fig. 4.1 *A 'model' forest reserve with a totally protected 'core area surrounded by concentric zones in which management becomes progressively more intensive towards the reserve boundary. The preservation of biotic diversity is the primary objective of management in the Nature Reserve 'core', whereas timber production is the primary objective of management in the outer zone. The relative importance of the two management objectives is inversely related, and changes gradually from the reserve's core to its boundary. After Harris (1984).*

preventing them from becoming too isolated from one another. The concept is illustrated in Fig. 4.2.

- The selection of areas for upgraded conservation status should give preference to mature climax forest communities that are unaffected by human disturbance.

- Precautions should be taken to avoid possible land-use conflicts by siting protected areas in forests (or parts of forests) that are unlikely to prove especially valuable for timber production, or other uses that are incompatible with protected status.

4.2 Application of the strategy

In this section I elaborate a scoring system that can help guide decisions on the development of an appropriate protected area network in Uganda's forests. Scoring systems of the kind described below are widely used in conservation planning (see, for example, Margules and Usher, 1981; MacKinnon, 1986; Usher, 1986) because they help ensure that management decisions are taken as objectively as possible, according to clearly defined criteria. Of course they can never be perfectly objective, because some rather subjective decisions have to be taken in the selection of the criteria to be scored. The scores derived will always be the subject of debate and controversy, and it would be inappropriate to interpret them too literally or regard them in any way as definitive. Their value lies more in helping to clarify thinking on the issues that need to be considered in conservation planning, than in providing firm guidelines for action. Thus, the analysis below, which

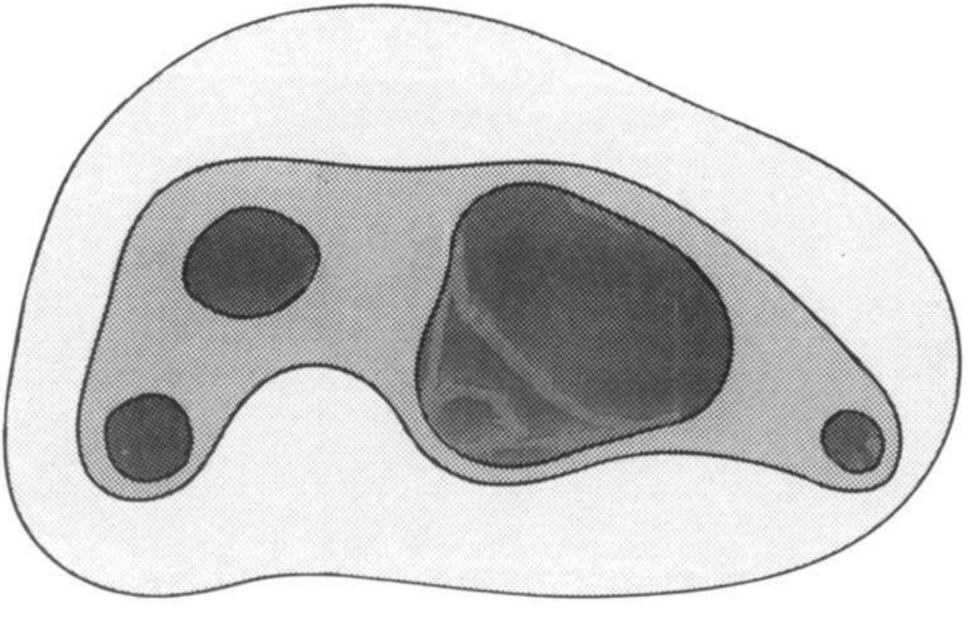


Fig. 4.2 *Idealised zoning of a major forest reserve, with one large Nature Reserve protecting a substantial 'core area' of undisturbed forest connected, by means of a low-intensity use ('buffer') zone to three smaller 'satellite' Nature Reserves which protect distinctive habitats or features not represented in the 'core area'. The outer management zone is intensively used for timber production.*

depends too heavily on incomplete and outdated information, should be viewed as an illustration of an appropriate approach to conservation planning in Uganda's forests, which could be debated, refined and developed as more information becomes available, before being used to guide the establishment of protected areas.

The method employed derives an overall importance score for each forest reserve by considering its importance for species conservation, its importance for threatened animals, its importance for ecological community conservation, its potential for non-consumptive multiple-use, and its potential as an area for timber production. Each of these five parameters is given equal weighting, and the overall importance score for each forest is used to determine the proportion of its total area to be protected.

The scoring system is designed primarily as a means of deciding on the size and distribution of protected areas within the tropical high forest zone, and, for simplification, I have excluded the Rwenzori and Mount Elgon reserves from the final evaluation. There are several reasons for this, the most important being the fact that these high mountains serve critical water catchment functions, which precludes serious considerations of anything but strict protection of these areas. Much of the habitat in these reserves lies above the tree line so the criteria that are important in deciding on appropriate forms of protection are quite different to those applied in the tropical high forest reserves.

The five component scores are calculated as follows:

- An importance score for species conservation has already been calculated for each forest in Chapter Two. These scores reflect each area's importance for plant and animal conservation, determined by consideration of the number and rarity of the species present. The importance values given in Chapter Two were re-scaled to give a maximum score of 10, equivalent to the scores derived for other parameters (see below).

- An importance score for threatened animals was derived for each forest by considering the number and conservation importance of animals under threat of global extinction. Species classified as endangered were allocated a score of 3, those classified as vulnerable or indeterminate a score of 2, and those classified as rare a score of 1. A total for each forest was derived by adding each of the individual scores (based on the species list provided in Chapter Two, Table 2.6), and then re-scaling these totals to give a top score of 10.

- An importance score for ecological community conservation was derived from consideration of the altitudinal zones represented in each forest reserve, as a measure of habitat heterogeneity. The presence or absence of successive 100 m altitudinal zones in each forest was first tabulated (Table 4.3), and each altitudinal zone allocated a total score of 1.00 to be divided between the number of forest reserves in which forest habitat occurs at this altitude. These individual scores are summed for each forest to give an initial importance score (A, Table 4.3). Thus, the magnitude of the score for any given forest depends on the uniqueness of the altitudinal zones represented in that forest, as well as the overall altitudinal range. The final importance score (B, Table 4.3) is derived as the initial score re-scaled so that the highest-scoring forest is given a value of 10.0.

Table 4.3 Representation of different altitudinal zones in the principal forests, and derived scores for ecological community conservation importance. + denotes forest reserve includes more than 1 km2 of forested land at the altitude indicated. - denotes that it includes no forest at this altitude, or not more than 1 km2. For derivation of scores, see text.

	FOREST RESERVE												
ALTIDUDINAL ZONE (m)	Kibale	Semliki	Budongo	Kalinzu-Maramagambo	Bugoma	Bwindi (Impenetrable)	Kasyoha-Kitomi	Itwara	Sango Bay	Mabira	Mount Elgon	Rwenzori	Mean score per forest unit
601-700	-	+	-	-	-	-	-	-	-	-	-	-	1.00
701-800	-	+	-	-	-	-	-	-	-	-	-	-	1.00
801-900	-	-	+	-	-	-	-	-	-	-	-	-	1.00
901-1000	-	-	+	+	+	-	-	-	-	-	-	-	0.33
1001-1100	-	-	+	+	+	-	+	-	-	+	-	-	0.20
1101-1200	+	-	+	+	+	-	+	-	+	+	-	-	0.14
1201-1300	+	-	-	+	-	+	+	+	-	+	-	-	0.17
1301-1400	+	-	-	+	-	+	+	+	-	-	-	-	0.20
1401-1500	+	-	-	+	-	+	+	+	-	-	-	-	0.20
1501-1600	+	-	-	+	-	+	+	-	-	-	+	-	0.17
1601-1700	-	-	-	+	-	+	+	-	-	-	+	-	0.25
1701-1800	-	-	-	+	-	+	+	-	-	-	+	+	0.20
1801-1900	-	-	-	-	-	+	-	-	-	-	+	+	0.33
1901-2000	-	-	-	-	-	+	-	-	-	-	+	+	0.33
2001-2100	-	-	-	-	-	+	-	-	-	-	+	+	0.33
2101-2200	-	-	-	-	-	+	-	-	-	-	+	+	0.33
2201-2300	-	-	-	-	-	+	-	-	-	-	+	+	0.33
2301-2400	-	-	-	-	-	+	-	-	-	-	+	+	0.33
2401-2500	-	-	-	-	-	+	-	-	-	-	+	+	0.33
Initial importance score (A)	0.9	2.0	1.7	1.9	0.7	3.5	1.5	0.6	0.1	0.5	2.9	2.5	
Final importance score (B)	2.5	5.7	4.8	3.8	1.9	10.0	4.4	1.6	0.4	1.5	8.4	7.2	

In my use of this parameter, I am suggesting two things. First, that forests which occur at altitudes that are not represented elsewhere, or are relatively rare, should have more of their total area protected than those that occur at altitudes represented in many different forest units; and, second, that the greater the number of altitudinal zones represented in any given forest, the more valuable an area becomes for habitat conservation. The score is unquestionably crude, since it uses altitude as a single criterion upon which to assess an area's value, and ignores many other important factors which determine the type and diversity of habitat. However, it is generally accepted that the selection of reserves for wide topographical heterogeneity is an easier way of ensuring the protection of a wide range of species than making very large reserves (Mackinnon and Mackinnon, 1986), and the approach adopted here appears justified in view of the poor information-base upon which proposals are being made. The inclusion of this score is likely to correct the effects of bias in the derivation of the importance score for species conservation arising from the use of incomplete species lists (Chapter Two, Section 2.2.1).

- A simple score reflecting each forest's potential for the development of non-consumptive multiple-use of resources was derived by consideration of ten relevant criteria listed in Table 4.4. Each forest was allocated a score of 0 or 1 against each criterion, and a total score for multiple-use potential was derived as the sum of these individual scores re-scaled to give the highest scoring forest a value of 10.0. In my use of this parameter I am suggesting that forests with a high potential for non-consumptive multiple-use should have more of their total area protected than those with lower potential.

- A score was derived for each forest's suitability for commerical forestry by considering the quantity of standing timber and the accessibility of each forest. The average tree basal area (m^2/ha) is divided by a three-point accessibility rating for each forest to derive an initial score which is then re-scaled so that the highest-scoring forest is given a value of 10.0 and the others are scaled down accordingly (Table 4.5). Although the data used are based on old enumerations, they are the best currently available and are probably indicative of the present situation in most areas. In my use of this parameter I am acknowledging that forests which have a high potential for commercial forestry on account of being well-stocked and easily accessible cannot, realistically, have as much of their area protected against exploitation as those with low commercial forestry potential.

The five scores derived in this way provide a reasonably objective basis for evaluating the suitability of the country's principal forests for upgraded conservation status. A summary of the scores for each forest is provided in Table 4.6. An overall importance score for biological conservation (D; Table 4.6) is derived as the sum of the individual scores for species, threatened animals and ecological community conservation; and an overall importance score for protected area establishment (G; Table 4.6) is derived as the sum of the scores for biological conservation and multiple-use potential minus the area's suitability for commercial forestry.

Examination of these scores in relation to the conservation objectives applicable to different categories of protected area (Table 4.1), and the discussion in Section 2 above, provides a basis for proposing appropriate conservation status for different areas. Overall, the Bwindi

Table 4.4 Potential for non-consumptive multiple-use of the principal forests, based on ten relevant criteria

Non-consumptive multiple-use criterion	FOREST											
	Kibale	Semliki	Budongo	Kalinzu/	Bugoma	Bwindi	Kasyoha-	Itwara	Sango Bay	Mabira	Mount Elgon	Rwenzori
GENERAL ISSUES												
1. Vehicular access to within 1 km of undisturbed forest	+	+	+	+	-	-	-	-	-	-	+	-
2. High human population (> 200/km2) in areas surrounding reserve	-	+	-	+	-	-	+	-	-	+	-	+
3. Visitor facilities (e.g. trails, campsites) exist	+	-	+	+	-	+	-	-	-	+	-	+
RECREATION AND TOURISM POTENTIAL												
4. Forest adjoins National Park/lies on 'tourist cirdak'	+	-	+	+	-	-	+	+	-	+	+	+
5. Within 1 hr of major town with hotel facilities	+	-	+	-	-	-	-	+	-	+	+	+
6. Special attractions exist (e.g. gorillas, chimps, exceptional scenery)	+	+	+	+	+	+	+	+	-	-	+	+
RESEARCH HISTORY/POTENTIAL												
7. More than 10 person-years of ecological research completed	+	-	-	-	-	-	-	-	-	-	-	-
8. Ecological research underway and expected to continue	+	-	-	-	-	+	-	-	-	-	-	-
EDUCATIONAL VALUE												
9. Educational institution long established	+	-	+	-	-	-	-	-	-	-	-	-
10. Local environmental education programme underway	+	-	-	+	-	+	-	-	-	+	-	-
TOTAL SCORE FOR MULTIPLE USE POTENTIAL	9	3	6	6	1	4	3	3	0	6	4	5

Table 4.5 Assessment of each forests' suitability for commercial forestry, based on Lockwood Consultants' (1973) evaluations of timber stocking and forest accessibility. For derivation of forestry suitability score, see text.

FOREST RESERVE

Forestry criteria	Kibale	Semliki	Budongo	Kalinzu/ Maramagambo	Bugoma	Bwindi (Impenetrable)	Kasyoha-Kitomi	Itwara	Sango Bay	Mabira	Mount Elgon	Rwenzori
Timber stocking - Basal area (m3/ha) for trees exceeding 50cm dbh	65	27	192	82*	55	45	55	47	22	37	40+	15+
Accessibility rating **	1	3	1	1*	(1)	3	2	1	1	1	2	(3)
Forestry suitability score	3.4	0.4	10.0	4.3	2.9	0.8	1.4	2.4	1.1	1.9	1.0	0.2

** Accessibility ratings are given as 1 = readily accessible, 2 = moderately accessible, 3 = relatively inaccessible

* Kalinzu portion only considered

\+ No enumeration data available. Figures given represent an informed (personal) guess

( ) Accessibility ratings given in parentheses are personal assessments, used where no rating is provided by Lockwood Consultants (1973)

(Impenetrable) forest scores very much higher for protected area establishment than any other reserve, mainly because of its outstanding importance for biological conservation. Clearly, this forest warrants the highest possible level of protection, either as a National Park or a Forest Park. Two other forests, Kibale and Semliki, also score substantially above average for protected area establishment (G; Table 4.6), and should be considered for National Park or Forest Park status. Kibale forest scores exceptionally high for multiple-use potential, so in this case, Forest Park would appear to be the most appropriate status for the area (Table 4.1). Reference to the lists of indicator species provided as Appendices A-D reveals that these three forests together are known to harbour 75% of Uganda's forest trees, 92% of forest birds, 92% of diurnal forest primates and 97% of indicator butterflies, so adequate conservation measures in these three forests would make a very significant contribution to the preservation of Uganda's forest wildlife.

The scores presented in Table 4.6 are also useful as a basis for deciding how much of each forest should be designated for protection. If the 20% average figure proposed by Forest Department as the proportion of the natural forest to be designated as Nature Reserves is

Table 4.6 Summary of scores for various parameters contributing to the overall importance of each of the principal forests for protected area establishment and, derived from these scores, the suggested percentage of each forest that should be upgraded if a figure of 20% overall is used.

PARAMETER	Kibale	Semliki	Budongo	Kalinzu/ Maramagambo	Bugoma	Bwindi (Impenetrable)	Kasyoha-Kitomi	Itwara	Sango Bay	Mabira
A. Importance for species conservation	7.5	9.8	7.9	7.8	5.2	10.0	5.5	4.0	7.2	6.1
B. Importance for threatened animal conservation	8.7	4.4	5.0	5.6	3.1	10.0	3.7	3.7	1.2	1.9
C. Importance for ecological community conservation	2.5	5.7	4.8	3.8	1.9	10.0	4.4	1.6	0.4	1.5
D OVERALL IMPORTANCE FOR BIOLOGICAL CONSERVATION (A + B + C)	18.7	19.9	17.7	17.2	10.2	30.0	13.6	9.3	8.8	9.5
E. Non-consumptive multiple-use potential	10.0	3.3	6.7	6.7	1.1	4.4	3.3	3.3	0.0	6.7
F. Suitability of area for commercial forestry	3.4	0.4	10.0	4.3	2.9	0.8	1.4	2.4	1.1	1.9
G. OVERALL IMPORTANCE FOR PROTECTED AREA ESTABLISHMENT (D + E-F)	25.3	22.8	14.4	19.6	7.3	33.6	15.5	10.2	7.7	14.3
H. PERCENTAGE OF FOREST RESERVE TO BE UPGRADED ASSUMING 20% OVERALL*	29.6	26.7	16.8	22.9	8.5	39.3	18.1	11.9	9.0	16.7

* Derived as: $\frac{\text{Overall importance score for forest X}}{\text{mean overall importance score for all forests}} \times 20$ (overall percentage of forest land to be designated as Nature Reserve)

used as a basis for calculation, then the proportion of each reserve to be designated for protection can be calculated as

$$W/X \times 20\%$$

where W = the overall importance score for protected area establishment (G; Table 4.6)

X = the mean overall importance score for all forests

20% = the overall proportion of forest land to be designated for protection

The percentage of each reserve that would be recommended for upgrading on this basis is given in Table 4.6 (line H), and ranges between 8.5% of Bugoma and 39.3% of the Bwindi (Impenetrable) forest. Whilst accepting the limitations of the methodology used in deriving these figures (which limitations are discussed in Appendix Q), and recognising that decisions over the establishment of protected areas will probably have to be made without adequate data because of pressure from other interest groups, I use these figures as a basis for my recommendations on protected area establishment in Chapter Six and the Forest Profiles appended to this report (Appendices E - P).

5. Chapter Summary

1. The aim of this chapter is to review the options in establishing protected areas in the natural forest, consider how the conflicting demands of wildlife conservation and production forestry can best be reconciled, and derive guidelines for the establishment of an appropriate protected area network.

2. Under existing legislation, there are three ways to increase the level of legal protection afforded to Uganda's reserved forests, namely to designate them as National Parks, Game Reserves/Animal Sanctuaries or Nature Reserves. The possibility of a fourth category, to be known as Forest Parks, is presently under discussion. The four categories are described, and the main advantges and disadvantages of each outlined.

3. Forest Nature Reserves, designed to protect examples of undisturbed forest, have been established in most of the country's principal forest reserves. Fieldwork conducted as part of this project has shown that 24 Nature Reserves have been proposed at various times in the principal forest reserves, of which only nine have been officially designated and are currently recognised, at least on paper. Of these nine, only three remain essentially intact, whilst the remainder have been seriously disturbed by pitsawyers and agriculturalists.

4. Guidelines are provided for an expanded protected area network, based on consideration of relevant biological and management criteria. An appropriate management system would involve the zoning of each forest reserve into a totally

protected Nature Reserve core, surrounded by a benign buffer zone in which low-intensity harvesting of forest resources were permitted, with an outer zone managed for maximum sustained production of forest products. On average, the core area might represent 20% of the total, with 30% designated as buffer zone. A scoring system is used to illustrate how important decisions over the size and location of forest Nature Reserves in different forests can be made as objectively as possible.

Chapter Five: Integrating Forest Conservation into District Development: a Case Study

by Peter Howard, Francis Butono [1], Patrick Kayondo-Jjemba [2], and Charles Muhumuza [3]

1. Introduction

In this chapter we describe an integrated natural resources development study that we conducted in Bwamba County, Bundibugyo District from July 1986 to December 1987. Bwamba is a remote region in the extreme west of Uganda, where some particularly valuable forests lie alongside one of the most densely populated rural areas of the country. Most of the forest which once occurred on public land in Bwamba has been cleared to make way for agriculture, and widespread encroachment of the county's forest reserves has become a major problem in the past fifteen years. Against this background, the Bwamba Natural Resources Development Project was initiated in May 1986 with the following objectives:

- to gather baseline data on the renewable natural resources of the area;
- to document present systems of resource use;
- to identify environmental management problems and their causes, with particular reference to deforestation and the encroachment of forest reserves; and
- to make recommendations for improvements in natural resources management aimed at raising the living standards of local people whilst maintaining, on a long-term basis, the area's great biological diversity and the ecological life-support systems upon which economic development depends.

---

1 District Forest Officer, Ministry of Environment Protection, P.O. Box 1144, BUNDIBUGYO
2 Research Officer, Kawanda Research Station, Ministry of Agriculture, P.O. Box 102, ENTEBBE
3 Acting Deputy Vice Principal, Nsamizi Training Institute of Social Development, Ministry of Local Government, P.O. Box 92, ENTEBBE

2. Study area description

Bwamba county occupies an area of approximately 850 km^2 in Bundibugyo District in the extreme west of Uganda, between the northern spur of the Rwenzori Mountains and the Zaire border (Fig. 5.1). It is an area exceptionally well endowed with renewable natural resources. To a large extent, this can be attributed to the vast range of altitude represented here; the highest point lies in the Rwenzori at 4,400 m, the lowest in the bottom of the rift valley at 670 m. About half the county can be described as steeply sloping, mountainous country of the Rwenzori massif, whilst the remainder is of a gentler topography characteristic of the foothills and rift valley floor.

2.1 Geomorphology, geology and soils

In Miocene times, some ten million years ago, Uganda and eastern Zaire probably formed a continuous peneplain, with sediments filling whatever rift there was (Osmaston and Pasteur, 1972). At that stage, a number of rivers flowed westwards across the peneplain and the rift, draining into the Congo Basin. Subsequently, the floor of the rift sank and the sides rose, reversing the drainage of many valleys and ponding up Lake Victoria. Along the rift, major faults occurred, and the Rwenzori massif was tilted and thrust up well above the level of the ancient peneplain. The Rwenzori has since been eroded to a considerable degree, and the rift valley filled with sediments, to a depth of some 2,000 m in the Lake Albert basin. Thus, the underlying rocks of present-day Bwamba county are Kaiso-Kisegi and Semliki Series sediments in the valley bottom, and ancient Precambrian Basement Complex gneisses, granites and amphibolites on the mountain slopes.

Derived from these rocks, six major soil types can be distinguished, three on the rift valley sediments and three on the mountain-slope Basement Complex rocks (Harrop, 1960). In general, the most productive of these soils are those of the Bwamba Complex, which lie on the gently undulating land of the Bwamba lowlands; and to a lesser extent, the Mulinda Series soils of the mountain slopes between about 1,500 and 2,100 m (Table 5.1; Fig.5.2). The alluvial Semliki Series soils of the valley floor, which occupy a large part of the county (including most of the land designated as the Semliki Forest Reserve), are poorly drained dark grey clays, with a predominance of sodium in the exchange complex, which renders them unsuitable for most crops (Leggat, 1961). The higher altitude soils of the Kyansabo Series and Bujuku Complex tend to be very acid, of high organic content, and deficient in exchangeable bases (Leggat and Beaton, 1961).

A limited investigation of the soils of the Semliki Forest Reserve, involving the analysis of samples from 21 sites, was undertaken by Osmaston and Harvey in 1953 and reported by Leggat (1961). Subsequently, Jjemba (1988a) has examined well over 100 samples taken from a much wider area of the county, including soils of the Semliki Series, Bwamba Complex and Mulinda Series. The conclusions of these studies with regard to the agricultural potential of Bwamba's soils are:

- The Bwamba Complex soils are of moderate to high fertility, suitable for a wide range of crops. There is a considerable degree of local variation in soil quality related to land use and other site characteristics.

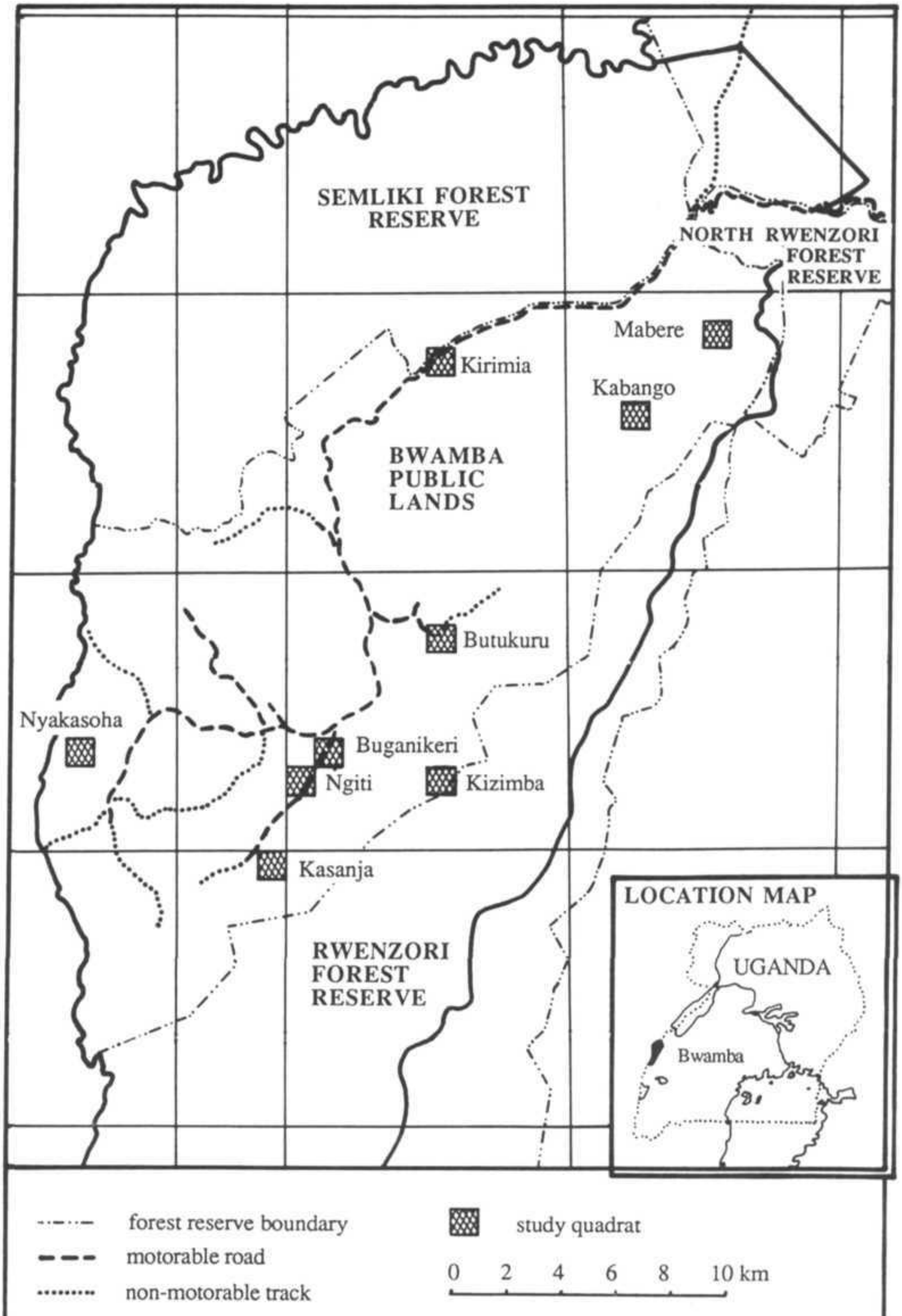


Fig. 5.1 *Bwamba County, showing the location of the forest reserves, the road network, and the ten quadrats where sampling was carried out in the public lands under this study.*

Table 5.1 The soils of Bwamba (after Harrop, 1960)

Mapping Unit	Locality*	Dominant soil types	Parent material	Productivity
Semliki Series	lower-lying areas of rift valley floor	dark grey clays alluvium	lake and river	low
Papyrus peat	alongside Semliki river	peaty soils	papyrus peat	medium to high
Bwamba Complex	raised sites in the Bwamba lowlands	deep reddish brown sandy clay loams; non-latensed	rift valley sediments and some Basement Complex granites	medium to high
Mulinda Series	Rwenzori slopes at 1,500-2,100 m	brown gritty clay loams	Basement Complex granites, gneisses, amphibolites	low to medium
Kyansabo Series	Rwenzori slopes at 2,100-3,000 m	peaty loam over dark brown loam	ditto	none
Bujuku Complex	Rwenzori slopes above 3,000 m	peat over rock or moraine	ditto	none

• See map, Fig. 5.2

- The Mulinda Series soils are slightly less fertile, but nevertheless suitable for a wide range of crops. Again, a considerable degree of local variation in soil quality is apparent.

- The Semliki Series soils are generally unsuitable for most crops, except along the river valleys where better drainage characteristics improve their potential.

2.2 Climate

The climate is tropical, governed by seasonal movements of the Inter-Tropical Convergence Zone, and by altitude and topography. There are two rainy seasons each year, from March to April and August to November. Total annual rainfall varies from about 1,100 to over 2,000 mm with the driest parts of the county lying in the rift valley, and the wettest high in the Rwenzori. At Bundibugyo township, an eight-year mean rainfall of 1,346 mm has been recorded (Jjemba, 1988a), with rain falling on 122 days per annum.

Temperatures and evaporation are closely correlated with altitude, with the highest parts of the Rwenzori experiencing frequent sub-zero temperatures and remaining under snow cover for long periods. At the other extreme, areas which lie in the bottom of the rift valley experience temperature and humidity conditions much higher than most other parts of Uganda. Bundibugyo township, and much of the Bwamba lowlands, have mean annual minimum temperatures of around 15°C, and mean maxima of about 25°C (Atlas of Uganda, 1967; Jjemba, 1988b). In short, the climatic conditions of this small area of western Uganda are extremely variable, and, as well as supporting an exceptional diversity of ecological communities, offer considerable scope for the development of a diverse and productive agriculture.

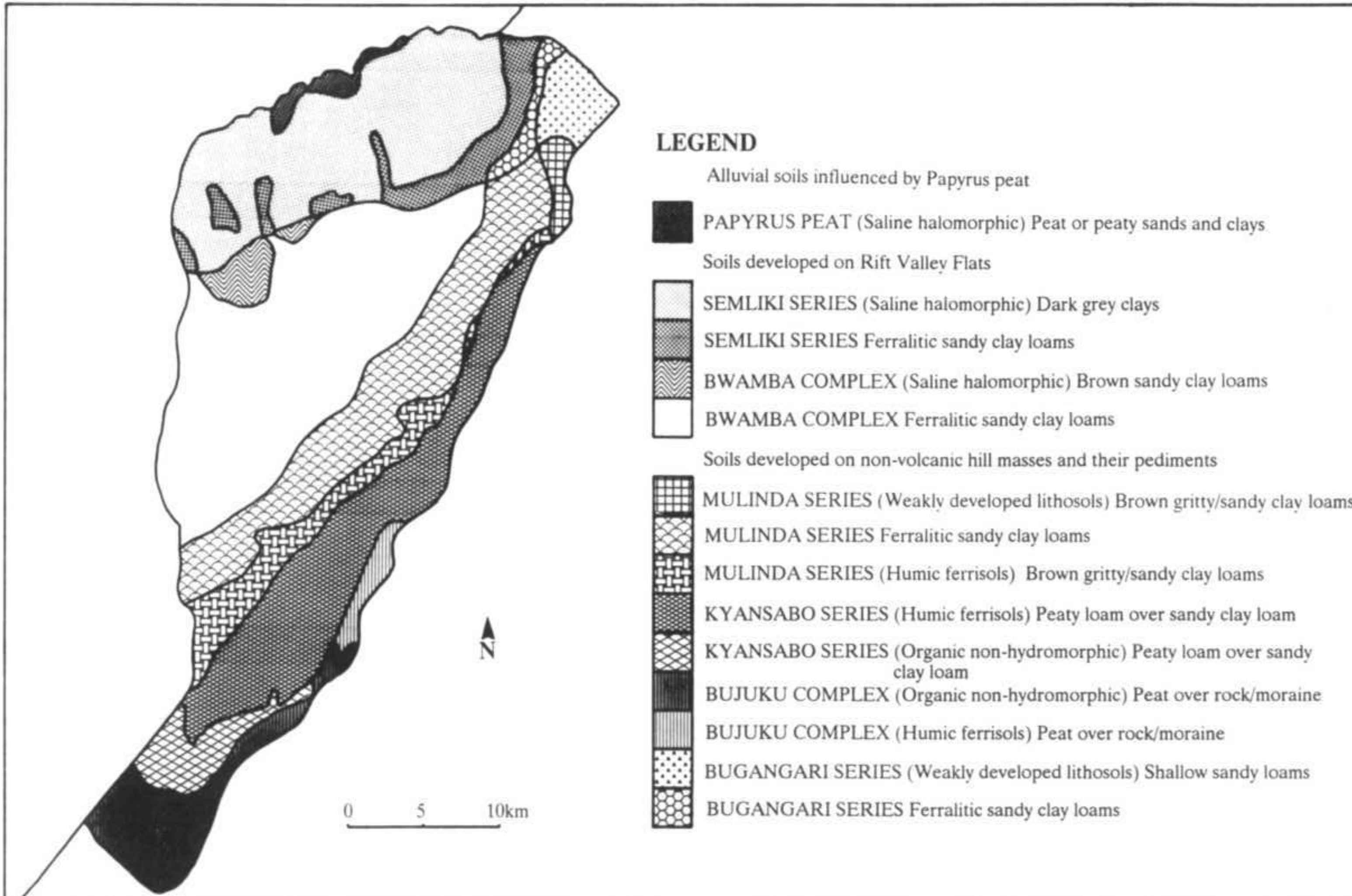


Fig. **5.2** *The soils of Bwamba*

2.3 Ecology

Ecologically, Bwamba shows strong affinities with areas of the Congo basin which lie to the west. It is, in effect, cut off from the rest of East Africa by the formidable natural barrier of the Rwenzori massif, and its forests represent an easterly extension of the great Ituri forest of north-eastern Zaire. Winter (1952) has noted the strong affinities between the people and cultures of Bwamba and those of neighbouring Zaire, and the same affinities have been recorded with respect to the wildlife of this area (Kingdon, 1971a; Van Orsdol, 1983). Howard (1988b) lists nine species of mammal, 31 birds, and eight trees which are known only from Bwamba in the East African parts of their ranges - all species characteristic of the Congo basin forests.

There are ten distinct vegetation types in Bwamba, characteristic of different altitudinal zones, soil types, drainage conditions and cultivation history (Howard, 1988b; Fig. 5.3). The most widespread of these is a forest/savanna cultivation mosaic community of intermediate altitudes, which results from prolonged human activity and is characterised by a patchwork of remnant forest patches, cultivation plots, elephant grass *(Pennisetum purpureum)* and incoming savanna trees (Langdale-Brown *et al.,* 1964). The natural vegetation of the higher reaches of the Rwenzori mountains is altitudinally zoned into four types; an Afro-alpine moorland community occurs near the top of the mountain; a giant heather zone between about 3,000 and 3,800 m; a zone of bamboo *(Arundinaria alpina)* forest between 2,400 and 3,000 m; and a zone of montane mixed forest below 2,400 m (Hedberg, 1957; Osmaston and Pasteur, 1972). On the steep foothills at about 2,100 m this montane forest gives way to the forest/savanna cultivation mosaic described above, and although the boundary between the two types is now maintained artificially (by forest reservation - see below), it does in fact coincide with a change in soil conditions (Leggat and Beaton, 1961). The northern spur of the Rwenzori is a somewhat drier area, and here the natural vegetation is maintained by fire as an open moist *Combretum* savanna. In the floor of the rift valley three distinct forest communities occur; most of the area is covered by semi-deciduous forest in which the ironwood tree *Cynometra alexandri* forms almost pure stands; there are some areas of swamp forest along the Semliki river; and the better drained sites with more fertile soils support a species-rich type of mixed evergreen forest. In addition, small areas of seasonally flooded grasslands occur in some lower-lying areas of the rift-valley floor.

The forests of Bwamba are outstandingly rich in wildlife, and internationally recognised as such (see, for example, Van Someren and Van Someren, 1949; Moreau, 1966; Friedmann and Williams, 1971; Kingdon, 1971a). Moreau (1966, p. 288) has pointed out that twenty square miles of the Semliki forest contains half as many species of birds as the entire Congo and nearly two-thirds as many as the 70,000 square miles (181,000 km^2) of the whole Upper Guinea Forest. The reasons for this great biological diversity are not entirely clear, but an important factor is thought to be that this area served as a forest refuge during the last arid period of the Pleistocene era, when conditions elsewhere on the continent were too dry to support forest vegetation. At this time, species that were dependent on a forest environment became restricted to certain refuge areas, and many subsequently failed to re-colonise new areas of forest that were re-established as conditions again became wetter. Hence those areas that served as forest refuges now support a greater diversity of species than those elsewhere (Kingdon, 1971; Hamilton, 1974; 1976; 1981). Another important aspect of the ecology of Bwamba is the fact that evolutionary processes

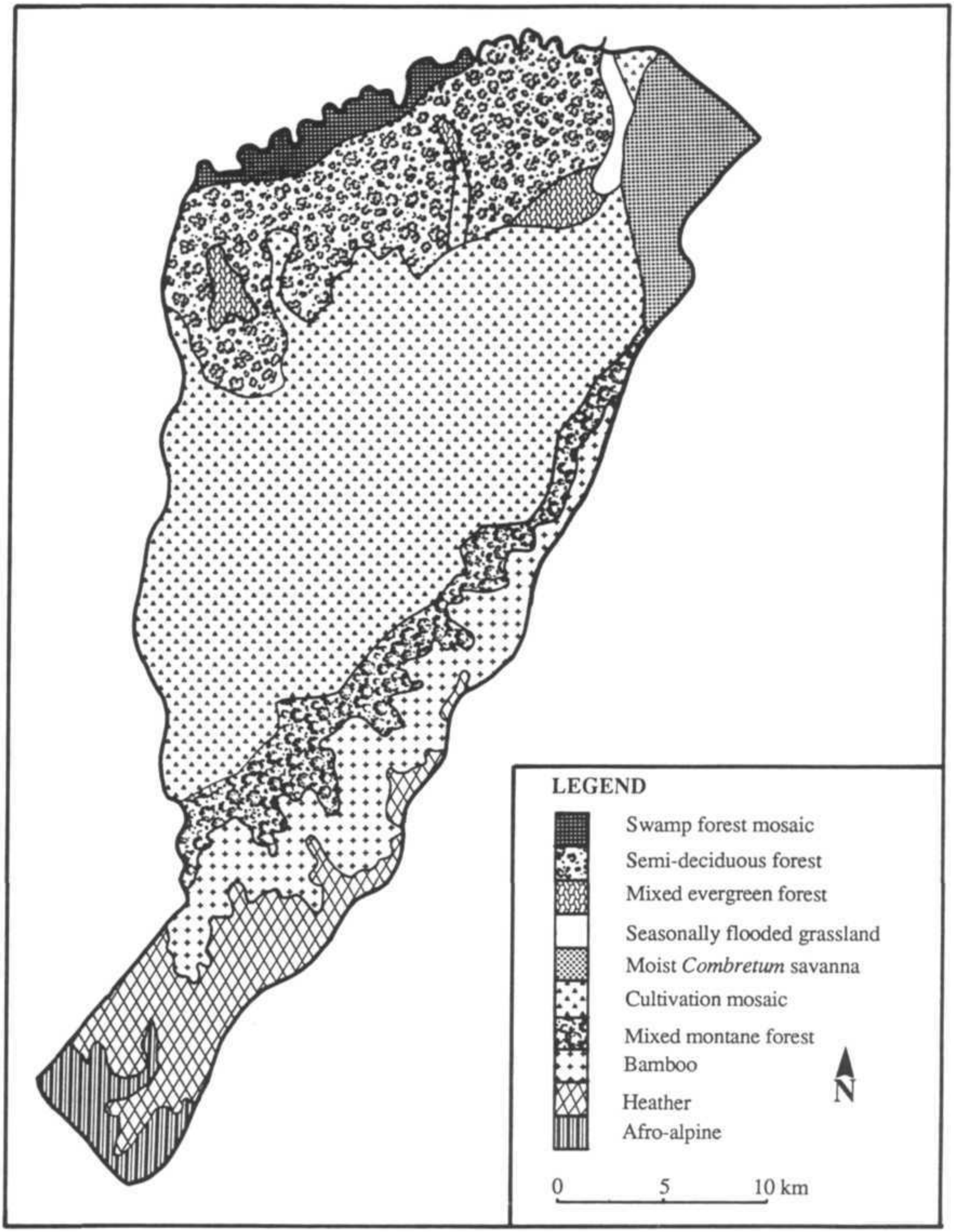


Fig. 5.3 The vegetation types of Bwamba

on the Rwenzori mountains have given rise to a great many unique plants and animals, as a result of the area's isolation as an island of montane habitat widely separated from its nearest neighbours (Hedberg, 1957; Prigogine, 1985; Mackinnon and Mackinnon, 1986; Salt, 1987).

2.4 Land Use

Bwamba has a long history of human occupation, but it is only recently that man has begun to dominate the local landscape (Winter, 1952; 1954). Until early this century the area was probably densely forested and supported scattered groups of people living in relatively isolated villages, which functioned as independent political units (Winter, 1952). Today, people have been excluded from large parts of the area which have been designated as forest reserves, and land use in the remaining areas has become progressively more intensive in response to human population growth. Bwamba is now divided into four land-use units (Fig. 5.1):

- **Public lands (390 km^2).** Most of the land lying between 750 and 2,100 m, which includes most of the potentially productive soils, is designated for agricultural development and is now densely populated. This area was, until recently, heavily forested with a species-rich mixed evergreen forest type, but most of this has now been cleared (see below), including six Local Forest Reserves (totalling 15 km^2; Butono, 1988a). The Bwamba public lands were the focus of much of the fieldwork reported here.

- **Semliki Forest Reserve (220 km^2).** Most of the forested land in the floor of the rift valley below 750 m was designated as the Semliki Forest Reserve in 1932, following the evacuation of the few people who were living there in 1924. This was largely a measure aimed at controlling the spread of sleeping sickness and yellow fever, which were especially prevalent in this area (Haddow *et al.*, 1947; Winter, 1952). Most of the land lies on poorly drained halomorphic clays which have low agricultural potential, and support a semi-deciduous forest type dominated by ironwood, *Cynometra alexandri*. Human settlement, cultivation and stock grazing are prohibited, and little active management of the area has taken place. Because ironwood has little commercial value at present, an attempt was made in the early 1970s to replace the existing tree cover with one of higher commercial value using local 'taungya' labour to clear the land (Leggat, 1961; Kingdon, 1971a; Howard 1986). Unfortunately, massive encroachment of the reserve followed, and the intended tree planting did not take place. Consequently much of the original tree cover in the western two-thirds of the reserve has been cleared, and although most of the encroachers have now been evicted, the forest remains in a severely degraded state (Appendix F; Butono, 1988a).

- **North Rwenzori Forest Reserve (8 km^2 within Bwamba county).** An area of moist *Combretum* savanna on steeply sloping land of the northern spur of Rwenzori was designated as the North Rwenzori Forest Reserve in 1940 (Leggat and Beaton, 1961). Although some agricultural encroachment of this reserve has occurred (Butono, 1988a), it is government policy to maintain and protect it free of human settlement, cultivation and stock grazing as a fire-maintained savanna for water catchment purposes.

- **Rwenzori Forest Reserve (250 km^2 within Bwamba County).** The whole of the Rwenzori mountains above about 2,100 m was gazetted as a forest reserve in 1941 with the primary objective of protecting the area's important water catchment properties (Leggat and Beaton, 1961). Apart from some exploitation of bamboos and other minor forest products by local people for their own use, the area is maintained free of human disturbance (Appendix P).

2.5 People

The people of Bwamba belong to two main ethnic groups, the Baamba and the Bakonjo, together with a small remnant population of Batwa pygmies. The Baamba are the more numerous, making up approximately 74% of the county's population (based on 1980 census statistics; Fig. 5.5). They are an agricultural people, essentially an Ituri Forest tribe, with strong cultural affinities with the peoples of eastern Zaire. Their society is matnlineal and polygamous; it has been described in remarkable detail by anthropologist, E.H. Winter (1952; 1954) who spent three years living in Bwamba in the early 1950s. The Baamba occupy the lowlands of Bwamba to the foot of the Rwenzori, an area territorially discrete from that of the Bakonjo.

The Bakonjo make up approximately 23% of the county's population (Fig. 5.5), and are the only people living on the Rwenzori slopes, both in Uganda and Zaire. Culturally, they are quite different from the Baamba, and occupy a transitional position between the Ituri

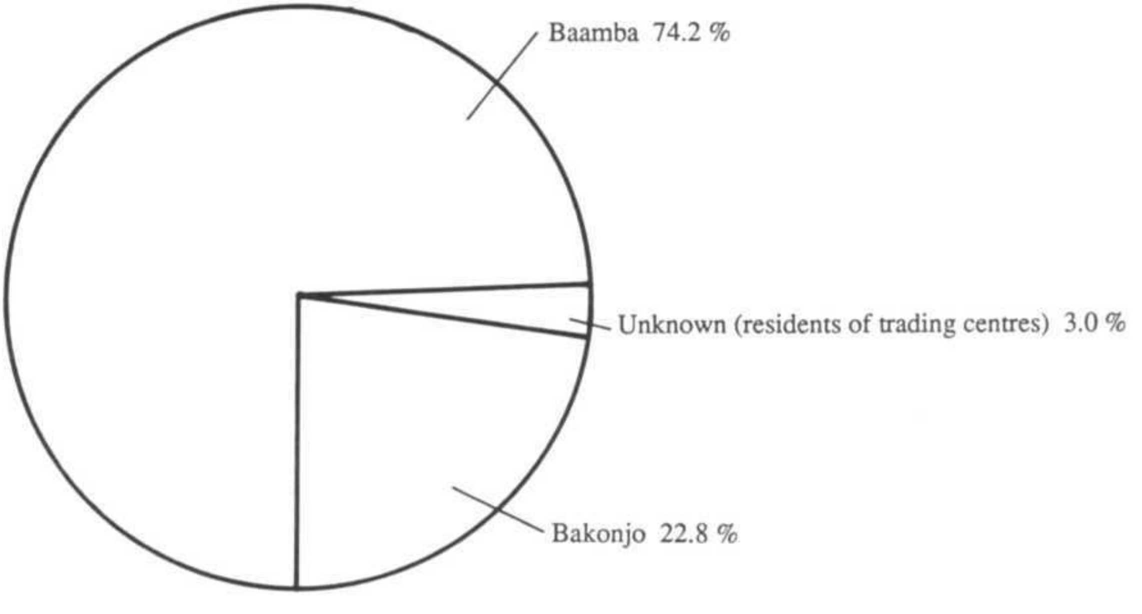


Fig. 5.5 Representation of different ethnic groups in Bwamba (based on 1980 census statistics; Anon, 1982)

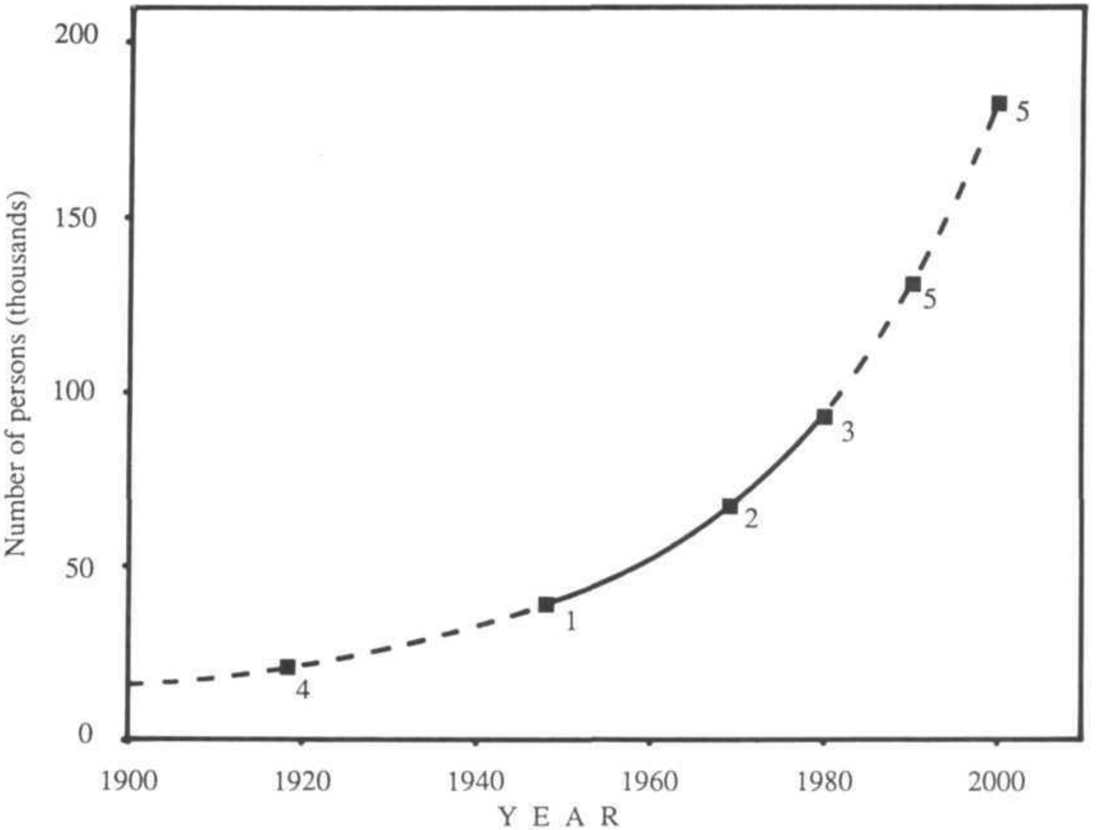
Forest tribes and the Interlacustrine Bantu living to their east (Winter, 1952). For example, they have never used the forest tribe's system of woman exchange, preferring the bride-wealth system of the Bantu. On the other hand, like the Baamba, they practise circumcision; and are avid hunters of monkeys and other forest animals (unlike the Batoro and other Interlacustrine Bantu). Their language is unintelligible to the Baamba, and there is practically no inter-marriage between the two groups (Winter, 1952).

The human population of Bwamba has grown rapidly, especially over the last fifty years. At the time of the latest census in 1980, the population stood at 93,097, up from about 65,900 in 1969, and an estimated 39,600 in 1948 (Fig. 5.6). The population was growing at the rate of 3.4% p.a. between 1969 and 1980, which suggests a 1988 population of 121,647, and 181,696 people by the year 2000. At this rate of growth the population doubles in just 21 years. Already, the public lands of lowland Bwamba are populated at a density estimated at over 380 people per square kilometre (assuming 77.1% of the county's population lives in 245 km^2 of lowland Bwamba), whilst the highland areas support an estimated 206 people per square kilometre.

2.6 Land tenure and agricultural systems

Winter (1952, 1954) has described the traditional system of land tenure in Bwamba, a system which serves a society in which land has until now been plentiful and inter-personal relationships assume much greater importance than rights over land. Traditionally, land is not 'owned', 'bought' and 'sold' as in modern western societies, but rights over it are transferred gradually between individuals and groups over long periods of time. Land falls into three categories: virgin land, land under cultivation, and resting land. All virgin land is regarded as common property, and any member of a village community is able to claim rights over it by clearing and cultivating it. When the land is later left fallow, the rights of the individual who cultivated it are retained, but gradually diminish over time. If a second man comes to clear the same piece of land without the permission of the first, he may be evicted, depending on the length of time that has elapsed since it was last cultivated. It is normal agricultural practice in Bwamba to leave land fallow for periods of 3-4 years, so if the second man came in after say, four years, the original cultivator would have no problem in asserting his rights; but if the land has been left for, say, 30 years, he would have difficulty denying the second man access to it. When a man re-opens fallow land, his claims to it are restored to their original vigour (Winter, 1952).

Today, most of the available land in Bwamba has been cultivated, so men no longer have the opportunity to acquire land rights by clearing virgin land. Traditionally, a man is able to give away his rights over resting land, a practice which has given rise to the modern system of transfer in which land rights are commonly sold by one individual to another. Muhumuza (1988b) found that 24% of households in Bwamba now occupy land acquired in this way. It is still far more common, however, for land rights to be transferred by traditional methods of inheritance from father to son, either upon the death of the father, or more gradually as the sons mature; 70% of households now occupy land acquired in this way (Muhumuza, 1988b). A noteworthy recent development in land tenure is the practice of lending land to other people for specified periods of time; 15% of householders lend part of their land to others, while 10% cultivate land loaned to them by a relative, friend or neighbour (Muhumuza, unpublished data).



Notes:

1. 1948 population estimate based on a census figure of 30,590 for the lowlands of Bwamba (Winter, 1952), assuming that this represents 77.1 % of the county's total, as in 1980 (Anon, 1982).

2. 1969 population estimate based on a census figure of 79,420 for Bundibugyo District, assuming that 83.0 % of the district's population lived in Bwamba County, as in 1980 (Anon, 1982).

3. 1980 population census figure (Anon, 1982).

4. 1918 population estimate derived as a back-projection from the 1948 census figure, assuming a population growth rate of 2.5 % p.a., as observed over the period 1948-69.

5. Population estimates derived as a projection from the 1969 and 1980 census figures, assuming a population growth rate of 3.4 % p.a., as observed over the period 1969-80.

Fig. 5.6 *Population growth in Bwamba County*

Women have no rights over land, but play a crucial role in agricultural production as the principal source of labour. They do not organise themselves into working parties, but each of a man's wives is allocated a certain piece of land which she cultivates individually. Thus, the more wives a man has, the more land he is able to put under cultivation.

A great variety of crops are grown, and farming systems depend on a considerable capital of accumulated knowledge, gained through a continuous process of experimentation with new crops, new farming techniques and different site conditions. For example, the Baamba are familiar with several dozen varieties of plantains, and know exactly which to plant where (Winter, 1954). Fanning systems have readily adapted to the introduction of new crops, including rice early in the century, coffee in the 1920s, cotton and cassava in the 1930s (Winter, 1954), cocoa in the 1950s and wheat in the 1980s. Likewise local farmers have been quick to abandon crops which no longer meet their needs; millet, which was the principal grain crop until early this century has completely disappeared, and so has cotton, one of the area's main cash crops until the 1970s. The implications of this for development are clear; the people of Bwamba are remarkably adaptable, and there should be no difficulty in introducing new systems that are appropriate to satisfying their needs.

One of the most important issues now facing the people of Bwamba is the availability of land. When Winter (1952; 1954) conducted his studies there was no land shortage in Bwamba, and he was able to examine agricultural systems under these 'ideal' conditions. He found that an average family (of 6 people) at that time cultivated 0.90 ha of land, and required a further 0.64 ha under fallow. In other words, per capita land requirements were shown to be 0.24 ha, giving a maximum possible population density of 416 people per square kilometre. In practice, some land is required for roads, buildings, streams etc, and some is inherently unsuitable for cultivation, so this theoretical maximum cannot be attained. However, the population density in the Bwamba lowlands now stands at an estimated 380 people per square kilometre (Section 2.5, as above), a figure dangerously close to the theoretical maximum. There is therefore a very real danger that any further increase in the population will result in a reduction in the length of the fallow period, declining soil fertility, and accelerating environmental degradation. Clearly, this is a critical period in the environmental history of Bwamba.

2.7 Infrastructure and services

Bwamba, by virtue of its remote location and difficult access, has remained seriously under-developed. It was not until 1938 that the area was finally made accessible by road (Winter, 1954), and effectively opened up to development activities. Nevertheless the infrastructure still remains poor, transport and communications are particularly difficult, and government services are largely ineffective. A summary of the present situation in Bwamba with respect to infrastructure and public services is provided in Table 5.2, and given further consideration elsewhere by Ndyabihika (1988), Olwitingol (1988) and Wamara (1988).

2.8 Economy

The economy of Bwamba in the 1950s has been described by Winter (1954), and appears to operate in a similar way today. It is essentially an agricultural economy, in which revenue generated by the sale of cash crops is used to finance imports of food and other commodities, clothes and other manufactured goods, and various services. The general

Table 5.2 Bwamba infrastructure and services in 1988

Facility	Present status/remarks
Roads	The county is served by approximately 70 km of motorable roads (Fig. 5.1). There is only one road out of the county, built in 1938, which is now in a very poor state of repair; it takes a minimum of 3-4 hours to drive the 80 km between Bundibugyo and Fort Portal in a sturdy 4WD vehicle. A further 30 km of formerly motorable roads are no longer passable (Fig. 5.1).
Public transport	Three old landrovers transport paying passengers between Bundibugyo and Fort Portal, a journey which usually takes about 8 hours. There is no other public service transport. The total number of serviceable vehicles (private, government, missionary and cooperative vehicles) stationed in Bwamba at present is probably 15-20.
Footpaths	The county is very well served by footpaths, including many which pass through the Semliki Forest Reserve into Zaire, and through the Rwenzori Forest Reserve to Kabarole District. A considerable amount of external trade is transacted by people using these paths.
Electricity	There is no electricity, even in the trading centres. The only generator is installed in the Bundibugyo hospital, but has rarely been used in recent years for lack of diesel and spare parts.
Water supply	Bundibugyo township is supplied with piped (untreated) water from a nearby stream. Elsewhere surface water is used universally. Most homesteads are thatched, so few people collect and store rainwater.
Posts and telecommunicatons	There is one post office, situated in Bundibugyo township. Tt has recently resumed services after a period of closure from 1985-87. Mail services are erratic and unreliable: a letter to or form Kampala is rarely delivered in less than a month. A public radio-telephone service has recently been re-instated. A second radio link between Bundibugyo and the outside world is maintained by the Uganda Police post. There are no other internal or external telecommunications facilities.
Hospital and health	A large, fully equipped district hospital was established in Bundibugyo township in the 1960s. This has provided a rather unreliable service, partly because of the difficulty of keeping qualified medical staff in such a remote rural locality. The hospital was completely closed in 1985, and re-opened in 1987. There are no government clinics in the rural area, although missionaries provide some health care facilities.
Schools	There are two secondary and a large number of primary schools in Bwamba (Simbya and Semliki).
Administrative facilities	Bundibugyo became an independent administrative district in 1974, but still lacks appropriate facilities. Government offices are located in shop premises abandoned by departed Asians, in Bundibugyo township. There are four sub-county headquarters buildings, at Bubandi, Bubukwanga, Busaru and Harugali and a prison at Bubukwanga.
Housing	Civil servants lack housing; most are presently accommodated in the hospital staff quarters.
Financial institutions	A branch of the Equator Building Society opened in Bundibugyo in 1987; the Post Office has recently started a Savings Bank; and the Uganda Commercial Bank is expected to open a branch in Bundibugyo in 1988. Banking facilities have not previously been available in Bwamba.
Cooperatives	The Bwamba-Rwenzori Coffee Growers Cooperative Union is the only agency licensed to handle coffee, the county's principal cash crop. The Union includes a number of primary cooperative societies in the rural areas.
Police	There is one Uganda Police Station, situated in Bundibugyo township. The Police have a 4WD vehicle, and maintain a radio-link with Fort Portal.
Other government services	There are approximately 25 government officers from outside the district stationed in Bundibugyo, providing a range of services including health, education, agricultural and livestock development, community development, forestry, the supervision of works, trade development, tax collection, cooperatives, and district administration. All of these staff lack adequate facilities, are poorly paid and accommodated, and largely unable to carry out their duties effectively. One of the main constraints is a lack of transport: government presently maintains six 4WD vehicles in Bwamba, for use by the District Administrator (DA), District Executive Secretary (DES), Uganda police, District Education Officer (DEO), District Medical Officer (DMO) and District Agricultural Officer (DAO); and a motorcycle for the District Forest Officer (DFO).
Non-governmental (missionary) services	A number of missionary groups operate in Bwamba, prominent amongst which are the Anglican and Catholic churches, and the Moslems. They initiated formal education in Bwamba, and presently provide a range of other community services particularly in the field of primary health care. These programmes are often more effective than those provided by government.

pattern of trade is illustrated in Fig. 5.7. Within Bwamba, much of the cash crop production is in the hands of the Baamba, who use some of their earnings to buy foodstuffs produced by the Bakonjo. The people of Bwamba collectively trade with three groups of outsiders; from neighbouring Zaire, from Ntoroko County and from elsewhere in Uganda. The trade with Zaire involves the smuggling of coffee out of Uganda, a profitable enterprise since the price paid locally is under government control and only about a quarter of the world market price offered just across the border in Zaire (Jjemba and Baguma, 1988). Much of Bwamba's coffee production probably finds its way to Zaire in this way, where it finances the purchase of cloth, other manufactured goods, and medical services. Coffee probably accounts for 80% of Bwamba's export earnings, cocoa and palm oil a further 10%, and other products the remainder. Except for the substantial quantities of coffee smuggled to Zaire, most of the area's produce is taken out by road via Fort Portal, either by the coffee marketing co-operative, or private traders. In exchange, Bwamba receives substantial quantities of government-controlled commodities including sugar, salt, soap, and paraffin; household goods such as saucepans, tableware and jerricans; clothing; agricultural inputs and government services. The people of Bwamba enjoy meat and fish, which they purchase in large quantities from the pastoralist Batuku of neighbouring Ntoroko County, and the fishermen on the southern shores of Lake Albert; these purchases are partially paid for by cassava and vegetables produced in Bwamba.

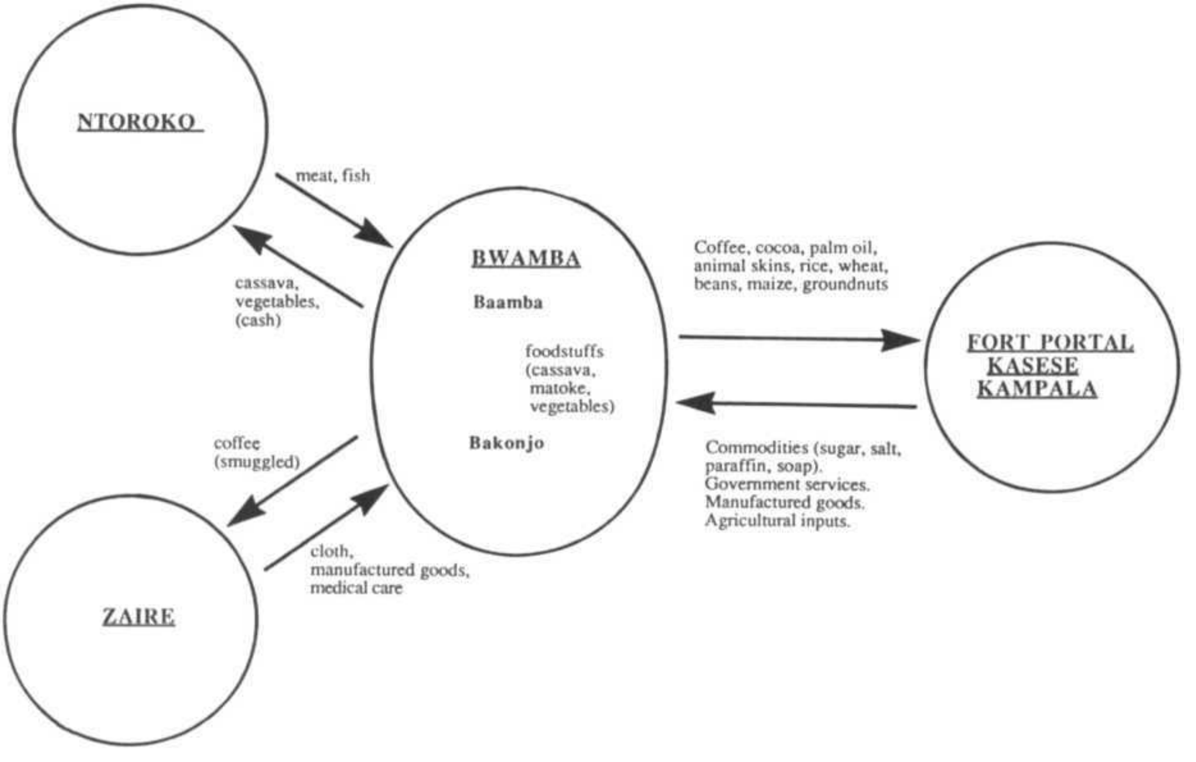


***Fig.* 5.7** *Principal items of trade in the Bwamba economy*

Ninety-five percent of people in Bwamba earn their living primarily through the sale of agricultural products, while 5% rely on trade as their main source of income (C. Muhumuza, unpublished questionnaire data). Asked about what they spend their money on, 38% of a randomly selected sample of household heads reported that clothes and bedding were the most important items, while 37% spent most on household hardware, 11% spent most on school fees, 9% on fish and other foodstuffs, and 5% on medical treatment, taxes, or other expenses. It is perhaps significant that nobody considered building materials, or alcoholic drinks to be an important item of expenditure in the household budget (Muhumuza, unpublished data).

3. Survey and research methods

Field surveys were carried out between July 1986 and December 1987 in order to gather information on the renewable natural resources of the area. These surveys concentrated on evaluations of the soils, agricultural systems, tree cover, people and their attitudes within the county boundaries. Some general surveys were carried out initially, followed by more detailed examinations within selected sampling areas.

3.1 Soil surveys

The soils of Bwamba were examined by P. Jjemba, who collected and analysed a total of 120 samples from 22 areas of the county. Twenty of these samples were drawn from ten widely separated sites in the Semliki Forest Reserve, with two samples taken at each site, at depths of 0-15 cm and 15-30 cm. The remainder of the samples were taken from sites in the Bwamba public lands, mostly within ten randomly located quadrats (see below), where the soils were under a variety of different land uses. All samples were analysed for pH, organic content, Nitrogen, Phosphorus, Sodium, Potassium and Calcium - parameters selected to provide the maximum possible amount of information on the agricultural potential of the soils. The full details of this survey are reported elsewhere (Jjemba, 1988a).

3.2 Forest surveys

The distribution and extent of forest cover throughout the county was determined by P. Howard and F. Butono who conducted a series of ground surveys, in which different areas of the forest reserves and public lands were visited on foot. Areas of forest reserve encroachment, and the locations of any remaining patches of natural forest in the public lands were mapped.

3.3 Area sampling

The bulk of the fieldwork on which this report is based was carried out within ten km^2 sampling plots located on the Bwamba public lands. Random number tables (Snedecor and Cochran, 1980) were used to locate these plots, based on the national grid. Five of the ten plots fell in the highland area of the county, and five in the lowlands, thus over-sampling the highlands to some extent (the highland area accounts for 135 km^2 of the Bwamba public lands, compared with 245 km^2 which lies in the lowlands). Within each of these 1 km^2 (100 ha) plots, a nested quadrat of 250x250 m (6.25 ha) was located in the southwestern corner, and within this another nested quadrat of 100x100 m (1.00 ha) in the southwestern corner. The 1 ha and 6.25 ha plots were surveyed and temporarily demarcated on the ground using cut-lines and tags. Within each of the ten sampling plots, resource surveys were carried out in whichever nested quadrat was of the most suitable size for the type of survey undertaken (see below). The surveys included assessments of land use, the types of crops grown and production efficiency achieved, agricultural pests, diseases and other constraints, trees and their uses, human settlement, and people's attitudes.

- **Patterns of land use.** Patterns of land use were evaluated in the 6.25 ha quadrats by measuring and surveying the land according to land-use category (Jjemba, 1988c).

- **Crop production.** Individual cultivation plots under different crops were measured and surveyed in the 1.00 ha quadrats. Each crop was examined for pest and disease infection, mineral deficiency symptoms and management problems, and an anticipated yield for the crop estimated. The estimated yields were compared with those that should be possible locally under improved management (Jjemba, 1988d).

- **Trees.** All trees within the 1.00 ha plots were individually measured for stem diameter at breast height (dbh), and their heights were estimated. In the case of coppiced trees, each stem was assessed separately. These data were used to calculate the total volume of live wood in each of the 1.00 ha plots, from which an estimate of the sustainable yield of wood available to local people was derived (Butono, 1988c). In addition, trees considered to be of potential value in the production of sawn-timber were enumerated and measured in the 6.25 ha quadrats (Butono, 1988c).

- **Sociological issues.** A comprehensive personal interview questionnaire survey of household heads within the ten 1 km^2 quadrats was conducted by C. Muhumuza. Initially, a questionnaire comprising 47 questions was administered to 34 respondents from two of the (lowland) quadrats, but this was later modified and expanded before completing interviews in the remaining eight quadrats. A necessary preliminary to conducting these interviews was that the interviewer met with the local people to discuss the objectives of the survey (Muhumuza, 1988c). Then all homesteads within each 1 km^2 quadrat were mapped, and a random sample comprising 25% of the total was selected by use of a lottery method. Interviews were held between C. Muhumuza and the selected (male) household heads, with the help of local extension staff of the Department of Community Development, who served as interpreters where necessary. Each interview was carried out at the respondents homestead, and lasted for an average of one hour. Some respondent fatigue was noted, but not considered to be a serious problem (Muhumuza, 1988c). In unsuccessful attempts to secure interviews, each of the homesteads selected for inclusion in the survey was visited twice, before being discarded from the sample in favour of another homestead.

The full interview schedule is included as Appendix T. It involves a total of 84 questions seeking information on land tenure systems, agricultural and livestock production, forestry resources, trade, population demography and family planning.

3.4 Specific studies

Several additional studies were carried out to examine specific aspects of natural resources management in the study area. These included:

- An analysis of tree seedling uptake and survival over the period 1984-87 from four CARE-assisted Forest Department tree nurseries (Butono, 1988d);

- A preliminary evaluation of tree growth rates in four timber trials established during the 1960s in the Semliki Forest Reserve (Butono, 1988g);

- Compilation of information concerning the use of non-wood forest products with particular reference to medicinal plants (Butono, 1988e);

- Examination of crop yields under controlled experimental conditions using five of the area's principal crops (maize, rice, beans, soyabeans and groundnuts) in pure stands and as intercrops, with and without rotation (Jjemba, 1988f); and

- An analysis of the use of family planning facilities in the study area (Muhumuza, 1988c).

4. Survey and research results

4.1 Land use in the public lands

The results of the land-use survey of the Bwamba public lands have been reported by Jjemba (1988c), and are summarised in Fig. 5.8. There are significant differences in land-use between the lowland and highland regions of the county. In the lowlands, approximately half the land is under cultivation, mostly to permanent crops, of which coffee is much the most important. The remainder of the lowlands is occupied by small patches of forest (21% of the total area), *Pennisetum* grassland (25%) and fallowland (3%). In the highlands, only about one quarter of the land is under cultivation, but this includes significant areas of temporary cropland (14% of the total area) and considerably less permanent cropland than in the lowlands (just 9% of the total area). Most of the highland area (58%) is grassland, much of it too steep for cultivation, which is used as communal grazing land. There are also numerous forest patches, particularly along the river valleys, which together account for 11% of the highland area and a significant 7% of the land is under fallow.

4.2 Land availability

Muhumuza (1988b) examined land availability by considering the size of individual land holdings in relation to household membership, and whether a plot was considered adequate by the household head. Although the size of land holdings was not properly surveyed, but estimated by eye (to the nearest fifth hectare), an average size of 2.3 ha per household of 7.1 people was derived from 134 questionnaire respondents. This is in line with expectations, giving a population density of 316 people per square kilometre (compared with 320 people per square kilometre estimated from census statistics projections - section 2.5, above). Land holdings range in size from 0.4 to 8.1 ha, with 77% of households occupying 53% of the land in plots of 2.4 ha or less, and 23% of households occupying 47% of the land in larger plots (Muhumuza, 1988b).

Of the questionnaire respondents, 47% of Baamba and 63% of Bakonjo said that their land was insufficient (Table 5.3). These people had 0.26 ha and 0.19 ha of land per family member (Baamba and Bakonjo respondents respectively), compared with an average of 0.43 ha and 0.41 ha per person in Baamba and Bakonjo households where the land holding was considered adequate. Households with insufficient land were characteristically larger than those where the land holding was considered adequate (Table 5.3). It is of interest that Winter (1954) calculated a per capita land requirement of 0.24 ha for the Baamba, an area now considered inadequate, possibly because of a deterioration in land quality resulting from continued land use and poor land management practices.

4.3 Problems and constraints to agricultural development

Agriculture is still very inefficient in Bwamba (Jjemba, 1988d). Only 35% of the land designated for agricultural development is currently under cropland, but even here production efficiency is low. The yields realised by local farmers are generally below half what would be expected for these crops under good management; only banana and upland rice production are reasonably efficient with yields of 62-76% of those expected under good management. Robusta coffee, the area's main cash crop, yields an estimated 660 kg per hectare per annum under local conditions, or about 47% of what should be produced; cocoa, the second most important cash crop, yields approximately 40% of what should be produced under local conditions with good management. Food crop production efficiency is especially low, the figures for sweet potatoes, cassava and maize, for example, being 15%, 4% and 5% respectively (Jjemba, 1988d).

There are many factors limiting production, the more important of which are listed in Table 5.4, and discussed in more detail by Jjemba (1988d). These include poor land distribution; a lack of agricultural inputs; poor farming practices; use of low-yielding varieties; and problems of declining soil fertility. In the opinion of local householders, by far the most outstanding crop production constraint is that of crop pests and diseases (mentioned by 60% of questionnaire respondents; C. Muhumuza, unpublished), followed by a lack of implements (mentioned by 13%), problems of soil fertility, a lack of agrochemicals, and land shortage (each mentioned by 7% of respondents) (Table 5.4).

4.4 Status of Bwamba's forests

Fig. 5.9 shows the present extent of forest cover in Bwamba, and the degree to which areas of forest that were surveyed from the air in 1955 have been cleared. Slightly over half (52%) of the forest which occurred at intermediate altitudes between the Semliki and Rwenzori Forest Reserves has been lost in the past 33 years, and a further 40% has been severely degraded (with an estimated 31-80% of tree basal area removed) (Table 5.5). The only sizeable patches of forest which now remain in a relatively undisturbed state on the public lands of Bwamba occur in steep-sided valleys high in the Rwenzori (Fig. 5.9). Six Local Forest Reserves, which covered 13 km^2 of the intermediate-altitude public-land forests, have been allocated for settlement, and now support more than 500 households (Butono, 1988a). The loss of these intermediate-altitude forests is of particular concern to the wildlife conservation community because they represented habitats of extra-ordinary species richness, quite unlike the semi-deciduous (ironwood) forests of the Semliki reserve, or the montane forests of Rwenzori (Appendix F; Howard, 1988b).

Table 5.3 Household and land holding size amongst Baamba and Bakonjo questionnaire respondents who consider that they have enough land, and those who do not. (Means are shown = standard deviation).

Group of people	Number of households in sample	Number of people per household	Size of land holding (ha)	Area of land (ha) per household member
Baamba with adequate land	47	6.3 = 4.0	2.7 = 1.7	0.43
Baamba without adequate land	41	8.0 = 4.8	2.1 = 1.6	0.26
Bakonjo with adequate land	17	6.4 = 3.5	2.6 - 1.7	0.41
Bakonjo without adequate land	29	7.9 = 4.1	1.5 = 0.9	0.19

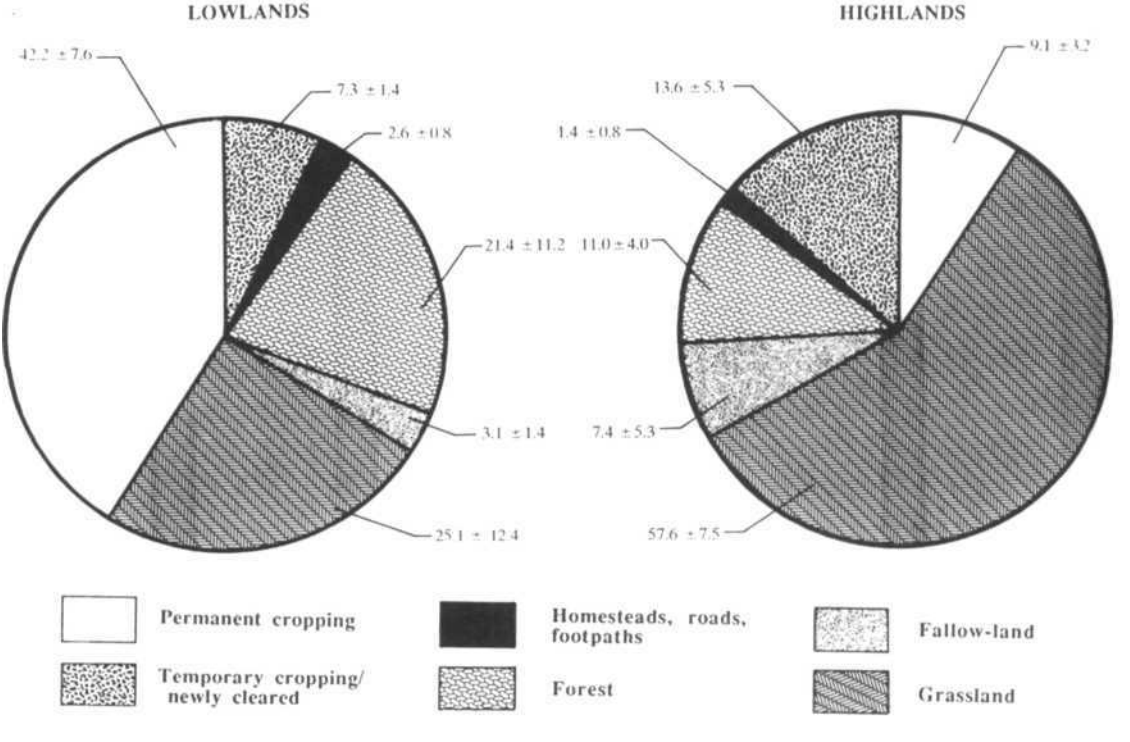


Fig. 5.8 *Land use in Bwamba County, based on surveys of ten 6.25 ha randomly located quadrats, five in the lowlands and five in the highlands. Figures are mean percentages ± one standard error (represented by arcs around the perimeter of the pie charts).*

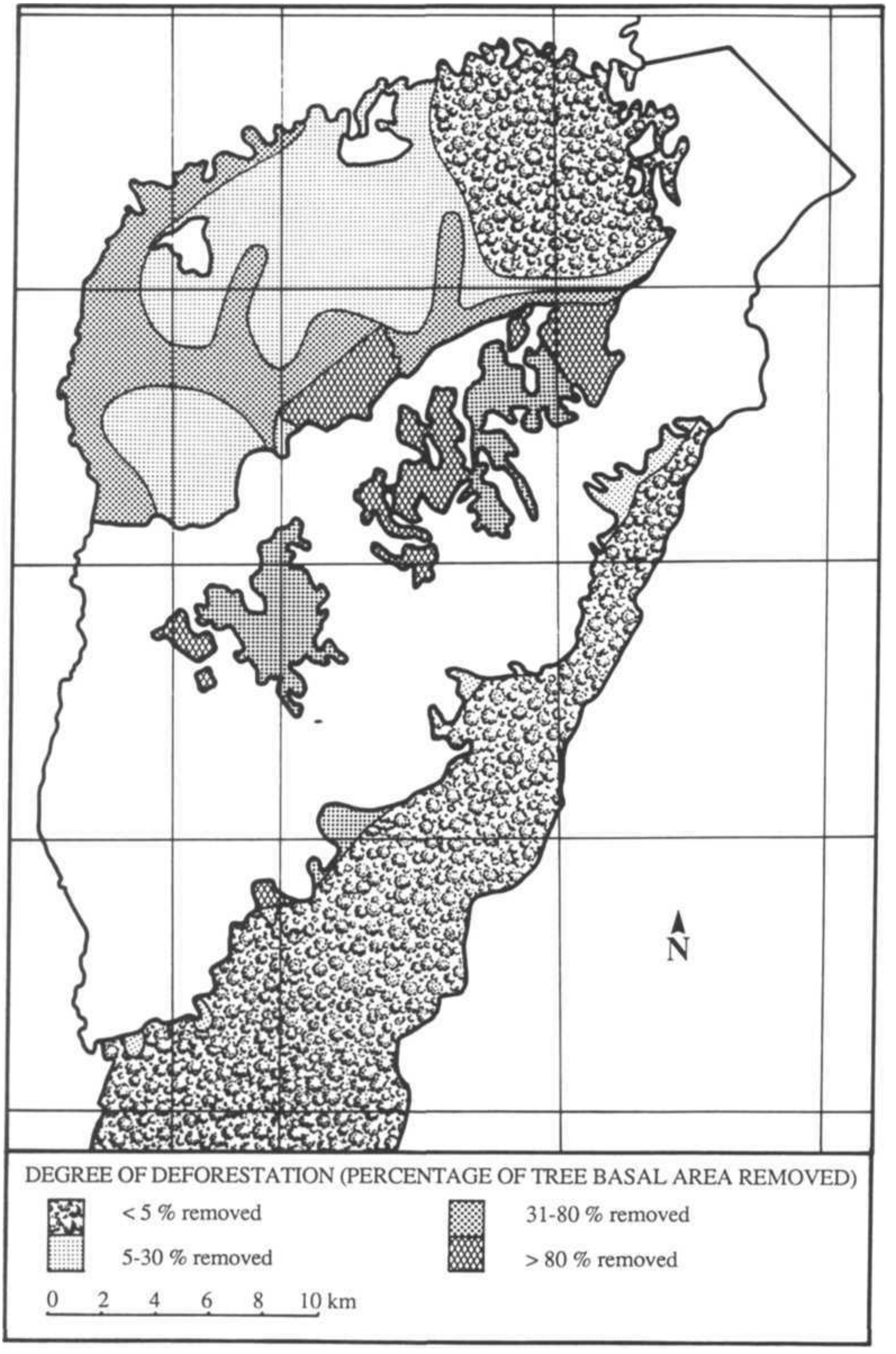


Fig. 5.9 *The present status of Bwamba's forests, based on consideration of areas that were mapped as forest from 1955 aerial photography.*

Ground survey work reveals that the Rwenzori forest reserve remains largely unaffected by agricultural encroachment, and its vegetation is still essentially intact. However, the Semliki reserve has suffered badly from encroachment, which began in the early 1970s when local people were permitted to clear forest land as part of a taungya forest management policy (Howard, 1986; Butono 1988a). Unfortunately, no trees were planted in the taungya cultivation plots, and progressively more land was cleared during the years of economic hardship and lawlessness which followed Amin's accession to power. Most of the encroachers were evicted from the area in 1983, but many remained and the last are only now moving away as a result of President Museveni's personal intervention. The result of this prolonged period of agricultural activity in the reserve is that approximately 30% of the area has been badly degraded (with loss of an estimated 31-80% of tree basal area), particularly along the river valleys where soils are better drained and more fertile (Table 5.5; Fig. 5.9). It is these areas which previously supported the only good stands of species-rich mixed, evergreen forest, the majority of the reserve being characterised by semi-deciduous ironwood-dominated forest: hence their degradation is of particular concern in the context of wildlife conservation (Appendix F; Howard, 1988b). Only about 30% of the reserve now remains essentially intact, although the rest is still dominated by forest and abandoned cultivation plots are reverting quickly to 'bush' (pers. obs.).

4.5 Environmental awareness and attitudes to forest reservation and management

Twelve questions seeking information about peoples' level of environmental awareness and attitudes to forest reservation and management were put to 101 questionnaire respondents in eight quadrats (the questions were not included in the pilot questionnaire used in the Kirumia and Buganikeri quadrats). A summary of opinions expressed in response to these questions is provided in Table 5.6, from which a number of conclusions can be drawn:

- There is a high level of awareness that large forests play an important role in environmental protection, especially in improving rainfall.

- The people of Bwamba feel that the Rwenzori forest is of greater benefit to them than Semliki.

- Most Bakonjo, and nearly two-thirds of the Baamba recognise problems associated with living close to large forests, of which the most important is that they serve as a refuge for animals that damage crops or kill livestock. One respondent reported that his mother and a brother had been killed by a leopard.

- Three-quarters of the Baamba, and 41% of the Bakonjo find forest animals useful, primarily as a source of meat and skins. There are approximately the same number of people in favour of protecting animals as against. It is perhaps surprising that those in favour think the most important reason for protecting animals is that they 'are useful to government'.

- About two-thirds of the local population have no idea why the county's two principal forest reserves were gazetted. Only 16% of Bakonjo and 4% of Baamba respondents mentioned that water catchment protection, and the prevention of

Table 5.4 Principal constraints to agricultural productivity in Bwamba

Constraint	Percentage of questionnaire respondents recognising constraint (n=135)	Crops worst affected
1. Poor land distribution	7	All
2. Inadequate production incentives/ poor product marketing facilities/ difficulties with product processing	6	Coffee, oil palm
3. Lack of technical expertise/advice	2	Coffee, cocoa, cassava, groundnuts, oil palm
4. Use of poor, low-yielding varieties	0	Cocoa, beans, soyabeans, groundnuts, oil palm, maize, sweet potatoes
5. Soil fertility problems	7	Bananas, rice, beans, soyabeans, groundnuts, mai2e, wheat
6. Lack of agrochemical inputs	7	Coffee, cabbage
7. Crop pests and diseases	60	Arabica coffee, cocoa, bananas, rice, cassava, beans, soyabeans, groundnuts, cabbage, maize
8. Lack of implements	13	Food crops
9. Weeds	4	Coffee, bananas, cassava, wheat

Table 5.5 The areas (km2) of forest degraded to varying degrees in the major land-use zones of Bwamba. Figures are based on consideration of forest shown on Department of Lands and Surveys' maps sheets 56/1 and 56/3 at 1:50,000, drawn from 1955 aerial photography.

	Extent of forest clearance (% of tree basal area lost)			
Land-use zone	0-4% cleared	5-30 cleared	31-80% cleared	>80% cleared
Semliki forest reserve	64	91	65	0
Rwcnzori forest reserve	248	2	0	0
Bwamba local forest reserves (Kabango, Bundikeki, Matta, Rwigo, Nyakakindo, Nyaburongwe)	0	0	1	12
Unreserved forest on Bwamba public lands	2	3	25	22
TOTAL	314	96	91	34

Table 5.6 Attitudes and opinions about the natural forest

Question Number (Appendix T)	Opinion expressed	Proportion (%) of questionnaire respondents expressing opinion	
		Baamba (n-55)	Bakonjo (n-46)
44.	It helps to have large forests nearby because they:		
	- stabilise the climate	11	59
	- improve the rainfall	62	78
	- prevent flooding	13	28
	- provide a steady flow of stream water	4	15
	(do not know)	(33)	(0)
45.	The Rwenzori forest reserve is of more direct benefit to me than the Semliki reserve	51	96
	I cannot tell which of the two reserves is most helpful to me	29	0
47.	There is no harm having large forests nearby	4	20
	Large forests nearby are harmful because they:		
	- act as a reservoir for diseases	2	0
	- serve as a refuge for crop pests	22	13
	- serve as a refuge for harmful animals	38	65
	I do not know whether there is any harm in having large forests nearby	34	2
48.	Forest animals are useful to me:		
	- as a source of meat	58	30
	- as a source of skins	9	30
	- as a source of medicine	0	2
	- because they control the number of other wild animals which would otherwise become pests	7	7
	Forest animals are of no use to me	25	59
49.	Forest animals:		
	- transmit diseases	24	0
	- damage my crops		93
	- kill my livestock	53	70
50.	Forest animals should be protected:		
	- so that they do not move out of the forest and kill livestock	13	0
	- so that they do not move out of the forest and damage crops	24	2
	- because they are useful to government	27	18
	- so that they can provide meat	5	18
51.	The reason for gazetting the Semliki forest reserve was:		
	- to protect the forest's rain formation capability	11	9
	- because the area was tse-tse infected	13	a
	- to protect timber resources	4	2
	- to preserve wild species of tree	0	13
	- to serve as an animal sanctuary	7	13
	- to protect the water catchment	0	4
	(Do not know)	(65)	(61)
58.	The reason for gazetting the Rwenzori forest reserve was:		
	- to protect the forest's rain formation capability	16	4
	• to protect timber resources	2	2
	- to prelect wild species of tree	0	f
	- to serve as an animal sanctuary	4	9
	- to protect the water catchment	0	7
	- to prevent floods	0	7
	- to prevent soil erosion	4	2
	(Do not know)	(74)	(61)
59.	Within the forest reserves people are allowed to:		
	- collect firewood for their own use without a permit	18	39
	- collect building poles without a permit	16	25
	- walk through the forest without a permit	35	61
	- collect oil palm nuts tomake oil for sale, if they have a permit	25	24
	Within the forest reserves people are not allowed to:		
	- go humting	65	72
	- cultivate	65	78
60.*	I have cultivated land inside a forest reserve in the past	11	35
61.	People with cultivation plots inside forest reserves should be:		
	- allowed to cultivate specified areas with a permit	62	83
	- allowed to build houses a settle there	27	4
	- evicted from the reserves	38	22
62.	In respect of forest reserves that have suffered encroachment. government should:		
	- degazette the worst affected areas	14	6
	- replant the cultivation plots with useful trees	11	2
	- manage the forest oo a taungya system	35	80
	- leave the forest to natural regeneration	40	11

* N.B. The replies to this question were somewhat contradictory to those given in reponse to Q. 43 in which 37% of Baamba and 17% of Bakonjo said that they had used forest reserve land for cultivation purposes in the last ten years (Table 5.11).

flooding and soil erosion were important reasons for the protection of the Rwenzori forest.

- Knowledge of what people are allowed to do in forest reserves is poor. Most people do not understand that they have special privileges in respect of unreserved forest produce used for private domestic purposes; they feel that most activities (even the collection of firewood) within forest reserves are outlawed.

- Of the Baamba respondents, 11% said they had cultivated land within forest reserves, compared with 35% of the Bakonjo. This is somewhat surprising in view of the fact that the Bakonjo areas are more sparsely populated and less intensively used than those of the Baamba (see Section 4.2, above). However, a much higher proportion (63%) of Bakonjo expressed a problem of land shortage than Baamba (Section 4.2), and the data suggest that it is the Bakonjo who are largely responsible for forest reserve encroachment, even in the Semliki reserve which lies in a Baamba area. Further support for this suggestion is provided by the fact that 80% of Bakonjo favour the adoption of a taungya forest management system in the encroached forest lands (compared with only 35% of Baamba); but only 4% of Bakonjo think that people should be allowed to build houses and settle in the forest reserves (for cultural reasons they would not wish to settle in the Semliki reserve), compared with 27% of Baamba (who would be culturally quite 'at home' in the Semliki reserve). Furthermore, almost twice as many Baamba (38%) as Bakonjo (22%) feel that encroachers should be evicted from the forest reserves. It seems that the Bakonjo, as much as the Baamba, are responsible for encroachment of the Semliki forest reserve.

4.6 Availability and use of wood products

Table 5.7 provides a summary of tree enumeration data for the ten 1 ha quadrats, the calculated volume of woody biomass, and estimated annual increments. A great deal of variation in biomass volume was recorded between quadrats, so all estimates carry wide confidence limits (Table 5.7); however, a mean volume of 18.9 m^3 per hectare was calculated for the lowland area, and 5.2 m^3 per hectare in the highlands, providing estimated sustainable yields of 1.22 m^3 and 0.36 m^3 per hectare in the lowland and highland areas respectively. Upper estimates of sustainable supply, based on 95% confidence limits, are 2.74 m^3 and 0.81 m^3 per hectare for lowland and highland areas respectively.

No figures are available for local levels of demand for fuelwood, but nationally 1.24 m^3 is probably used per person each year, (World Bank, 1986), and this may be a useful approximation for demand in Bwamba. As far as use of wood for building poles is concerned, C. Muhumuza (unpublished) determined that 101 questionnaire respondents use an average of 272 (± 267 S.D.) metres of building pole, every 7.8 years ago (responses to questions 30, 31; Appendix T). Assuming these poles to be of 10 cm diameter, this is the equivalent of 0.27 m^3 of wood per household each year, or 0.038 m^3 per person.

Table 5.8 shows where people obtain their firewood and building poles; clearly the vast majority of this wood comes from the householder's own land, or that of a neighbour. However, the Bakonjo appear to be considerably less self-reliant in this respect than the Baamba, since 41% of their firewood and 17% of their building poles is collected from

Table 5.7 Estimates of woody biomass volume (m3), based on enumerations of trees in ten 1 ha quadrats in the lowlands and highlands of Bwamba (after Butono, 1988c). n refers to the number of trees enumerated per size class in each quadrat.

Sampling area (1 ha quadrats)		Diameter (dbh) class (cm) 0-10	11-20	21-30	31-t0	41-50	51-60	61-70	71-80	TOTAL
Lowlands:	Kirumia	0.06 (n=9)	1.05 (n=17)	2.18 (n=11)	0.6 (n=1)	0.00	2.50 (n=1)	0.00	0.00	6.44
	Ngiti	3.65 (n=659)	1.96 (n=27)	2.94 (n=9)	5.45 (n=18)	0.94 (n=1)	18.17 (n=5)	22.84 (n=5)	0.00	55.94
	Nyakasoha	0.28 (n=55)	0.96 (n=13)	0.53 (n=2)	0.00	0.00	2.14 (n=1)	0.00	0.00	3.91
	Buganikeri	0.37 (n=102)	0.46 (n=6)	2.22 (n=6)	1.64 (n=2)	3.58 (n=2)	0.00	5.22 (n=1)	0.00	13.49
	Buhundu	0.06 (n=12)	0.85 (n=11)	1.39 (n=6)	2.16 (n=4)	0.00	6.41 (n=2)	0.00	3.73 (n=1)	14.60
Lowlands, mean volume (m3) per hectare (± std. dev.)		0.88 (±1.55)	1.06 (±0.55)	1.85 (±0.92)	1.98 (±2.11)	0.90 (±1.55)	5.84 (±7.27)	5.61 (±9.89)	0.75 (±1.67)	18.88 (±21.21)
Highlands:	Butukuru	0.04 (n=10)	0.26 (n=7)	0.13 (n=1)	0.00	0.00	0.00	0.00	0.00	0.43
	Kabango	0.09 (n=25)	0.11 (n=3)	0.24 (n=6)	1.95 (n=2)	0.00	0.00	0.00	0.00	2.39
	Kizimba	0.93 (n=108)	0.42 (n=8)	0.27 (n=2)	1.39 (n=3)	0.00	6.63 (n=5)	8.06 (n=4)	0.00	17.70
	Mabere	0.00	0.34 (n=13)	1.24 (n=8)	0.00	0.00	0.00	0.00	0.00	1.58
	Kasanja	0.09 (n=18)	0.86 (n=12)	0.76 (n=3)	1.44 (n=2)	1.00 (n=1)	0.00	0.00	0.00	4.15
Highlands, mean volume (m3) per hectare (± std. dev.)		0.23 (±0.39)	0.40 (±0.28)	0.53 (±0.47)	0.96 (±0.90)	0.20 (±0.45)	1.33 (±2.96)	1.61 (±3.60)	0.00	5.25 (±7.09)
Estimated proportional annual increment		0.80	0.15	0.05	0.03	0.02	0.02	0.01	0.01	
Lowlands, estimated annual volume increment (m3)(± std. dev.)		0.70 (±1.24)	0.16 (±0.08)	0.09 (±0.05)	0.06 (±0.06)	0.02 (±0.03)	0.12 (±0.15)	0.06 (±0.10)	0.01 (±0.02)	1.22
Highlands, estimated annual volume increment (m3)(± std. dev.)		0.18 (±0.31)	0.06 (±0.04)	0.03 (±0.02)	0.03 (±0.03)	0.01 (±0.01)	0.03 (±0.06)	0.02 (±0.04)	0.00	0.36

Notes:

1. Volume estimates are based on the mean diameters and heights of trees in any given size class for each quadrat. Since values for these parameters differ between quadrats, the mean volume per tree in any given size class also varies between quadrats. Volumes were calculated as:

$$\text{Volume} = \pi/4.d^2.h.f$$

where d = diameter at breast height, h = estimated total height of tree to top of uppermost branches, and f = an estimated 'form factor' of 0.45.

2. Annual increment figures are estimated from consideration of expected average growth rates of different species of tree under local conditions, and the proportional representation of the 29 different species enumerated (see Butono 1988c for full species lists).

Table 5.8 Proportion (%) of questionnaire respondents who last used firewood and building poles from various sources. n refers to the number of respondents in each group.

Source of supply	Firewood		Building poles	
	Baamba (n=89)	Bakonjo (n=46)	Baamba (n=55)	Bakonjo (n=46)
Personal land	57	42	61	46
Neighbour's land	27	17	29	24
Friend or relative's land	0	0	5	13
Public land	3	17	5	11
Forest reserve	13	24	0	6

forest reserves or public land forest patches; compared with 16% and 5% for firewood and building poles collected by the Baamba.

Assuming population densities of 380 and 206 people per square kilometre in the Baamba and Bakonjo areas of the county respectively (Section 2.5, above) it is apparent that present estimated demands for fuelwood and building poles already exceed the sustainable supply obtainable from the public lands by a factor of four in the case of Baamba areas, and by a factor of seven in the case of Bakonkjo areas. Even if we consider demand in relation to the most optimistic upper estimate of sustainable supply, it is clear that the demands of the Baamba are already almost twice what can be provided on a sustainable basis, and those of the Bakonjo are more than three times the level of supply. Unless urgent action is taken to reverse this situation, the people of Bwamba can expect to spend progressively more of then-time collecting these wood products, further and further from their homes. Already, 73% of Baamba and 50% of Bakonjo say that they have insufficient firewood; and 75% of Baamba and 67% of Bakonjo say there are insufficient building poles in their home areas (responses to questions 24, 29; Appendix T).

4.7 Tree planting on private land

Table 5.9 summarises the replies to questions concerning tree planting on private land. Overall, 36% of Baamba respondents said that they had planted an average of 25 trees (± 28 (S.D., n=11)) over the previous five years, compared with 52% of Bakonjo respondents who planted 85 trees (± 157 (S.D., n=24)) over the same period. On average, 0.3 tree seedlings were planted in the lowlands each year per head of the Baamba population and 1.2 were planted in the highlands each year for each member of the Bakonjo population. These trees were planted mainly to provide building poles (and to a lesser extent firewood), and were predominantly *Markhamia* and *Eucalyptus* (Table 5.9). Most of the seedlings were obtained from the householder's own plot of land, or that of a neighbour, although the Bakonjo also took a significant number of seedlings from reserved forests, and the Baamba obtained many of their seedlings from government tree nurseries (Table 5.9).

Table 5.9 Questionnaire responses relating to tree planting in Bwamba

Question Number (App'x T)	Category of respondent	Baamba	Bakonjo
51a	Proportion of respondents who have planted trees in the past five years (%)	36	52
52	Proportion of respondents who have land where they could plant trees (%)	31	63
51b	Proportion of respondents who planted trees (%) planting:		
	- oil palms	3	0
	- *Maesopsis*	25	0
	- *Cordia*	25	13
	- *Eucalyptus*	34	42
	- *Chlorophora*	3	0
	- *Markamia*	59	54
51b	Proportion of those who planted trees (%) doing so:		
	- to provide building poles	46	67
	- to shade cocoa plantations	15	0
	- to provide firewood	23	25
	- to provide palm oil	8	0
	- to provide cash returns	0	4
51b	Proportion of those who planted trees (%) who obtained seedlings from:		
	- a government tree nursery	18	4
	- a forest reserve	0	25
	- own land	15	8
	- neighbour's land	46	63
53	Proportion of respondents who would be willing to plant trees if they were made available (free) in their villages (%)	74	89

Based on consideration of the number of householders who have planted trees, and the number of seedlings each one planted (see above), a figure of 59,400 seedlings planted each year in the whole of Bwamba is derived. The highest possible estimate based on 95% confidence limits, would be 101,400 seedlings planted. Fast-growing species on reasonably fertile lowland soils are capable of yielding 0.004 m^3 of wood per tree each year (when grown under plantation conditions, with 1.5 m between plants; D. Earl, pers. comm.), so the seedlings planted in Bwamba each year might produce a sustainable yield of 238 m^3 per annum (± 168 m^3 at 95%) if all of them survived (which is most unlikely; Butono (1988d) records 61% survival of government nursery stock in Bwamba).

When these figures are compared with estimates of present and projected demand for wood in Bwamba, and estimates of the sustainable supply (Table 5.7), it is clear that existing tree-planting activities are hopelessly inadequate. Bwamba's 121,600 people (17,000 households) require about 151,000 m^3 of firewood and 4,600 m^3 of building poles each year (Section 4.6). Even if this demand could be met by existing tree cover, the population - and the demand for wood - is increasing at 3.4% each year (Section 2.5), adding 5,280 m^3 to local wood requirements each year. Existing tree planting activities can only provide 328 m^3 of this, not even 5% of the annual increase in demand. It would be necessary to establish 1.32 million seedlings of fast-growing species (yielding 0.004 m^3/tree/an) every year in order to satisfy just the increased demand resulting from growth in Bwamba's population - equivalent to 10.8 seedlings per person, or 78 per household.

In fact, the situation is far worse than these figures suggest, because local wood supplies are already depleted very seriously, and demand already exceeds the sustainable supply by a wide margin (Section 4.6). Even if it were possible to maintain present population densities - and demand for wood products - in the rural areas of Bwamba, a major tree-planting programme would be required to restore tree cover to a level where it could provide the required yields on a sustainable basis (Table 5.10). In the lowland areas, every man, woman and child would need to plant 40 trees each year for ten years in order to provide the required quantities of fuelwood and building poles on a sustainable basis; in the highlands the figure is 47 trees (Table 5.10). Ideally these would be grown amongst a farmer's agricultural crops, but if woodlots are preferred, about 28% of the land in the lowlands will need to be allocated to wood production (compared with the present 21%; Section 4.1), as will 15% of the highland area (compared with the present 11%) (Table 5.11).

4.8 Use of non-wood forest products

Some of the uses which 135 questionnaire respondents have made of Bwamba's forests in the past ten years are listed in Table 5.11 and further details are provided by Butono (1988a). Apart from the cultivation of forest land and the collection of wood products (which have already been discussed), forest reserves are used as a source of bamboos by 52% of the Bakonjo; as a hunting area by 1% of Baamba and 11% of Bakonjo; as a source of medicines by 3% of Baamba and 17% of Bakonjo, as a transit route to Zaire or Kabarole by 8% of Baamba and 70% of Bakonjo; and as a source of palm nuts. Other possible uses of the forest reserves were not mentioned by any of the respondents, but this may have been partly because the interviewer did not probe deeply on this subject, preferring to offer a list of suggestions.

Table 5.10 Calculation of tree planting requirements in the lowlands and highlands of Bwamba

Statistics	Lowlands	Highlands
1. Population density (persons/ha)	3.80	2.06
2. Wood requirements (m3/ha/an) assuming 1.28 m3 per person per annum (Section 5.3.6)	4.86	2.64
3. Sustainable production (m3/ha/an) from existing trees (Table 5.7)	1.22	0.36
4. Present production deficit (m3/ha/an)	3.64	2.28
5. Number of trees/ha required to provide sustainable yield equivalent to present production deficit (assuming 0.004 m3 per tree per year*)	910	570
6. Proportion of land required to satisfy requirements of present population (see 2 above) of converted to high-production woodlot*	0.28	0.15
7. Number of trees to be planted per person each year to eliminate present deficit within ten years (without providing for increased demands; assuming 60% seedling survival)	40	47
8. Number of trees planted per person each year over the 1982-6 period (questionnaire replies)	0.3	1.22

* based on an estimated production of 17.4 m3/ha/an for fast-growing fuel wood plantation species (e.g. Eucalyptus), spaced at 1.5 x 1.5 m (Earl, pers. comm.).

The use of medicinal plants from the forest reserves may be far more widespread than the figures in Table 5.11 suggest, because most people who rely on traditional medicine visit a traditional healer for treatment, rather than collect the medicines themselves. Very few people have the necessary knowledge to be able to treat themselves, and most recipes are a carefully guarded secret (Butono, 1988e). Table 5.12 lists 33 species of tree and two herbs about which information on medicinal uses was collected through interviews with five local medicine-men and one medicine-woman (Butono, 1988e). Many more species are likely to be in use, but a more detailed study would be required to document them.

4.9 Acceptability and use of family planning facilities

There is only one family planning clinic in Bundibugyo District, which is unable to provide a dependable service, and was used by only 0.1% of the district's population in 1987, although 8.0% of questionnaire respondents knew of its existence (Muhumuza, 1988c).

Table 5.11 The proportion (%) of questionnaire respondents who have made use of the county's forest reserves in the past ten years in various ways (responses to Question 43, Appendix T)

Use	Baamba (n = 89)	Bakonjo (n = 46)
Collection of medicines	3	17
Cultivation of land*	37	17
Collection of firewood*	8	26
Collection of building poles	7	22
Collection of palm nuts	1	0
Collection of bamboos	1	52
Hunting	1	11
Transit to Kabarole or Zaire	8	70
Other uses	0	0

* Note that there is some discrepancy between these figures and those provided in response to other enquiries reported in Tables 5.6 and 5.8.

Nevertheless a sizeable minority (29%) of male householders in Bwamba said that they would use family planning facilities if they were made freely available in their villages; and 12% said that they had practised birth control in the past (Muhumuza, 1988c; unpublished data). The average householder in Bwamba has 6.2 children but most would like a great many more; 67% of householders would like an average of 13.2 children (± 12.7(S.D.); n=91), while 33% say they would like just as many children as God gives them; and 83% of questionnaire respondents who responded to the question of how many children they could afford to support, gave a figure averaging 11.7 children (± 11.2(S.D.); n=84). It appears that small families are considered undesirable, since only 19.3% of householders specified five or fewer children as their optimum family size, and only 23.8% thought that they could only afford five or fewer children (unpublished data). Large families are regarded as an insurance against the loss of some of them so that enough survive to provide security to the parents in old age; 66% of those rejecting the use of family planning services provided this as their reason for doing so (Muhumuza, 1988c).

5. Conclusions and recommendations

The main conclusions of this study are:

- Under present systems of management, the land available for human settlement in Bwamba is already populated at a density close to its maximum carrying capacity. In the lowlands, about half the land is presently under cultivation (Section 4.1), 28% is

Table 5.12 Trees used for medicinal purposes in Bwamba (after Butono, 1988e)

Species (species numbers refers to those used by Hamilton (1981). adopted in Appendix A)	Used in the treatment of	Plant part used	Method of application
13. *Draceana afromontana*	Stomach-ache	Bark	Boiled in water, used as enema
34. *Elaeophorbia* sp. nov.	Food poisoning	Sap squeezed from bark	Consumed with food - induces vomiting
59. *Chlorophora excelsa*	Wounds	Bark	Boiled in water, used in washing wounds
63. *Ficus exasperata*	Diarrhoea	Leaves	Pounded in water, drunk
66. *Ficus mukuso* with 369. *Markhamia platycalyx*	Uterus problems	Bark	Boiled in water, drunk
67. *Ficus congensis*	Constipation, stomach worms	Bark	Boiled in water, drunk
82. *Ficus natalensis*	Acute stomach-ache	Bark	Boiled in water, drunk
82. *Ficus natalensis* with 338*. *Eucalyptus sp. and* 344*. *Erythrina abyssinica*	Severe chest pains	Bark	Boiled in water, drunk
88. *Celtis durandii*	Cough, stomach-ache	a) Leaves, b) Bark	Pounded, mixed with clean, cold water, drunk; pounded boiled in water, drunk
101. *Neoboutonia melleri*	Uterus problems	Bark	Boiled in water, used as enema
112. *Cordia millenii*	Dysentry	Cambium layer below bark	Mixed with water, filtered, used as enema
118. *Sterculia dawei*	Shortens child-birth labour	Bark	Pounded, boiled in water, drunk
119. *Dombeya mukole*	Dysentry	Cambium layer below bark	Mixed with water, drunk
127. *Glyphaea brevis*	Ear infections	Leaves	Boiled in water, cooled, dropped into ear
171. * *Vernonia amygdalina*	Fever	Leaves	Squeezed in water, filtered, drunk
211. *Diospyros abyssinica*	Big spleen, boils	Bark	Boiled in water, used as enema
252. *Chaetacme aristata*	Back wounds, spinal weakness	Leaves	Boiled in water, used for washing
267. *Alstonia boonei*	Stomach worms	Bark	Boiled in water
307. *Pauridiantha callicarpoides*	Wounds	Bark	Finely ground dried bark applied as fine powder directly onto wounds
321. *Psychotria megistosticta*	Scabies, skin rash	Root sheaths	Sun dried, finely ground and mixed with cow ghee. Applied as an ointment.
344. **Erythrina abyssinica*	Tuberculosis	Roots	Boiled in water, drunk
369. *Markhamia platycalyx*	Cough, severe chest pains	Roots	a) Roasted in fire, chewed; b) Boiled in water, drunk
370. *Spathodea campanulata*	Wounds	Cambium layer below bark	Scraped off, applied directly to wound, covered with a bandage
371. *Kigelia africana*	Female infertility; child constipation, big spleen	Bark	Boiled in water, drunk
403. *Khaya anthotheca*	a) Head-ache	Young leaves	Pounded or crushed, applied to fresh cuts made with a razor on the sides of the head
	b) Wounds	Bark	Boiled in water, used to wash wounds
419. *Blighia unijugata*	Big spleen in children	Bark	Boiled in water, used as enema
424. *Cassia spectabilis*	Constipation with measles	Flowers	Boiled in water, used as enema
428. *Cynometra alexandrii*	Acute back-ache	Bark	Boiled in water, used as enema
433. *Erythrophleum suaveolens*	a) Hernia	Seeds	Roasted, ground to fine powder, applied to affected part
	b) 'Inoculation' against measles	Seeds	placed on the arm
438. *Dichrostachys glomerata*	Constipation, stomach worms; assists child-birth	Bark	Boiled in water, used as enema
447. *Albizia zygia*	Acute stomach-ache	Bark	Boiled in water, drunk
- *Melia azedarach*	Toothache, stomach worms	bark	Boiled in water, drunk or used as enema
- *Mangifera indica*	a) Cough	a) Bark; b) Young leaves	Roasted and chewed; b) chewed
	b) Big spleen	Bark	Boiled in water, used as enema
- *Helinus sp.*	Strained back muscles	Leaves	Boiled in water, used for bathing
- *Alcacinaceae sp.*	Skin irritation	Bark	Boiled in water, used for bathing

required for domestic wood production (Section 4.7), and 7% is required under fallow to support present levels of temporary cropping activity (assuming temporary cropland is cultivated for half the time; Section 2.6). The remaining 15% of the land is theoretically available for development, although existing land tenure practises probably prevent this. In the highlands, the situation appears to be slightly less critical, although much of the land which is presently under grassland and might be available for agricultural development occurs on steep sites that are unsuitable for cultivation.

- Although 56% of the land in Bwamba is designated as forest reserve, these protected areas occupy land which is generally unsuitable for cultivation, on account of poor soils, poor drainage, or ecological fragility. The Rwenzori Forest Reserve (250 km^2) plays a crucial role in water catchment protection, which must not be compromised. The Semliki Forest Reserve (220 km^2) occupies a part of the rift valley floor which is characterised by poorly drained halomorphic soils which are generally unsuitable for agriculture; about 60 km^2 lies on better-drained soils with some agricultural potential, but the release of this land for agricultural development would carry heavy environmental costs without providing substantial long-term benefits to the people of Bundibugyo or the nation as a whole. In fact, 60 km^2 of this land could do not more than accommodate the 21,000 people who will be added to the county's population within the next five years (assuming the most optimistic forecast of carrying capacity for this land to be 350 people per square kilometre, and population growth to continue at 3.4% p.a. (Section 2.5)).

- Bwamba is known internationally for its rich wildlife communities, but most of the best lowland mixed evergreen forest habitats have been lost in recent years to agricultural development, and encroachment of forest reserves. Most of the lowland forest which remains in Bwamba is dominated by ironwood, and much of it is unusually species-poor. The few remaining stands of mixed evergreen forest are of critical conservation importance, and should be afforded the maximum possible levels of protection.

- An integrated programme of development activities is necessary if the people of Bwamba are to avert the consequences of environmental degradation which are likely if present land management practises and human population growth rates continue. The details of an appropriate programme are provided below.

5.1 Population management

The most pressing need is to stabilize the population of Bwamba, or, at least, the number of people who are directly dependent upon the land. At present an estimated 4,100 people are added to the county's population each year (Section 2.5), so an appropriate target would be to eliminate the dependence of this number of people on the land each year. At the very least, planners must be aware that 2,300 people were added to the adult job-seeking population in 1988 (3.4% of the 1970 population), and are in most urgent need of land or employment through which to earn a living. Stabilizing the population that is directly dependent upon Bwamba's land can be done in three ways, and we recommend that appropriate programmes be developed as soon as possible.

- **Facilitate emigration.** The resettlement of people outside Bwamba probably provides the greatest short-term prospect for alleviating the pressure of too many people on the land. Government should consider the most appropriate way of encouraging people to leave the area and become established elsewhere.

- **Reduce birth rates.** In the short-term this may be difficult to achieve, but community-based family planning programmes should be introduced without delay, so that those who have indicated a desire to use such facilities (Section 4.9) are able to do so. Further recommendations for appropriate action are provided by Muhumuza (1988c).

- **Provide employment opportunities.** Another important means of taking the pressure off the land is to provide employment opportunities.

5.2 Agricultural development

The efficiency of present agricultural systems in Bwamba is extremely low (Jjemba, 1988d; Section 4.3), and a lot can be done to improve the living standards of local people through improvements in agricultural methods. Jjemba and Baguma (1988) provide the following recommendations:

- **Improve agricultural extension services.** Bwamba presently has over 40 agricultural extension workers, but they are underpaid, ill-equipped and inefficient; they need to be supported. A district farm training institute should be established; the activities of the schools' Young Farmers Associations revived; and the emphasis of extension work should be on promoting regenerative methods of agriculture, rather than those that depend on external inputs.

- **Improve the marketing and pricing of produce.** Government cash crop price controls limit production incentives and need to be abolished. If this is not possible, it is essential that farmers are at least paid promptly for their produce.

- **Initiate and support agricultural research.** Research is badly needed to help develop maximally productive agricultural systems under local conditions. On-farm trials, and variety trials are particularly important.

- **Develop appropriate infrastructure.**

- **Improve crop processing facilities.** This would ensure proper food utilization and reduce the work-load of women.

Organise input distribution. Agricultural inputs (e.g. pesticides, herbicides, certified seed) are supposedly supplied at subsidized rates by government, but rarely arrive in Bwamba on time or in sufficient quantities. Their distribution should be organised through the co-operative movement.

5.3 Forest management

In order to resolve some of the present forest management problems it is necessary to bring the county's forest reserves back under the control of the Forest Department, and ensure that the maximum possible long-term benefits resulting from these areas accrue to the local people. Our recommendations are:

- **Forest reserves should be given adequate protection.** This involves re-marking forest boundaries, and ensuring adequate support and supervision of forest guards. Live tree markers should be planted along all reserve boundaries.

- **The taungya forest management system should not be re-introduced.** This recommendation is made despite the obvious advantages of the system in a place like Bwamba with high population densities, land pressure, and plenty of degraded forest land in need of rehabilitation; and despite the popularity of this system amongst the local people. We feel that it is unlikely to be workable under present socio-economic conditions, and would probably lead to further encroachment and forest degradation.

- **The Rwenzori Forest Reserve should be maintained strictly as a protection forest.**

- **Every possible effort should be made to enhance the direct economic benefit of the Semliki Forest Reserve.** This will involve enrichment planting of old encroachments with a mixture of high-value indigenous species including oil palms and timber trees. The nursery work, planting and weeding of tree seedlings will provide immediate employment, and the trees grown will ultimately provide direct economic returns, thus enhancing the value of the forest to local people and the nation as a whole.

- **Research should be carried out** into the most cost-effective way of restoring the productivity of forest encroachments. Permanent trial plots should be established and different regeneration methods monitored including natural regeneration, seed scattering, and enrichment planting.

- **Pressure to allocate land within the Semliki Forest Reserve for cocoa plantation establishment should be resisted.** Such plantations reduce the ecological value of the forest considerably because complex multi-species communities of plants and animals are replaced by virtual monocultures.

- Because of the unique wildlife communities characteristic of the Semliki Forest Reserve, **priority should be given to wildlife conservation** in certain areas of the reserve (see Section 5.6, below). The critical areas occupy about 60% of the reserve, and should be maintained relatively free of human intervention and disturbance.

- **Fuelwood plantations should be established** in a strip 500 m wide within the Semliki Forest Reserve, around the reserve's perimeter. Such plantations would help alleviate the population pressure in adjacent areas by releasing land that would otherwise have to be used for fuelwood production. A 500 m strip of fuelwood plantation yielding 15 m^3/ha/an would provide for the requirements of all the people presently living within 1.5 km of the reserve's boundary. Indigenous species are preferred for the establishment of these plantations. Careful consideration should be given to the possibility of leasing this land to those who have insufficient land of their own on which to grow trees, enabling them to satisfy their own domestic wood requirements by growing trees under Forest Department supervision. If this were done, extreme vigilance would be necessary to ensure that the land was used only for trees; a small pilot scheme is recommended initially.

5.4 Forestry extension services

Considerable efforts need to be made in promoting tree planting initiatives by private individuals in Bwamba. If the county's people are to satisfy their own domestic wood requirements, they must each plant about 45 trees each year for the next ten years (Section 4.7), compared with the present average planting rate of less than one tree seedling per person per year. In order to achieve this target, we recommend:

- **Forestry extension staff should be employed** to teach, demonstrate and promote tree planting, in close co-operation with agricultural extension workers;

- **Agro-forestry demonstrations should be established** on the farms of prominent local people including chiefs, elders and Resistance Committee executives;

- **Tree nurseries should be established** in every parish at schools, churches and other institutions, with the assistance of the Forest Department. The importance of these nurseries should not, however, be over-emphasised, since people are clearly used to collecting their own self-sown seedlings from the natural forest (Butono, 1988d), and it is probably more important to teach and demonstrate the importance of tree planting as it is to supply seedlings.

5.5 Development of alternative energy sources/energy conservation measures

The present population of Bwamba requires about 116 km^2 of high-yielding forestry plantation (or its equivalent) to provide its domestic wood requirements on a sustainable basis (assuming a population of 118,000 consuming 1.23 m^3 per annum, and plantation yields of 13.0 m^3 per hectare per annum). However, since 97% of this requirement is for domestic energy (Section 4.6), any measure which reduces the people's dependence on wood energy will enable land that would otherwise be used for wood production to be used in crop production instead. Accordingly, efforts should be made to develop alternative sources of energy, particularly hydro-electric power; and to promote the use of fuel-efficient stoves. The latter measure alone could reduce fuelwood requirements by as much as 20% (J. Miskall, pers. comm.).

5.6 Wildlife protection measures

It is unlikely that any significant areas of undisturbed natural forest will survive on the Bwamba public lands, and wildlife conservation efforts should therefore be concentrated in the Rwenzori and Semliki Forest Reserves. The whole of the Rwenzori forest should be protected for its water catchment and other values (Howard, 1988a), and its wildlife given special protection against hunting and other forms of disturbance. The Semliki Forest Reserve will, unfortunately, be unlikely to survive as a wildlife preserve, and it will be necessary to integrate wildlife conservation with other forest management activities which provide more substantial direct economic benefits to local people. Accordingly, we recommend that the following areas of the Semliki Forest Reserve, which include the most valuable wildlife habitats remaining, be retained and managed primarily for wildlife conservation purposes:

- the whole of the area east of the Kirimia river, presently designated as a Nature Reserve;

- a strip of land 3 km wide along the entire length of the Lamia and Semliki rivers north of the point at which the boundary of Zaire's Virungas National Park joins the opposite bank of the Lamia river at 0°47'N. This strip of land will protect the species-rich swamp and mixed evergreen forests characteristic of the riverside margins and provide a corridor for animals and plants moving between Zaire's National Park and the Nature Reserve; and

- a strip of land 1 km wide along the west bank of the Kirimia river, which will protect an area capable of regenerating into mixed evergreen forest.

We recommend that these three adjoining areas be rigorously protected against agricultural encroachment, timber extraction and hunting; and that no attempt is made to improve the economic value of timber resources in these areas through enrichment planting or other forest management practices. The three areas represent approximately 60% of the reserve's total area, and might serve as the totally protected core of a new Semliki Forest Park.

In making these recommendations we are conscious of the fact that most of Bwamba's most valuable forests - which were the focus of earlier biological investigation by other workers - have been irretrievably lost. What we propose is to restore and preserve a small representative sample of the Ituri Forest, which happens to lie in Uganda, and is unique in an East African context. It should be pointed out, however, that much larger areas of this forest type are probably protected quite adequately within the neighbouring Parc National des Virungas in Zaire, and the preservation of remaining forest within the Semliki reserve is more of a national than international priority.

5.7 Environmental education

There is a need to initiate an environmental education programme in Bwamba to develop more fully the people's understanding of environmental issues. Special emphasis in such a programme should be placed on teaching the people why the county's forest reserves are important to them, and educating them about the legal status of these areas - two issues where understanding is particularly weak (Section 4.5).

5.8 Land reform

The present problem of land shortage is partly the result of the inequitable distribution of land, with 23% of householders occupying almost half the land (Section 4.2). Therefore, we follow Jjemba and Baguma (1988) in recommending that careful consideration be given to possible land reform measures. All land holdings might first be registered, and a moderate annual land tax levied on any individual with more than, say, two hectares. Failure to pay this tax would lead to compulsory sale of the land in question, so that it is redistributed to somebody who is able to use it productively.

6. Broader implications of this study

Many of the problems of renewable natural resources management which we have documented for Bwamba County are widespread, and the need for appropriate conservation measures may be even greater in other areas than it is here. Our impression is that many parts of Kabale, Rukungiri, Bushenyi and Mbale districts, as well as the entire Rwenzori massif, are in urgent need of conservation activities similar to those we prescribe for Bwamba. We believe that rural populations in many areas of Uganda are, as in Bwamba, living off environmental capital which may have taken hundreds of years to accumulate - through deforestation and the 'mining' of the soil. The encroachment of forest reserves is only a symptom of far wider problems of environmental mismanagement: it is these problems which have to be addressed as a matter of urgency, if people are to live in a sustainable relationship with their environment.

6. Chapter Summary

1. An integrated natural resources development study was carried out in Bwamba County, Bundibugyo District, aimed at evaluating resources and their use, with particular reference to the problems of deforestation and encroachment of forest reserves.

2. The study area covers approximately 860 km^2 of land on the western slopes of the Rwenzori massif, stretching down into the rift valley floor. The area is geologically, climatically and ecologically diverse, and supports some of the most species-rich forests in Africa. Fifty-six percent of the land is designated as forest reserve, mainly on the poorer soils of high altitudes (Rwenzori Forest Reserve) and the rift valley floor (Semliki Forest Reserve). The remainder of the land is intensively cultivated by Baamba and Bakonjo people living at a density of approximately 320 people/km^2. The population was increasing at a rate of 3.4% p.a. between 1969 and 1980.

3. Field surveys were carried out between July 1986 and December 1987, which concentrated on detailed evaluations in ten randomly located quadrats in the settled part of the county. Land-use patterns, agricultural production efficiency and constraints, the quantities of woody biomass available, and the attitudes and opinions of local people on issues relating to natural resources management were assessed.

4. Most of the land available for settlement is being used, but production efficiency is low. A little over half the people say that they are short of land. This has led to large-scale encroachment of the Semliki Forest Reserve since 1971, both by the Baamba (in whose traditional area the reserve lies) and the Bakonjo (who live on the mountain slopes some way away).

5. The estimated demands of local people for fuelwood and building poles exceed the sustainable supply from the settled part of the county by a factor of four in the lowlands and of seven in the highlands. A ten-year programme to restore tree cover to a level that could meet present levels of demand on a sustainable basis would require each person to plant 40-50 trees every year, compared with present tree-planting rates of less than one tree per person per year.

6. Recommendations are made for an integrated programme of development activities aimed at reversing the present trends of environmental degradation. The programme includes population management, agricultural development, forest management, forestry extension services, the development of alternative energy sources and energy conservation measures, wildlife protection, environmental education and land reform.

7. The natural resources management problems we have documented here are not unique to Bwamba, and many of the measures we propose are equally necessary elsewhere. The encroachment of forest reserves is often a symptom of widespread environmental mismanagement outside the reserves, problems which have to be addressed if conservation goals are to be achieved.

Chapter Six: Outlook and Recommendations

1. Introduction

The purpose of this chapter is to review the forestry activities that are planned for the next five years, and their likely impact on the natural forest; and to provide recommendations of a general nature aimed at ensuring sustainable forest management, which safeguards the supply of timber and other forest products from the natural forest, and ensures the maintenance of environmental services, without the loss of species.

2. Outlook

Concern over the outlook for forestry in Uganda, and the need for an accelerated programme of afforestation, was first expressed in the forestry development reports of UNESCO (1964), FAO (1967) and Lockwood Consultants (1973) (Hamilton, 1984). However, despite these early warnings, the past 20 years have been a period of considerable further deterioration in the outlook for forestry, as a result of the collapse of the Forest Department's management capability and the ever-increasing demands for wood products from the country's rapidly growing population (Chapter One). The widening gap between the demands for wood products and their supply has become a major cause of government concern, which has resulted in a series of recent protracted negotiations to secure external aid to assist in revitalising the forestry sector. Several important new programmes of external assistance have been negotiated over the past five years, most of which are now starting, or are expected to do so by mid-1989. Together, these programmes represent an approximately ten-fold increase in annual forestry expenditure, and have the potential to make a significant contribution to solving some of the present problems. The activities to be supported under each of these programmes, and their possible impact, are reviewed below.

2.1 Forestry Support Programmes

Forestry Rehabilitation Project (US$36.8 million over six years)

Negotiations for this project were initiated in 1984, and implementation began in March 1988. The project aims to improve the management of Uganda's forest resources to meet domestic needs for timber, fuelwood and other wood products on a sustained basis, while at the same time increasing the area and improving the management of conservation forests in order to protect unique ecological systems. The project has six components, and is funded by a consortium of five external agencies, and the Uganda Government. Approximately 45% of project costs are provided in the form of external grants (from the EEC, DANIDA,

- Rehabilitation of the Forestry Department: this component aims to rehabilitate offices and accommodation, provide transport and equipment to assist in forestry supervision, and provide technical assistance for planning, procurement and financial management and studies.

- Farm Forestry: this component aims to establish tree nurseries in rural areas, support forestry extension services, and promote agroforestry activities.

- Natural Forest Management Rehabilitation: this component aims to re-demarcate all forest reserve boundaries, replant 17,000 ha of encroached forest-land, enrich 9,000 ha of degraded forest, improve the management of logging and charcoal production, provide for the revision of working plans, conduct forest inventory work, and support the establishment of Nature Reserves covering 20% of the natural forest, and low-intensity use ('buffer') zones covering a further 30%.

- Industrial Softwood Plantation Rehabilitation: this component aims to rehabilitate 13,900 ha of softwood plantations that have been left untended for the past 10 to 12 years, and establish 2,750 ha of new plantation using the taungya forest management system.

- Training: this component aims to rehabilitate the Nyabyeya Forestry College to provide in-service training as well as training for new forestry staff, and to rehabilitate the Nakawa sawmill to provide training in milling and logging operations.

- Peri-urban plantations and pilot wood farms: this component aims to re-establish 900 ha of plantations using the taungya system, and provide seedlings for the establishment of 1,000 ha of private woodlots under licence on gazetted forestry land in peri-urban areas.

National Biomass Survey

The Norwegian Forestry Society is expected to finance a survey of woody biomass outside forest reserves, focussing on selected peri-urban areas, but including some sample assessments in rural areas. The aim of the survey is to evaluate the sustainable supply of woody biomass as a basis for forestry planning.

Village Tree Planting Project (US $1.4 million over three years, finishing mid-1987)

CARE-International in Uganda has been assisting with the establishment of village tree nurseries, and the support and training of Forest Department extension staff over a three-year period from early 1984. This has involved support to approximately 300 nurseries in 11 districts and the training of over 80 forestry staff. CARE-Uganda is expected to continue its commitment to community forestry by implementing the Farm Forestry component of the Forestry Rehabilitation Project (see above).

Development through Conservation in Southwestern Uganda (US $1.2 million for the first two years of a five-year project)

CARE-International in Uganda and the World Wildlife Fund (WWF-US) have developed a programme to assist with the integration of rural development and the conservation of forest resources in Kabale and Rukungiri Districts in southwestern Uganda. The project is expected to commence late in 1988 with USAID funding, and will involve in-forest activities (ecological surveys and research, management planning, multiple-use zoning, environmental education) in the Bwindi (Impenetrable), Mgahinga and Echuya forests, as well as out-of-forest rural development activities (agroforestry, soil and water conservation activities, family planning, livestock production, etc).

Sustainable Development and Forest Conservation in Uganda (US $0.35 million over one year)

The International Union for Conservation of Nature and Natural Resources (IUCN) and the Ministry of Environment Protection, with NORAD funding, are to design a programme of activities for the conservation of resources in and around the degraded forests of Mount Elgon, Kibale and Semliki. This feasibility study, due to commence in July 1988, is expected to lead into an implementation phase involving the integration of in-forest conservation measures with rural development activities in the areas surrounding these forests.

Makerere University Biological Field Station in Kibale Forest (US $0.2 million)

The New York Zoological Society (NYZS) and Makerere University, with EEC and USAID funding, are to establish a biological field research station in Kibale Forest, based at Kanyawara Forest Station, the site of NYZS's Kibale Forest Project. This facility is expected to provide a focus for applied research on forest ecology, of relevance to the management of the tropical high forest in general, and the Kibale Forest in particular.

Other forest-related activities

In addition to the six major programmes listed above, there are a number of smaller ones underway which play an important role in forest conservation. Noteworthy amongst these are:

- the Karamoja Development Programme has been raising tree seedlings and establishing woodlots in Moroto and Kotido districts since 1979;
- the Uganda Red Cross Society is active in the field of environmental education and has established a number of tree nurseries, especially in schools and colleges;
- the Wildlife Clubs of Uganda are active throughout the country in the field of environmental education;
- the International Labour Organisation (ILO) has supported six tree nurseries in Kotido District since 1983, and is now involved in a pilot project at Kalege, Luwero involving tree nursery support;

- various churches maintain tree nurseries, and play an active role in promoting tree planting;

- the NYZS's Kibale Forest Project has pursued an active programme of ecological research in Kibale Forest since 1971 and undertaken other conservation activities in the area of Kibale Forest;

- the WWF's Impenetrable Forest Conservation Project has conducted ecological research, developed an environmental education programme, and assisted with the protection and management of the Bwindi (Impenetrable) Forest since 1986;

- The Joint Energy and Environment Programme (JEEP), an indigenous non-governmental organisation, has established an agroforestry demonstration centre in Mukono District, runs an environmental education programme, and promotes the use of improved cooking stoves;

- the Forest Diversity Project of Stanford University's Center for Conservation Biology has been conducting applied ecological research in the Mabira Forest since 1987;

- the Makerere University Institute of Environment and Natural Resources, established in 1987, is playing an important role in coordinating meetings and promoting appropriate research;

- the United Nations Environment Programme (UNEP) with the Ministry of Environment Protection, is developing three 'model' villages to demonstrate self-sufficiency in food and energy under the environmental conditions prevailing in different parts of the country.

- the Norwegian Red Cross Society is undertaking a community forestry project in Mbarara and Kasese Districts;

- the International Centre for Research in Agroforestry (ICRAF) is conducting applied research on agroforestry and farming systems in the montane areas of Uganda;

- the IDRC is supporting research on the production and use of natural gums and resins.

2.2 The Possible Impact of Forestry Support Programmes on the Natural Forest

Most of these forestry support programmes are still being planned, or are at an early stage of implementation, when important decisions are being made on the details of activities to be undertaken. It is therefore appropriate to consider, at this stage, the extent to which these programmes address the problems of forest resource management; identify possible weaknesses; and ensure that adequate safeguards are built into the programmes to guarantee that their long-term environmental and economic impact is as beneficial as possible.

The success of the programmes will undoubtedly be dependent largely upon the level of political, social and economic stability achieved in Uganda in the coming years. Assuming a steadily improving situation of increased political stability and economic growth, it is not difficult to see how the proposed programmes will benefit the nation. They are designed to satisfy increasing demands for fuelwood, building poles and sawnwood by:

- encouraging self-sufficiency in firewood and building poles in the rural areas of the country;
- protecting the forest estate;
- regulating the exploitation of forest resources, and
- planting up areas of encroached and degraded forest land, as well as establishing new plantations.

These objectives are unquestionably appropriate to Uganda's present forestry needs. What is less certain is whether the planned programmes are sufficient to meet the country's requirements, either in terms of supplying enough fuelwood and timber, or in terms of reversing the present rapid environmental degradation.

For example, if planting targets are achieved, only 17,000 ha of the encroached forest estate will be replanted over the next six years, less than half the 38,000 ha of encroached land in the twelve principal forests considered in this study (Chapter Three). If the replanting effort was concentrated on Mount Elgon, most of the encroached area of this one reserve would be returned to forestry use by 1993, but this would be achieved at the expense of replanting *any* of the encroached land elsewhere, including the degraded parts of South Busoga, Mabira, Kibale and Semliki forests.

Similarly, the target for enrichment planting of forest degraded by the sawmilling industry is just 1,500 ha per annum, but 44,000 ha has been mechanically harvested in the twelve principal reserves since 1950 (Chapter Three), of which a minimum of 20,000 ha needs to be restored to a productive state (Wood, 1978). The area to be enriched each year is equivalent to the area of undisturbed forest that has to be cut in order to yield 75,000 m^3 of roundwood (assuming 50 m^3/ha), or about a quarter of the country's annual requirements. Even if three-quarters of demand is satisfied by the exploitation of the country's over-mature softwood plantations, it is clear that the proposed enrichment planting programme will make good only as much forest as might be degraded over the same period, and will do nothing to restore the vast areas of degraded forest resulting from past harvesting operations.

Even the substantial efforts being made in the field of farm forestry appear to fall far short of what might be required, with an end-of-project target on the Forestry Rehabilitation Project of 27 million tree seedlings produced annually, or just 1.5 trees per head of population. If the growing demands for fuelwood and building poles are to be satisfied without further serious environmental degradation, a seedling production figure ten times as large would be more appropriate.

Two further questions need to be addressed in relation to the proposed programmes of support to the forestry sector. The first is whether or not Forest Department staff are likely to be paid enough to enable them to become efficient project executants. Present government salaries are so low that it is quite impossible for any civil servant to survive more than a few days on his month's salary (Chapter One). Unless the forestry support programmes are able to provide sufficient allowances and other benefits to forestry staff, the success of the programmes is likely to be severely handicapped by staffing problems. Staff will be unable to commit themselves to project activities, equipment provided will be diverted to private use, and may even facilitate the (illegal) exploitation of forest resources by Forest Department staff. It must of course be a long-term objective of Government to restore staff salaries to acceptable levels so that forestry activities can become self-sustaining beyond the tenure of foreign aid, but as a short-term measure, it would appear that direct staff support must be provided as part of any effective programme.

The second issue - one which could be the subject of considerable controversy - is whether it is appropriate to re-institute forest management systems which were developed more than 20 years ago, when conditions in Uganda were very different. Is it possible to ensure the level of management input that is necessary to sustain such systems, or would it be more appropriate to modify them in favour of systems that require less intensive management, accepting that this may result in lower production efficiency? Clearly, it is beyond the scope of this report to attempt an answer to these questions, but they are nevertheless important issues to consider.

3. Recommendations

3.1 Previous recommendations

The management of Uganda's tropical high forest resources has been the subject of three important reviews, carried out for the United Nations Food and Agriculture Organisation (FAO) by Wood (1978), for the Uganda Forest Department by Hamilton (1984), and for the United Nations Environment Programme (UNEP) by Aluma (1987). Notable earlier reports were prepared by UNESCO (1964), FAO (1967) and Lockwood Consultants (1973), and the latest appraisals have been carried out by the World Bank consortium in the formulation of the Forestry Rehabilitation Project, and other external forestry support programmes (see above). It is not my intention to review all of the recommendations made in these reports, although those I consider particularly important are included amongst my own recommendations, below.

There is general agreement that no simple, direct solution can be applied to solving the problems of deforestation in Uganda, and that wide-ranging integrated programmes are required. One particularly important aspect that has been the focus of earlier recommendations (e.g. IUCN, 1983; Hamilton, 1984; Struhsaker, 1987) is the need to reduce the rate of human population growth in Uganda. This is clearly of fundamental importance, not only to solving the problems of environmental degradation, but also in achieving economic development.

3.2 Recommendations of this report

In this section, I make a number of recommendations aimed at improving the conservation status of the country's natural forests, and the wildlife they support. Many of these recommendations have been made previously by others, and some appropriate actions are already being taken (see section 2.1 above). My aim is to draw attention to measures which I consider particularly important in achieving success in nature conservation. To a large extent the objectives of nature conservation and sustainable production forestry are the same, so many of the recommendations that follow are fully compatible with existing forestry practice. They are arranged in eight groups, describing measures necessary to:

- Institute forest management systems that recognise the preservation of biodiversity as a primary management objective;
- Protect suitable forest areas from all forms of extractive use;
- Alleviate the pressure for wood products from remaining areas of undisturbed natural forest;
- Safeguard the forest estate;
- Develop a strong nature conservation capacity within the Forest Department;
- Conduct research aimed at developing improved forest management techniques;
- Generate public awareness of tropical forest values;
- Provide an appropriate legal and administrative framework for the conservation of forests.

Recommendations which have received some consideration in the formulation of existing or proposed forestry programmes (as reviewed in section 2.1), but which, in my opinion, deserve further attention are marked with an asterisk (*). Those that have not previously been considered or acted upon are marked with two asterisks (**), while those that are receiving adequate attention under existing programmes are unmarked.

3.2.1 Recommendations aimed at instituting forest management systems that recognise the preservation of biodiversity as a primary management objective

Background: The need to preserve biodiversity and unique forest communities was discussed in Chapter Four, with particular reference to the establishment of a network of protected areas encompassing representative samples of undisturbed forest. These protected areas are unlikely to cover more than 20% of the forest estate, so the survival of most species will be dependent, to some extent, upon their persistence in disturbed forest habitats. Considerable effort should therefore be directed at integrating the needs of wildlife conservation and those of extractive forest industries in the disturbed forest habitats that will soon dominate Uganda's natural forest communities. The following recommendations are offered:

*<u>*Recommendation 1. The management of forest reserves should be based on their division into distinct management zones*</u>, as described in Chapter Four. Under such a system, each reserve would include a totally protected core area (Nature Reserve) surrounded by a buffer zone, with an outer zone managed for maximum sustained production of forest products. The relative size of these zones would vary between reserves, depending on the particular characteristics of each, but an average of 20%, 30%, and 50% for core, buffer and production zones respectively, as recently adopted by the Forest Department, appears appropriate. The buffer zones should be managed to maintain the ecological characteristics of a mature forest community by excluding mechanised timber extraction, applying rather high girth limits (perhaps 60-80 cm, depending on species), and minimising disturbance by restricting human activities to one or two management compartmnents at any one time. The management of production zones should be aimed at maximising yields of high quality

hardwood timbers, on a sustainable basis, whilst maintaining habitats suitable for the majority of wildlife species. The value of these areas to wildlife can be considerably enhanced if trees of proven value to wildlife ('keystone' species; Terborgh, 1986) are left standing when timber harvesting takes place; and if management compartments are felled in a sequence which maximises the age-difference between adjacent stands (this can be achieved by ensuring that felling is always carried out next to a management compartment of mid-rotation age (see Harris, 1984)).

*Recommendation 2. Careful consideration should be given to the development of Forest Parks in areas of high conservation value where multiple-use management is desirable. Exhaustive consultations over the constitution of such Parks should be held involving, at a minimum, the Uganda National Parks, community representatives from the areas concerned, and outside consultants with relevant experience from other parts of the world.

*Recommendation 3. Greater effort should be made to ensure that timber extraction from the production zones of the natural forest is practised in a sustainable manner. Some immediate measures that should be taken include:

- the completion of comprehensive inventories of timber and other resources (including biodiversity) prior to exploitation. Prospective concessionaires might be required to finance such inventories, which would be carried out independently.

- the revision (or preparation) of all forest management plans.

- the tightening of controls over pitsawing activities, including the re-introduction of the system of marking tree stumps, logs and boards, and the restriction of pitsawing to one or two management compartments in any given forest at any one time.

- the review (and, if necessary revision) of terms under which concessions to exploit the natural forest have been given.

- the development of logging techniques and technology that are compatible with sustainable natural forest management.

- ensuring satisfactory regeneration of areas after logging by reducing logging intensities and damage (thus permitting satisfactory natural regeneration) or re-introducing necessary enrichment and silvicultural procedures.

- the retention of seed-bearing trees of species that are selectively harvested, and other species that are known to be of particular value to wildlife (i.e. 'keystone' species).

**Recommendation 4. Forest animals should be given much stricter protection by increasing the efficiency of game guard patrols. In view of the limited resources available for this, it would be preferable to concentrate effort in a few carefully selected reserves where a high degree of success can be achieved. Under existing legislation, the protection of forest animals falls under the jurisdiction of Game Department, but it may be desirable to rationalise the protection of all forest wildlife by re-designating all game and forest guards as environmental guards charged with upholding both Game and Forests Acts (see also Recommendation 38, below). The protection of forest animals should receive high priority in the management of Forest Parks, if any such Parks are established.

**<u>*Recommendation 5. Extreme caution should be exercised in the introduction of non-indigenous species to the natural forest*</u>.. Such species frequently become invasive and are liable to take over from the naturally occurring ones. Local examples of this include the introduction of *Cassia spectabilis* to Budongo forest (Gitec Consultants, 1985. p.44), and of *Maesopsis etninii* to the East Usambara forests in Tanzania (Hamilton, 1987). Indigenous species should always be used for enrichment planting and the reclamation of encroachments, except where large areas are being converted to high-yielding plantation forestry. Wherever replanting is carried out, efforts should be made to maximise the wildlife value of the replanted area by planting in mixed species stands, or small (5 ha?) single species blocks with different species in adjacent blocks.

*<u>*Recommendation 6. Greater emphasis should be placed on realising those economic and social benefits of the natural forest, that do not involve timber extraction*</u>. Two of the most obvious possibilities are the development of nature-based tourism facilities in the natural forest, and the commercial development of minor forest products such as craft materials, medicines, butterflies, honey and so on.

3.2.2 Recommendations aimed at protecting suitable forest areas from all forms of extractive use

Background: Protected areas are not only necessary as a means of ensuring the survival of plant and animal species that are intolerant of habitat disturbance, but also serve an important role in sustaining the ecological viability of adjoining production forests. They act as a reservoir of species, providing seeds and seed dispersers, pollinators, predators and prey, that are able to re-colonise logged areas, and ensure their continued productivity. The planning of an appropriate network of protected areas was the subject of Chapter Four, and the following recommendations are based on the considerations discussed in that chapter.

*<u>*Recommendation 7. All forest estate (a) with little or no potential for commercial forestry: (b) the protection of which is essential for watershed maintenance: (c) which also holds significant tourist potential and (d) adjoins internationally recognised conservation areas in neighbouring countries, should be protected as National Parks*</u>. This applies specifically to the higher altitude of Rwenzori, Mgahinga and Mount Elgon.

*<u>*Recommendation 8. Forests which are (a) especially important for biological conservation: (b) provide significant benefits from commerical forestry (or have the potential to do so) and (c) have the potential to provide a wide range of benefits from non-consumptive uses (such as tourism, research and education) should be considered for Forest Park status, and have at least 50% of their area strictly protected against extractive uses*</u>. If, following exhaustive consultation (Recommendation 2, above) it is considered inappropriate to proceed with the development of Forest Parks, then at least 50% of the area of these forests should be designated as National Parks. This recommendation applies specifically to the Bwindi (Impenetrable), Kibale and Semliki forests (in the first instance), and should be extended to cover the Budongo, Kalinzu/Maramagambo and Kasyoha-Kitomi forests in future.

*<u>*Recommendation 9. Overall, at least 20% of the natural forest lying outside National Parks should be protected as Nature Reserves*</u> (in some cases these would be contained within Forest Parks, as detailed in Recommendation 8, above). The areas of each individual forest to be designated as Nature Reserve should be determined using criteria such as those

discussed in Chapter Four, which provide the basis for my scores of importance for protected area establishment (Table 4.6). Whilst accepting the obvious limitations of the methodology (Appendix Q), I use these scores to recommend that Nature Reserves should account for:

- about 50% of Bwindi, Kibale and Semliki forests (in these cases the area recommended is larger than that prescribed on the basis of scores derived, because these forests are recommended for special status as Forest Parks);

- 20-25% of the area of Kalinzu/Maramagambo lying outside Queen Elizabeth National Park;

- 15-20% of Kasyoha-Kitomi; Budongo and Mabira;

- 10-15% of Itwara;

- 8-10% of Bugoma and Sango Bay.

Some specific recommendations for Nature Reserve establishment are contained in the Forest Profiles appended to this report (Appendices E-P). Suitable areas for Nature Reserves have been identified (and their locations shown on the appropriate Appendix maps) in the Budongo, Bugoma, Itwara, Kalinzu and Kasyoha-Kitomi forests. The sizes of these proposed Nature Reserves and the altitudes at which they occur are summarised in Table 6.1, together with details of existing Nature Reserves. Altogether, 265 km^2 of forested land within the principal forest reserves is already designated as Nature Reserve, or identified for consideration (172 km^2 and 93 km^2 respectively). An additional 300 km^2 needs to be identified in the ten principal reserves where closed canopy forest is dominant in order to raise the proportion of reserved tropical high forest set aside as Nature Reserve to 20%. Some suggestions as to where these additional Nature Reserves should be located are provided in Table 6.1. It is particularly important to identify suitable areas for major Nature Reserves (covering at least 30 km^2 each) in the lower-lying parts of Budongo forest, and the 1,500-2,000 m zone of the Bwindi (Impenetrable), Mount Elgon and Rwenzori forest reserves.

It should be noted that these recommendations apply only to the principal forests, and that a great many smaller forest reserves exist, which need to be carefully evaluated before establishing Nature Reserves here as well. Although these will be much smaller than the ones in the principal forests, they can be expected to play an important role as 'stepping stones', assisting plant and animal dispersal (see also Appendix U).

3.2.3 Recommendations aimed at alleviating the pressure for wood products from remaining areas of undisturbed natural forest

Background: Conservation of the remaining areas of undisturbed natural forest is unlikely unless there are economically viable alternative sources of wood to satisfy the country's needs. It is therefore imperative that such alternatives are developed (or, where they already exist, put into production) as quickly as possible. Most demand stems from the need for fuelwood and building poles in the rural areas, so the success of farm forestry programmes is clearly crucial to this effort. At the same time, there are now large areas of reserved forest land that are sufficiently degraded by agricultural encroachment and poorly-

Table 6.1 The sizes (km2) of existing and proposed Nature Reserves, considered by altitudinal zone in the twelve principal forests. Figures without parentheses denote areas of existing Nature Reserves or study plots; figures in single parentheses denote areas of proposed Nature Reserves; and figures in double parentheses denote areas protected within Queen Elizabeth National Park. Areas where major new protected areas (covering at least 20 km2) still need to be identified and developed are indicated by **, and where smaller Nature Reserves need to be identified by *. Dashes are used to indicate altitudinal zones that are not represented in particular forest reserves.

ALTITUDINAL ZONE (m)	FOREST RESERVE Kibale	Semliki	Budongo	Kalinzu/ Maramagambo	Bugoma	Bwindi (Impenetrable)	Kasyoha-Kitomi	Itwara	Sango Bay	Mabira	Mount Elgon	Rwenzori
< 750	-	73	-	-	-	-	-	-	-	-	-	-
751-1000	-	- **	(11)	((35))	*	-	-	-	-	-	-	-
1001-1250	**	-	7 1	((242)) 4	(17)	- *	(3)	-	* **	11	-	-
1251-1500	57	-	- **(12)	((2)),3	-	2	(32)	(13)	-	-	-	-
1501-1750	-	-	-	3.(1)	- **	1 *	(4)	-	-	-	*	-
1751-2000	-	-	-	-	- **	3	-	-	-	-	*	*
2001-2250	-	-	-	-	- **	7	-	-	-	-	**	**
2251-2500	-	-	-	-	-	*	-	-	-	-	**	**
Total forested area (km2) already designated or identified as Nature Reserve ((protected as National Park))	57	73	18 ((279))	20	21	13	39	13	0	11	0	0
Recommended additional area (km2) of forest habitat to be designated 1	159 +	32 +	53	43+ +	5	147 +	20	0	14	40		

1 Based on consideration of the total area of forest habitat within each reserve (see forest profiles; appendices E-P), and recommended percentages for protection given in Table 4.6.

+ These figures represent 50% of the forest habitat in these reserves, which is a recommended minimum for protection under National Park or Forest Park status.

+ + Based on 22.9% of the forested land not already contained within Queen Elizabeth National Park.

managed timber extraction activities, as to be of little value for nature conservation. These areas alone have the regenerative capacity to satisfy the nation's projected sawn-wood requirements well beyond the year 2,000 and should become the focus of a major re-planting and silvicultural effort. The following recommendations are offered:

*_Recommendation 10. Government should pursue a policy of evicting encroachers from the forest estate, and should arrange, where necessary, for the resettlement of these people elsewhere._

*_Recommendation 11. High priority should be attached to replanting areas of encroached forest land, with the objective of maximising timber production from these areas, in the most environmentally sensitive way possible_. There are 38,000 ha of severely encroached land in the twelve principal forests covered by this project (see Chapter Three), which could provide a sustainable roundwood yield of 456,000 m^3, if converted to softwood plantation. However, since the country already has softwood plantations providing (potentially) a sustained yield of 200,000 m^3 (equivalent to almost half likely demand in the year 2000), no more than half the encroached land needs to be converted to softwood plantation in order to satisfy the country's entire needs for the foreseeable future. The remaining areas of encroached land should also be restored to productive forestry use, through appropriate replanting and silvicultural treatments.

*_Recommendation 12. Appropriate silvicultural treatments should be applied to areas of the natural high forest that have been degraded by the sawmilling industry, in order to ensure satisfactory regeneration and restore these areas to a productive state_. There are 80,400 ha of forest effected by mechanised timber felling operations in the twelve principal forests (Chapter Three), an area which could yield 160,000 m^3 of hardwood timber per annum on a sustained yield basis if properly managed (assuming a conservative 2 m^3 per hectare per annum; Earl, 1968). This would satisfy more than 60% of the nation's present sawn-timber requirements, and reduce the need to degrade more of the remaining forest.

*_Recommendation 13. Rural communities should be encouraged and facilitated to become self-sufficient in fuelwood and building poles_. The implementation of this recommendation would involve a number of approaches including:

- the establishment of tree nurseries and distribution of seedlings;
- the active promotion of tree planting through the organisation of national tree planting days, and public awareness campaigns;
- the provision of advice and forestry extension services in rural areas; and
- the development of agroforestry demonstrations.

A considerable amount of activity in this field is already planned or underway, but a great deal more is necessary (Section 6.2). For further useful discussion of social forestry requirements see Hamilton, 1984, and Struhsaker, 1987.

*_Recommendation 14. Government should resume a policy of rapid softwood plantation rehabilitation and development_. It is essential that the bulk of the country's demands for sawntimber are provided by softwood plantations. Meeting the growing demands requires long-term planning, and means that planting targets must be met. At present, Uganda has 13,400 ha of land under poorly managed softwood plantation, the rehabilitation of which requires that 1,300,000 m^3 of sawlogs be removed over the next five years (World Bank, 1986). This volume of timber would satisfy the vast majority of anticipated domestic demand over this period, but in the long term 13,400 ha can only be expected to provide about 200,000 m^3 of timber per annum on a sustained yield basis (assuming 15 m^3 per hectare per annum), or a little under half likely demand in the year 2000 (World Bank, 1986). New plantations might be developed in areas of the natural forest that have been severely degraded by agricultural encroachment (Recommendation 11).

* *Recommendation 15. An appropriate price differential between hardwood and softwood timber should be introduced, reflecting the differences in productivity and the costs involved in sustained yield management of tropical high forests and plantations*. Although tropical high forest management costs are likely to be lower than those involved in plantation management, (because no planting costs are incurred), the fact that softwoods yield 6-9 times as much timber per unit area is likely to result in a price differential of perhaps five times. This should shift the demand in favour of softwoods, and help ensure the sustained-yield management of natural forests.

3.2.4. Recommendations aimed at safeguarding the forest estate

Background: One of the most serious concerns of recent years has been the loss of forest land to agricultural encroachment which, as was shown in Chapter Three, is the result of complex interacting social, political and economic factors. It is clearly in the national interest that Forest Department should be able to reassert its control over the forest estate, and bring it back under effective management. This requires that the root causes of encroachment are tackled as a matter of urgency.

Recommendation 16. All forest reserve boundaries should be re-opened, and a line of conspicuous marker trees planted along them. Inadequate boundary demarcation has frequently been cited as a major factor in forest reserve encroachment. There is good circumstantial evidence from forests where boundaries were adequately marked some time ago to suggest that this measure had a significant deterrent effect on encroachment. Tree planting along boundaries is considered essential because the maintenance of cut-lines cannot be guaranteed.

***Recommendation 17. Forest Department staff should receive substantial increases in salaries and benefits*. Unless this is done, all attempts to restore the morale and efficiency of forestry staff are likely to fail, and no improvement in forest management can be expected. Aid agencies active in the forestry sector would be well advised to provide staff benefits sufficient to enable staff to commit themselves to full-time work as government servants, for as long as it takes for government to restore the purchasing power of official salaries to acceptable levels. This must clearly be done in line with Government of Uganda policy, which is unlikely to consider forestry as a special case. This being so, the issue of inadequate staff remuneration might be resolved through the transfer of forestry to a semi-autonomous Forestry Commission.

***ecommendation 18. Taungya forest management systems should be abandoned in the natural forest*. Taungya systems have resulted in considerable encroachment of the forest estate (Chapter Three), and clearly require a level of supervision and management that is impossible to achieve in Uganda at present.

* *Recommendation 19. Forest Department staff should receive much closer supervision from their senior officers*. This applies at all levels within the Department. Staff need to feel that they have specific duties to perform, at specific times, and are accountable for what they do.

Recommendation 20. Forest Department staff should be provided with adequate facilities to enable them to carry out their work. Such facilities include transport, uniforms, accommodation, office equipment, etc, as will be provided under the Forestry Rehabilitation Project.

***Recommendation 21. Local communities should be involved in the protection of their forest resources, and be able to benefit from them, either financially. or through access to forest resources*. Whilst it would be wrong to suggest that the control of central forest reserves should be transferred to local administrations (for the reasons given by Hamilton, 1984, 1987), there are arguments in favour of involving local communities in the protection and management of local forest resources. Resources that provide local benefits are likely to be valued and safeguarded. Local Resistance Committees might become involved in the regulation of timber exploitation by pitsawyers, and could certainly assist the Forest Department in policing the movement of timber.

**Recommendation 22. Every effort should be made to develop sustainable, productive agricultural systems, especially in the areas bordering forest reserves*. Unless the requirements of local people for agricultural land and wood products can be met from outside the reserves, these people are likely to pose an ever-increasing threat to the reserves. Small (2-100 ha) local forest reserves might be established for community use in the rural areas.

3.2.5 Recommendations aimed at developing a strong nature conservation capacity within the Forest Department

**Recommendation 23. A nature conservation unit should be established within the Forest Department*. Such a unit would be responsible for the design, selection and management of forest Nature Reserves; conducting research related to the conservation and management of forest wildlife; and advising on the integration of wildlife conservation with other forest management activities. The unit should be staffed by foresters, botanists and zoologists, and maintain a strong headquarters research unit as well as field officers, rangers, and guards in all the principal forests. If a decision is taken to develop Forest Parks, the nature conservation unit might assume responsibility for their planning and management.

***Recommendation 24. Postgraduate training in nature conservation should be provided to as many forest officers as possible, together with staff of the University's Forestry Department*. This will necessarily be done overseas initially - because no local courses are available at present - but local courses should be developed as soon as possible. Once University Forestry Department staff have received training themselves, it will be possible to incorporate nature conservation training into the university curriculum (see Recommendation 27 below), so that all new students will benefit from it.

***Recommendation 25. Staff of the Forest Department's proposed Nature Conservation Unit (Recommendation 23) should participate in study tours and exchange programmes involving visits to relevant forest conservation initiatives elsewhere.*

***Recommendation 26. Short nature conservation courses and workshops should be arranged for in-service training of all forestry staff at forest ranger level and above.* Such courses should be held at a suitable forest location, should involve practical fieldwork and demonstrations, and should be of at least five days duration.

***Recommendation 27. The forestry curriculum at Maker ere and Nyabyeya should be revised, with greater emphasis being placed on environmental and protection forestry.* This is particularly important now that the Forest Department has been transferred to the Ministry of Environment Protection, and an opportunity exists for district forestry staff to fulfil a wider role as local environmental protection agents.

3.2.6 Recommendations for research aimed at developing improved forest management techniques

Background: Intensive tropical high forest management is a relatively new field, and one about which little is known. Most of the techniques used in Uganda were developed during the period between 1945 and the late 1960s when management was closely linked to research, and was continuously adapted as a result of new knowledge and experience (see, for example, Dawkins, 1958; Earl, 1968). In recent years however, forestry research has been virtually abandoned (Wood, 1978), and any changes in forest management methods have been the result of short-term economic, social, political, and administrative pressures. There is an urgent need to re-institute methods of adaptive management, and continue the process of developing sustainable forest management techniques based on research results and monitoring programmes. Uganda is fortunate in having a very firm foundation of forestry research on which to build; by 1974 a total of 745 research plots had been established throughout the country to monitor the effects of forest management and assess the suitability of tree species and provenances to particular site conditions (Karani, 1974). To a large extent, what is required now is a general revival of former forestry research activities, but this should be accompanied by additional new research in a number of previously neglected fields.

**Recommendation 28. Forestry research requirements should be re-appraised and research plans revised accordingly.* This re-appraisal should include field inspections of all research and permanent sample plots to determine whether or not they can still be located and are of use.

***Recommendation 29. The Forestry Research Division should establish strong links with equivalent overseas institutions in order to benefit from research being carried out elsewhere.* (See also Wood, 1978; Hamilton, 1984).

**Recommendation 30. The Forestry Research Division should hold regular (annual?) research meetings, at which verbal presentations on all forest research activities are made.* It is particularly important that researchers from outside the Forest Department (including University staff and students; and foreign scientists) are involved in these meetings.

***Recommendation 31. Scientists from outside the Forest Department who are working in the tropical high forest should liaise more closely with the Forestry Research Division.* This should help ensure that research projects are designed to provide information which is of maximum benefit to forest management.

***Recommendation 32. The Ecological Committee of the National Research Council, or its appointed agent, should publish, annually, a collection of abstracts relating to all on-going forestry research projects.* This publication should be circulated to all contributors, to district forest offices, libraries, government institutions, international agencies, and sister institutions overseas.

***Recommendation 33. Re-activate ongoing research and initiate new research activities.* Research is particularly badly needed in the following fields related to natural forest conservation:

- **forest regeneration:** permanent research plots should be established in the recently exploited forest, to monitor forest regrowth (Wood, 1978); research is needed to determine the maximum levels of exploitation that are possible when forest management is based on unassisted regeneration.

- **baseline studies of wildlife communities:** the need for baseline studies of plant and animal communities is particularly urgent, because of the speed at which they are being altered, and the need to establish priorities for Nature Reserve establishment. Two fields of research that may be particularly useful are (i) species inventories of particular 'indicator' groups and (ii) accurate assessments of population densities of selected 'flagship' species, the plight of which can be used to generate public awareness and concern.

- **the effects of logging and other forms of habitat disturbance on wildlife communities:** some early useful studies of this subject have been conducted by Kibale Forest Project staff, but there is a need to expand them. In future studies it is important to standardise research methods, establish permanent sample plots, and monitor a number of different taxa of plants and animals at the same sites over long periods. These studies should be carried out in close cooperation with the Forest Department, to enable adequate monitoring *prior to, during* and *after* logging. It would be of considerable value to arrange a series of carefully controlled experimental fellings at different logging intensities in order to monitor their long-term impact on wildlife community dynamics. The environmental impacts of charcoal production in the natural forest needs to be thoroughly investigated and evaluated in relation to the economic and social benefits it brings.

- **the environmental impact of forest management:** the effects of forest management on ecological processes are poorly understood and need further research. There are a number of unparalleled opportunities for this type of research in Uganda, associated with the anticipated restoration of degraded forest lands, particularly at Mount Elgon and Mabira. It would be of considerable world-wide interest to monitor changes in water flow, nutrient cycling, soil erosion and weather patterns associated with these major programmes of re-afforestation.

- **invasive species:** research is needed on the ecology of invasive species, and their possible impact on natural forest dynamics. Methods of control need to be investigated.

- **sociological surveys:** sociological research is needed in all areas of the country to assist in the development of effective tree-planting and agroforestry programmes in rural communities. Surveys are also needed to help understand the values local people attach to forest resources, land tenure issues, and the ways in which their requirements are best accommodated.

- **development of non-timber forest products:** research is needed into ways of developing the economic potential of non-timber forest products, including medicines, resins, dyes, natural fibres, fruits, nuts and other foods (Poulsen, 1982).

- **identification of keystone species:** detailed biological research is needed in all the major forest types throughout the country to identify species of plants that are of critical importance in community ecology. Once identified these species can be selected for retention at felling, and might even be planted, for example as boundary markers.

3.2.7 Recommendations aimed at improving awareness of tropical forest values and management issues

Background: Communication and information exchange is particularly difficult in contemporary Uganda, and this severely limits the success of forestry development. There is a very real need to open channels of communication and ensure adequate information exchange between specialists in different aspects of forest management, and between these specialists and society at large. Open channels of communication, information exchange and education programmes have a particularly important role to play in:

- developing forest management systems that satisfy the demands of diverse interest groups;

- boosting the morale and efficiency of forestry staff;

- fostering public support for government's intended eviction of forest encroachers;

- encouraging private tree-planting; and

- fostering public support for wildlife conservation.

*<u>*Recommendation 34. The Division of Environmental Education in the Department of Environment, and the Public Relations Office of the Forest Department should be provided with adequate facilities and staff incentives to enable them to develop an effective national environmental education programme*</u>. The national programme should concentrate on regular radio presentations, newspaper columns, the production and distribution of printed materials, and a programme of education for NRM political cadres.

* <u>*Recommendation 35. Local forest conservation education centres should be established in selected principal reserves, and developed to provide comprehensive visitor information and interpretation services, as well as extension services*</u>. These centres should preferably offer

accommodation so that residential workshops and field courses can be arranged. One such centre is already being developed in the Bwindi (Impenetrable) Forest, but more are needed, especially in areas close to the cities (e.g. Mabira), and in areas of high population density where forest encroachment has occurred (e.g. Mount Elgon).

Recommendation 36. The Forest Department staff magazine/newsletter should be re-introduced. It used to provide an excellent forum for the exchange of views on forestry issues, and could be re-introduced at very low cost.

3.2.8 Recommendations aimed at providing an appropriate legal and administrative framework for effective forest conservation

It is widely recognised that the laws and administrative provisions relating to natural resources exploitation and environmental protection in Uganda are out-of-date and inadequate in a number of respects (IUCN, 1983; Butynski, 1984; Aluma, 1987), and that a major re-appraisal of these is long overdue.

***Recommendation 37. The Uganda Government, with assistance from IUCN. should coordinate the development of a National Conservation Strategy (NCS)*. A formal proposal for the development of such a strategy was prepared in 1983 (IUCN, 1983), and work on it began in 1985, but was soon terminated as a result of the difficult political and security situation at that time. The initiative should now be re-activated. One of the responsibilities of the NCS Steering Committee and Secretariat would be to discuss, plan, and develop legislative and administrative reforms necessary for forest conservation (see Recommendation 38).

***Recommendation 38. The laws of Uganda relating to the management of natural resources and protection of the environment should be revised*. When this is done, special consideration should be given to:

- vesting the responsibility for the country's forestry resources in a (parastatal) Forestry Commission (see also Recommendation 17);
- providing for the protection of unreserved forests on public land;
- increasing the penalties for violations of the law, so that they serve as effective deterrents;
- re-designating forest and game guards as environmental guards, charged with upholding both Game and Forests Acts;
- enacting new legislation to provide for the creation of Forest Parks (if desirable - see Recommendation 2); to control pollution, pesticide use, etc; and provide for mandatory environmental impact assessments on all major development projects.

**Recommendation 39. Uganda should acceed to the International Convention on Trade in Endangered Snecies (CITES)*.

References

Aluma, J.R.W. (1987). Uganda Forest Resources and Action Plan (Draft). Nairobi: UNEP.

Anon (1982). Report on the 1980 Population Census. Vol. 1. The provisional results by administrative areas. Census Office, Ministry of Planning and Economic Development, Kampala.

Atlas of Uganda,(1967). Department of Lands & Surveys. Entebbe : Government Printer.

Batisse, M. (1985). Action Plan for Biosphere Reserves. *Environmental Conservation* 12(1): 17-27.

Britton, P.L. (Ed.)(1980). Birds of East Africa: their habitat, status and distribution. Nairobi: East Africa Natural History Society

Brown, L.H. (1981). The conservation of forest islands in areas of high human density. *Afr. J. Ecol.* 19: 27-32.

Butono, F. (1988). A historical overview of encroachment of forest reserves in Bundibugyo District. In: Howard, P.C. (Ed.). Conservation and development of natural resources in Bundibugyo District, Uganda. WWF Project 3235 Research Publication. Gland: WWF-International

Butono, F. (1988b). The deforestation of Bwamba. *ibid.*

Butono, F. (1988c). Domestic wood requirements and availability in Bwamba County, *ibid.*

Butono, F. (1988d). An evaluation of the potential for tree planting on private land in Bundibugyo District. *ibid.*

Butono, F. (1988e). The use of forest products other than wood, with particular reference to traditional medicine. *ibid.*

Butono, F. (1988f). The importance of Bundibugyo's forests in maintaining environmental stability. *ibid.*

Butono, F. (1988g). An evaluation of some timber trials in the Semliki Forest Reserve. *ibid.*

Butynski, T.M. (1984a). Ecological survey of the Impenetrable (Bwindi) Forest, Uganda, and recommendations for its conservation and management. Unpublished report. New York Zoological Society.

Butynski, T.M. (1984b). A proposed system of Nature Reserves for the Impenetrable Forest. Unpublished report. New York Zoological Society.

Carcasson, R.H. (1960). The swallowtail butterflies of East Africa. *J.E. Afr. Nat. Hist. Soc.* special supplement No. 6.

Carswell, M. (1986). Birds of the Kampala area. *Scopus* special supplement No. 2. Nairobi: Ornithological sub-committee, EANHS.

Caufield, C. (1986). In the rainforest. London: Pan Books.

Dale, I.R. (1954). Forest spread and climatic change in Uganda during the Christian era. *The Empire Forestry Review* 33(1): 23-29.

Davidson, J. (1985). Economic use of tropical moist forests. Commission on Ecology Papers No. 9. Gland: IUCN.

Davies, A.C. (1987). The Gola Forest Reserves, Sierra Leone: wildlife conservation and forest management. Gland: IUCN.

Davis, S.D. *et al.* (1986). Plants in danger: what do we know? Gland: IUCN.

Dawkins, H.C. (1958). The management of natural high forest with special reference to Uganda. Commonwealth Forestry Inst. Paper No. 34.155pp.

Diamond, J.M. (1975). The island dilemna: lessons of modern biogeographic studies for the design of natural reserves. *Biol. Conserv.* 7: 129-146.

Earl, D.E. (1968). Latest techniques in the treatment of natural high forest in South Mengo District. Entebbe: Uganda Forest Department.

Eggeling, W.J. (1947). Observations on the ecology of the Budongo rain forest, Uganda. *J. Ecol.* 34: 20-87.

Eggeling, W.J. and Dale, I.R. (1951). The indigenous trees of the Uganda Protectorate. Entebbe: Uganda Government Printer.

FAO (1967). Timber trends and prospects in Africa. Rome: FAO.

FAO (1979). FAO Production Yearbook Vol. 29. 287pp. Geneva: FAO.

Forest Department (1951). A history of the Uganda Forest Department, 1898-1929. 26pp. Entebbe: Uganda Forest Department.

Forest Department (1955). A history of the Uganda Forest Department, 1930-1950. Entebbe: Uganda Forest Department.

Forest Department (1955). Working Plan for the Sango Bay Forests, Buddu County, Masaka District, Uganda. Entebbe: Forest Department.

Forest Department (1980). Progress Report 1973-1978. Entebbe: Uganda Forest Department.

Forest Department (1985). Progress Report 1980-84. Entebbe: Uganda Forest Department.

Frankel, O.M. and Soule, M.E. (1981). Conservation and Evolution. New York: Cambridge University Press.

Friedmann, H. (1966). A contribution to the ornithology of Uganda. Scientific results of the 1963 Knudsen-Machris expedition to Kenya and Uganda. Bulletin of the Los Angeles County Museum of Natural Science No. 3.

Friedmann, H. and Williams, J.G. (1968). Notable records of rare or little-known birds from western Uganda. *Rev. Zool. Bot. Afr.* 77: 11-36.

Friedmann, H. and Williams, J.G. (1969). The birds of the Sango Bay Forests, Buddu County, Masaka District, Uganda. Los Angeles County Museum Contributions in Science No. 162. 48pp.

Friedmann, H. and Williams, J.G. (1970a). Additions to the known avifauna of the Bugoma, Kibale, and Impenetrable Forests, West Uganda. Los Angeles County Museum Contributions in Science No. 198. 20pp.

Friedmann, H., and Williams, J.G. (1970b). The birds of the Kalinzu forest, south western Ankole, Uganda. Los Angeles County Museum Contributions in Science No. 195.

Friedmann, H., and Williams, J.G. (1971). The birds of the lowlands of Bwamba, Toro Province, Uganda. Los Angeles County Museum Contributions in Science No. 211. 70pp.

Friedmann, H., and Williams, J.G. (1973). The birds of Budongo Forest, Bunyoro Province, Uganda. *J. E. Afr. Nat. Hist. Soc.* 141: 1-18.

Gartlan, S. (1987). The Korup regional management plan: conservation and development in the Ndian division of Cameroon. Draft. WWF, Gland and Earthlife Foundation, London.

Gentry, A.H. (1982). Patterns of Neotropical plant species diversity. *Evolutionary Biology* 15:1-84.

Gentry, A.H. (in press). Tree species richness of upper Amazonia forests. *Proc. National Academy of Science.*

Gitec Consult GMBH (1985). Feasability study for plywood and veneer factory. Budongo, Uganda. Phase la: Preliminary assessment of forest resources. Entebbe: Ministry of Agriculture and Forestry.

Government of Uganda (1964). The Forests Act. Laws of Uganda 246.

Government of Uganda (1964a). The Game (Preservation and Control) Act. Laws of Uganda 226: 3829-3868.

Government of Uganda (1964b). The National Parks Act. Laws of Uganda.

Government of Uganda (1984). The Game (Preservation and Control) (Prohibition) Order 1984. Statutory Instrument No. 42.

Grubb, P. (1982). Refuges and dispersal in the speciation of African forest mammals. pp 537-553 In: Prance, G.T. (Ed.). Biological diversification in the tropics. New York: Columbia University Press.

Haddow, A.J., Smithburn, K.C., Mahaffy, A.F., and Bugher, J.C. (1947). Monkeys in relation to yellow fever in Bwamba County, Uganda. *Transactions of the Royal Society of Tropical Medicine and Hygiene* 40(5): 677-700.

Hall, J.B. (1983). Positive management for strict natural reserves: reviewing effectivenes. *For. Ecol. Manage.* 7: 57-66.

Hamel, P. (1972). Checklist of forest species recorded from eight medium-altitude forests in Uganda. Unpublished report.

Hamel, P.J. (198). Avifauna of the Kifu and Mabira Forests, Uganda. *Proc. IV Pan-Afr. orn. Congr.* 135-145.

Hamilton, A.C. (1969). The vegetation of southwest Kigezi. *Uganda J.* 33(2): 175-199.

Hamilton, A.C. (1974).Distribution patterns of forest trees in Uganda and their historical significance. *Vegetatio* 29: 21-35.

Hamilton, A.C. (1976). The significance of patterns of distribution shown by forest plants and animals in tropical Africa for the re-construction of upper-Pleistocene palaeoenvironments: a review. *Palaeoecol. Afr.* 9: 63-97.

Hamilton, A. C. (1981). The quaternary history of African forests: its relevance to conservation. *Afr. J. Ecol.* 19: 1-6.

Hamilton, A.C. (1981). A field guide to Uganda forest trees. Privately published.

Hamilton, A.C, and Perrott, R.A. (1981). A study of altitudinal zonation in the montane forest belt of Mt. Elgon, East Africa. *Vegetatio* 45: 107-125.

Hamilton, A.C. (1984). Deforestation in Uganda. Nairobi: Oxford University Press.

Hamilton, A.C. (1987). The East Usambaras: resources and their exploitation. Preliminary Draft of 29/7/87. Nairobi: IUCN.

Hamilton, A.C, Taylor, D., and Vogel, J.C. (1986). Early forest clearance and environmental degradation in south-west Uganda. *Nature* 320 (6058): 164-167.

Harris, L.D. (1984). The fragmented forest - Island Biogeography Theory and the Preservation of Biotic Diversity. Chicago: University of Chicago Press.

Harrop, J.F. (1960). The soils of the Western Province of Uganda. Memoir No. 6 (Series 1) of the Research Division, Agricultural Department, Uganda.

Hedberg, O. (1957). Afroalpine vascular plants. *Symb. bot. upsal.* 15: 1-411.

Holmes, J., and Kramer, S. (in prep., a) Ecological status of the Mabira Forest Reserve. Center for Conservation Biology, Stanford University.

Holmes, J., and Kramer, S. (in prep., b). The effects of logging on avian communities in the Kibale Forest. Kibale Forest Project report.

Howard P.C. (1986). Agricultural encroachment in the Semliki Forest Reserve, Western Uganda. 8 pp. WWF Project 3235: Unpublished report.

Howard P.C. (1988a). Proposal for the establishment of a new National Park in the Rwenzori Mountains, Uganda. 26 pp. WWF Project 3235: Unpublished Report.

Howard P.C. (1988b). Wildlife conservation in Bundibugyo District. In: Howard, P.C. (Ed.). Conservation and development of natural resources in Bundibugyo District, Uganda. WWF Project 3235 Research Publication. Gland: WWF-International.

IUCN (1980). World Conservation Strategy. Gland: IUCN.

IUCN (1983). Proposal for a National Conservation Strategy for Uganda. Gland: IUCN.

IUCN (1987). Directory of Afrotropical Protected Areas. Gland: IUCN.

Jackson, F.T., and Sclater, W.L. (1938). The birds of Kenya Colony and the Uganda Protectorate. Three Vols. 1592pp.

Jjemba, P.K. (1988a). The soils of Bwamba. In: Howard, P.C. (Ed.). Conservation and development of natural resources in Bundibugyo District, Uganda. WWF Project 3235 Research Publication. Gland: WWF-International.

Jjemba, P.K. (1988b). The climate of Bundibugyo District. *ibid.*

Jjemba, P.K. (1988c). Land use in the populated areas of Bwamba County. *ibid.*

Jjemba, P.K. (1988d). Agricultural efficiency and constraints in Bwamba County. *ibid.*

Jjemba, P.K. (1988e). Soil conservation: present practices and future requirements in Bwamba County. *ibid.*

Jjemba, P.K. (1988f). A preliminary comparative study of growing cereals and legumes under mixed cropping and monoculture with rotation in sandy loam forest and agricultural soils of Bwamba County. *ibid.*

Jjemba, P.K. (1988). Strategies for improving agricultural productivity in Bwamba County. *ibid.*

Jjemba, P.K., and Simoli, R.K. (1988). The role of cooperatives in agricultural marketing in Bundibugyo District. *ibid.*

Johns, A.D. (1983). The birds. pp. 205-245 In: Ecological effects of selective logging in a West Malaysian rainforest. Unpublished PhD thesis, University of Cambridge.

Johns, A.D. (1985). Selective logging and wildlife conservation in tropical rainforest: problems and recommendations. *Biol. Conserv.* 31: 355-375.

Johns, A.D., and Skorupa, J.P. (in press). Responses of rainforest primates to habitat disturbance: a review. *Int J. Primatol.*

Karani, P.K. (1974). Silvicultural research plan. Third revision for the period 1974-1980. Entebbe: Uganda Forest Department.

Kasenene, J.M. (1984). The influence of selective logging on rodent populations and the regeneration of selected tree species in the Kibale Forest, Uganda. *Trop. Ecol.* 25: 179-195.

Keast, A. (1985). Tropical Rainforest Avifaunas: An Introductory Conspectus. pp. 3-31 In: Conservation of Tropical Forest Birds. ICBP Technical Publication No. 4. Cambridge: ICBP.

Keith, S., Twomey, A., Friedmann, H., and Williams, J. (1969). The avifauna of the Impenetrable Forest, Uganda. *Amer. Mus. Novitates.* No. 2389. 41pp.

Kigenyi, F. (Secretary) (1988). Minutes of a meeting of a select committee to discuss the Ministry of Environment stand on up-grading some of the central forest reserves to National Park status: held at the Ministry headquarters on 8th March 1988. Unpublished mimeograph.

Kingdon, J. (1971). East African Mammals: an Atlas of Evolution in Africa. New York: Academic Press

Kingdon, J. (1971a). Appendix 1. Bwamba Forest. pp. 45-50 In: East African Mammals: an Atlas of Evolution in Africa. Vol. 1. London: Academic Press.

Kingdon, J. (1973). Endemic mammals and birds of western Uganda: measuring Uganda's biological wealth and a plea for supra-economic values. *Uganda J.* 37: 1-8.

Kisubi, A. (in prep.). Abundance and response of wild primates to forest habitats in western Uganda. Unpublished MSc thesis, Makerere University.

Knees, S.G., and Gardner, M.F. (1983). Mahoganies: candidates for the Red Data Book. *Oryx* 17(2): 88-92.

Langdale-Brown, I. (1960). The vegetation of Uganda (excluding Karamoja). Memoirs of the Research Division, Dept. of Agriculture, Series 2, No.6.

Langdale-Brown, I., Osmaston, H.A., and Wilson, J.G. (1964). The vegetation of Uganda and its bearing on land-use. Entebbe: Uganda Government Printer.

Laws, R.M., Parker, I.S.C., and Johnstone, R.C.B. (1970). Elephants and habitats in North Bunyoro, Uganda. *E. Afr. Wildl. J.* 8: 163-180.

Leggat, G.J. (1961). A Working Plan for Semliki Central Forest Reserve, Toro District, Uganda. First revision for the period 1st July 1961 to 30th June 1971. Entebbe: Uganda Forest Department.

Leggat, G.J., and Beaton, A. (1961). Working Plan for the Ruwenzori Central Forest Reserves. First revision for the period 1st July 1961 to 30th June 1971. Entebbe: Uganda Forest Department.

Leggat, G.J., and Osmaston, H.A. (1961). Working Plan for the Impenetrable Forest Reserve, Kigezi District, Western Province, Uganda. Period 1961-1971. Entebbe: Uganda Forest Department.

Lockwood Consultants (1973). Forest Resource Development Study, Republic of Uganda. Toronto, Canada: Lockwood Consultants.

Longman, K.A., and Jenik, J. (1987). Tropical forest and its environment. Second edition. Harlow: Longman Scientific and Technical.

Lovett, J. (1985). An overview of the moist forests of Tanzania (Draft). Tanzania National Scientific Research Council Research Monograph.

MacArthur, R.H., and Wilson, E.O. (1967). The theory of island biogeography. Princeton: Princeton University Press.

MacKinnon, J. and K. (1986). Review of the protected areas system of the Afrotropical realm. Gland: IUCN.

MacKinnon, J., and K., Child, G., and Thorsell, J. (1986). Managing Protected Areas in the Tropics. Gland: IUCN.

McNeely, J.A., Miller, K.R., and Thorsell, J.W. (1987). Objectives, selection and management of protected areas in tropical forest habitats. pp. 181-204 In: Marsh, C.W., and Mittermeier, R.,(Eds.) Primate Conservation in the Tropical Rainforest. New York: Alan Liss.

Margules, C, and Usher, M.B. (1981). Criteria used in assessing wildlife conservation potential: a review. *Biol. Conserv.* 21: 79-109.

Moreau, R.E. (1966). The bird faunas of Africa and its islands. New York: Academic Press.

MPED (1987). Rehabilitation and Development Plan 1987/88 to 1990/91. 2 Vols. Kampala: Ministry of Planning and Economic Development.

Muhumuza, C. (1988a). The people of Bundibugyo. In: Howard, P.C. (Ed.). Conservation and development of natural resources in Bundibugyo District, Uganda. WWF Project 3235 Research Publication. Gland: WWF-International.

Muhumuza, C. (1988b). Land tenure systems. *ibid.*

Muhumuza, C. (1988c). The acceptability and use of family planning facilities in Bundibugyo District. *ibid.*

Muhumuza, C. (1988d). A survey of environmental awareness amongst the people of Bwamba County. *ibid.*

Muhumuza, C. (1988e). Traditional customs, beliefs and societal organisation: implications for natural resources development in Bundibugyo. *ibid,*

Myers, N. (1984). The Primary Source: tropical forests and our future. New York: W.W.Norton and Co., Inc.

Ndyabahika, B. (1988). Infrastructural development in Bundibugyo District: a historical perspective. In: Howard, P.C. (Ed.). Conservation and development of natural resources in Bundibugyo District, Uganda. WWF Project 3235 Research Publication. Gland: WWF-International.

Oates, J.F. (1985). IUCN/SSC Primate Specialist Group Action Plan for African Primate Conservation: 1986-1990 (Draft). Gland: IUCN.

Olwitingol, F. (1988). The administration of local government. In: Howard, P.C. (Ed.). Conservation and development of natural resources in Bundibugyo District, Uganda. WWF Project 3235 Research Publication. Gland: WWF-International.

Osmaston, H.A. (1959a). Working Plan for the Kibale and Itwara Forests. First Revision, period 1959-1965. Entebbe: Uganda Forest Department.

Osmaston, H.A. (1959b). Working Plan for the Bugoma Central Forest Reserve, Bunyoro District, for the period 1st July 1959 to 31st December 1967. Entebbe: Uganda Forest Department.

Osmaston, H.A. (1960). Working Plan for the Kalinzu Central Forest Reserve, Ankole District, Western Province. Period: 1st July 1960 to 30th June 1970. Entebbe: Uganda Forest Department.

Osmaston, H.A. (1965). Ensa za Katoboha: ancient earthworks and waterholes at Karwata, Bunyoro. *Uganda J.* 29(2): 223-224.

Osmaston, H.A., and Pasteur, D. (1972). Guide to the Rwenzori. Kampala: Mountain Club of Uganda.

Otte, K. (in press). Deforestation at Mount Elgon, Uganda, and its effects on the ecosystem and land use. In: Kayanja, F.I.B. (Ed.). Proceedings of an International Symposium on African Wildlife, Kampala, Uganda, 8th-10th December 1986.

Padua, M.T.J., and Quintao, A.T.B. (1982). Parks and biological reserves in the Brazilian Amazon. *Ambio* 9: 309-314.

Pielou, E.C. (1979). Biogeography. New York: Wiley-Interscience.

Poulsen, G. (1982). The non-wood products of African forests. *Unasylva* 34(137): 15-21.

Prescott-Allen, R., and C. (1982). What's wildlife worth? Economic contributions of wild plants and animals to developing countries. London and Washington DC: International Institute for Environment and Development.

Prigogine, A. (1985). Conservation of the avifauna of the forests of the Albertine Rift. pp. 277-295 In: Conservation of Tropical Forest Birds. ICBP Technical Publication No 4. Cambridge: ICBP.

Raven, P.R. (1976). Ethics and attitudes. In: Simmons, J.B. *et al.* (Eds.). Conservation of Threatened Plants. New York: Plenum Press.

Richards, P.W. (1952). The Tropical Rainforest. Cambridge: Cambridge University Press.

Salt, G. (1987). Insects and other invertebrate animals collected at high altitudes in the Rwenzori and on Mount Kenya. *Afr. J. Ecol.* 25(2): 95-106.

Sangster, R.G. (1950). Working Plan for the South Mengo Forests, Uganda, for the period 1948-1957. Entebbe: Uganda Forest Department

Skorupa, J.P. (1983). Kibale Forest Bird Checklist. Unpublished, New York Zoological Society.

Skorupa, J.P. (1987). The effects of habitat disturbance on primate populations in the Kibale Forest, Uganda. Unpublished PhD thesis, University of California.

Snedecor, G.W., and Cochran, W.G. (1980). Statistical Methods. Seventh edition. Iowa: Iowa State University Press.

Soule, M.E. (1986). Conservation Biology: the science of scarcity and diversity. Sunderland, Mass.: Sinauer Associates Inc.

Soule, M.E. (1987). Viable populations for conservation. Cambridge: Cambridge University Press.

Soule, M.E., and Wilcox, B.A. (1980). Conservation Biology. Sunderland, Mass.: Sinauer Associates.

Struhsaker, T.T. (1975). The red colobus monkey. Chicago and London: University of Chicago Press.

Struhsaker, T.T. (1981). Forest and primate conservation in East Africa. *Afr. J. Ecol.* 19: 99-114.

Struhsaker, T.T. (1987). Forestry issues and conservation in Uganda. *Biol. Conserv.* 39: 209-234.

Struhsaker, T.T., and Leland, L. (1979). Socioeology of five sympatric monkey species in the Kibale Forest, Uganda. In: Advances in the Study of Behaviour, Vol. 9. Eds. Rosenblatt, J.S., Hinde, R.A., Beer, C, and Busnel, M.C. New York: Academic Press.

Struhsaker, T.T., and Malpas, R.C. (1982). Proposal for forest National Parks in Uganda. Unpublished report, 8 pp.

Stuart, S.N. (1981). A comparison of the avifaunas of seven East African forest islands. *Afr. J. Ecol.* 19: 131-151.

Synnott, T.J. (1968). Working Plan for Mount Elgon Central Forest Reserve. Ist revision. Period 1968 to 1978. Entebbe: Uganda Forest Department.

Synnott, T.J. (1971). Annotated list of the perennial woody vegetation of the west Ankole forests. *Uganda J.* 35(1):1-21.

Synnott, T.J. (1985). A checklist of the flora of Budongo Forest Reserve, Uganda, with notes on ecology and phenology. CFI Occasional Papers No.27.

Terborgh, J. (1986). Keystone plant resources in the tropical forest. pp. 330-344. In: Soule, M. (Ed.). Conservation Biology: the science of scarcity and diversity. Sunderland, Mass.: Sinauer Associates.

Thiollay, J.M. (1985). The West African Forest avifauna: a review. pp. 171-186. In: Conservation of Tropical Forest Birds. ICBP Technical Publication No. 4. Cambridge: ICBP.

Tumwine, J.M. (1988). Constraints to livestock development in Bundibugyo District. In: Howard, P. C. (Ed.). Conservation and development of natural resources in Bundibugyo District, Uganda. WWF Project 3235 Research Publication. Gland: WWF-International.

UNESCO (1964). African timber trends and prospects. Paris: UNESCO.

Usher, M.B. (1986). Wildlife conservation evaluation. London, New York: Chapman and Hall.

Van Orsdol, K.G. (1983). The status of Kibale Forest Reserve in western Uganda, and recommendations for its conservation and management. Unpublished report. 41 pp.

Van Orsdol, K.G. (1986), Agricultural encroachment in Uganda's Kibale Forest. *Oryx* 20 (2): 115-117.

Van Orsdol, K.G. (1983) Survey report on the Semliki (Bwamba) Forest Reserve of western Uganda. 6pp. unpublished report: Kibale Forest Project.

Van Someren, V.G.L., and Van Someren, G.R.C. (1949). The birds of Bwamba. *Uganda J.* 13 (Special Suppl.): 1-111.

Varady, R.G. (1982). Draft Environmental Profile of Uganda. Report on US AID Project RSSA SA/TOA 1-77.

Wamara Fr. J. (1988). The role of the Catholic Church in the development of Bundibugyo District. In: Howard, P.C. (Ed.). Conservation and development of natural resources in Bundibugyo District, Uganda. WWF Project 3235 Research Publication. Gland: WWF-International.

Webster, G. (1954). Working Plan for Mount Elgon Forest Reserve, Bugishu District, Eastern Province, Uganda: 1954-1958. Entebbe: Uganda Forest Department.

Webster, G. (1961). Working Plan for the South Mengo Forests, Mengo District, Uganda. 1st revision from 1st July 1961 to 30th June 1971. Entebbe: Uganda Forest Department.

Weekes, J.T. (1949). The birds of Ruwenzori. *Uganda J.* 13: 130-144.

Wheater, RJ. (1971). New National Parks and additions to existing ones. Mimeographed report pursuant to Board Minute 27/711. Uganda National Parks.

White, F. (1983). The vegetation of Africa. Natural Resources Research 20. Paris: UNESCO.

Wilcox, B.A. (1984). *In situ* conservation of genetic resources: determinants of minimum area requirements. In: McNeely, J.A., and Miller, K.R. (eds.). National Parks, conservation and development: the role of protected areas in sustaining society. Washington DC: IUCN and Smithsonian Institution Press.

Williams, J. (1967). A field guide to the National Parks of East Africa. London: Collins.

Williams, J.G. 1969). A field guide to the butterflies of Africa. London: Collins.

Williams, J.G., and Arlott, N. (1980). A field guide to the birds of East Africa. London: Collins.

Wing, L.D., and Buss, I.O. (1970). Elephants and forests. Wildlife Monographs 19.

Winter, E.H. (1952). Bwamba: a structural-functional analysis of a matrilineal society. Cambridge: East African Institute of Social Research.

Winter, E.H. (1954). Bwamba economy: the development of a primitive subsistence economy in Uganda. Kampala: East African Institute of Social Research.

Wood, T.W.W. (1978). Appraisal of the management of the natural high forest and silviculture research. UNDP/FAO Forestry Development Project UGA/74/019 Field Document No.2. Entebbe: Uganda Forest Department.

World Bank (1986). Joint LINDPAVorld Bank Energy Sector Management Assistance Program. Activity Completion Report No. 053/86: Fuelwood/Forestry Project Feasibilily Report. Washington D.C.: World Bank (cited with the authority of the Chief Forest Officer, Government of Uganda).

World Resources Institute, The, and The International Institute for Environment and Development. (1986). World Resources 1986. An assessment of the resource base that supports the global economy. New York: Basic Books Inc.

Wyatt-Smith, J. (1987). The management of tropical moist forest for the sustained production of timber: some issues. IUCN/IIED tropical forest policy paper No.4. Gland: IUCN.

Yeoman, G. (1985). Can the Rwenzori be saved? *Swara* 8 (3): 8-12.

Personal Communications

Dr G. I. Basuta, Co-Director, Makerere University Biological Field Station in Kibale Forest, P.O.Box 409, Fort Portal.

Mr R. Bere, Formerly Director, Uganda National Parks.

Dr T. Butynski, Director, Impenetrable Forest Conservation Project, World Wildlife Fund, P.O.Box 4930, Kampala.

Mr J. Carvalho, Senior Utilization Officer, Forest Department Research Centre, Nakawa, Kampala.

Dr D.E. Earl, Chief Technical Advisor, EC Natural Forest Management and Conservation Project, P.O.Box 5244, Kampala.

Dr A.C. Hamilton, Plants Conservation Officer, WWF-UK, Panda House, Godalming, United Kingdom.

Ms J. Holmes, 540 Woodford, Missoula, MT 59801, USA.

Dr J.M. Kasenene, MUBFS, P.O.Box 409, Fort Portal.

Mr A. Kisubi, Zoology Department, Makerere University, P.O.Box 7062, Kampala.

Mr L.S. Kiwanuka, Ag. Chief Forest Officer, Forest Department, Kampala.

Mr S. Kramer, Tropical Forest Diversity Project, Center for Conservation Biology, Stanford University, California, USA.

Dr R. Malpas, Regional Representative, 1UCN, P.O.Box 68200, Nairobi, Kenya.

Mr J. Miskall, CARE-International in Uganda, Kampala.

Mr S. Morris, Economist, Ministry of Planning and Economic Development, Kampala.

Mr S. Mpangire, District Forest Officer, Forest Department, Mukono.

Mr G. Mubiru, Senior Cartographer, Forest Department, Entebbe.

Mr Okech-Okot, District Forest Officer, Forest Department, Fort Portal.

Mr M. Rukuba, Forestry Rehabilitation Project, Forest Department, Kampala.

Mr Tumusiime, Salaries section, Ministry of Agriculture, Entebbe.

Appendix A. List of tree species recorded from twelve of Uganda's principal forest reserves. + denotes species presence recorded in the literature and/or at Makerere University herbarium prior to this study; + denotes species recorded for the first time during this study; • denotes species not recorded. Forests are designated as: 1 = Kibale, 2 = Semliki, 3 = Budongo, 4 = Kalinzu-Maramagambo, 5 = Bugoma, 6 = Bwindi, 7 = Kasyoha-Kitomi, 8 = Itwara, 9 = Sango Bay, 10 = Mabira, 11 = Mount Elgon, 12 = Rwenzori. Tree species numbers are those used in Hamilton (1981). Non-forest species are excluded.

	TREE SPECIES	FOREST NUMBER											
		1	2	3	4	5	6	7	8	9	10	11	12
1	*Cyatheamanniana*	+	•	•	+	•	+	+	•	•	•	+	+
2	*C. dregei*	•	•	•	•	•	•	•	•	•	•	+	•
3	*C.camerooniana*	•	•	•	•	•	+	•	•	•	•	•	•
4	*Podocarpusmilanjianus*	•	•	•	•	•	+	•	•	+	•	+	+
5	*P.gracilior*	•	•	•	•	•	+	•	•	+	•	+	•
6													
7	*Juniperusprocera*	•	•	•	•	•	•	•	•	•	•	+	•
8	*Phoenixreclinata*	+	÷	+	+	•	•	+	÷	+	÷	•	•
9	*Raphiafarinifera*	•	•	+	+	+	+	÷	•	÷	•	•	•
10	*Elaeisguineensis*	•	+	•	+	•	•	•	•	•	•	•	•
11	*Pandanusugandaensis*	+	+	+	•	•	•	+	•	•	•	•	•
12	*Dracaenasteudneri*	+	÷	•	+	•	•	+	•	÷	•	•	÷
13	*D. afromontana*	•	•	•	•	•	•	•	•	•	•	+	+
14	*D. fragrans*	•	•	+	+	•	•	+	÷	÷	•	•	÷
15	*D. laxissima*	+	•	+	•	•	+	•	•	+	•	•	•
16	*Ensete ventricosum*	•	•	•	+	•	•	÷	•	•	•	•	÷
17	*Arundinariaalpina*	•	•	•	•	•	+	•	•	•	•	+	+
18	*Oreobambosbuchwaldii*	•	•	+	•	•	•	•	•	•	÷	•	•
19	*Seneciaerici-rosenii*	•	•	•	•	•	•	•	•	•	•	•	+
20	*S. amblyphyllus*	•	•	•	•	•	•	•	•	•	•	+	•
21	*S. adnivalis*	•	•	•	•	•	•	•	•	•	•	•	+
22	*S. elgonensis*	•	•	•	•	•	•	•	•	•	•	+	•
23	*S. barbatipes*	•	•	•	•	•	•	•	•	•	•	+	•
24	*Stoebe sp.*	•	•	•	•	•	•	•	•	•	•	+	•
25	*Ericaarborea*	•	•	•	•	•	•	•	•	•	•	+	+
26	*E. kingaensis*	•	•	•	•	•	•	•	•	•	•	•	+
27	*Philippiaexcelsa*	•	•	•	•	•	•	•	•	•	•	+	•
28	*P.trimera*	•	•	•	•	•	•	•	•	•	•	+	+
29	*P. johnstonii*	•	•	•	+	•	•	•	•	•	•	•	+
30	*P. benguelensis*	•	•	•	+	•	•	+	•	•	•	•	+
31	*Euphorbiateke*	+	+	+	÷	+	•	•	•	÷	•	•	•
32	*E. obovalifolia*	•	•	•	•	•	•	•	•	•	•	+	•
33	*Euphorbia sp.*	•	+	•	•	•	•	•	•	•	•	•	•
34	*Elaeophorbia sp. nov.*	+	+	•	+	•	•	•	•	•	•	•	•
35	*Aningeriaaltissima*	+	÷	+	+	+	•	+	÷	÷	•	•	•
36	*A. adolfi-friederici*	•	•	•	•	•	•	•	•	•	•	+	+
37	*Bequaertiodendronoblanceolatum*	+	•	+	•	+	•	•	•	•	+	•	•
39	*Chrysophyllum muerense*	•	+	+	•	+	•	•	•	•	+	•	•
40	*C. albidum*	+	•	+	+	+	+	+	÷	+	+	•	•

41	*C. perpulchrum*	•	•	+	•	+	•	•	•	•	+	•	•
42	*C. gorungosanum*	+	•	•	+	•	+	+	÷	•	•	+	÷
43	*C. delevoyi*	•	•	•	•	•	•	•	•	+	÷	•	•
44	*C. beguei*	•	+	•	•	•	•	•	•	•	•	•	•
45	*C.pentagonocarpum*	•	•	•	•	•	•	•	+	•	•	•	•
46	*C. pruniforme*	•	•	+	•	•	+	•	+	•	•	•	•
47	*Mimusops bagshawei*	+	•	+	+	+	•	÷	÷	÷	+	+	•
48	*M. kummel*	•	•	+	•	•	•	•	•	•	•	+	•
49	*Manilkaramultinervis*	•	•	+	•	•	•	•	•	•	+	•	•
50	*M. butugi*	•	•	+	•	•	•	•	•	•	•	+	•
51	*M. obovata*	•	•	+	•	•	•	•	•	+	•	•	•
52	*M dawei*	•	+	+	+	+	+	•	•	•	+	•	•
53	*Pachystelabrevipes*	÷	•	+	÷	+	÷	÷	÷	+	+	•	•
54	*P. msolo*	•	+	•	•	+	•	•	•	•	•	•	•
55	*Afrosersalisiacerasifera*	•	•	+	+	•	•	+	÷	•	•	+	•
56	*Antiaristoxicaria*	+	÷	+	+	+	+	+	÷	÷	÷	•	•
57	*Antiaris sp.*	•	•	+	•	•	•	•	•	•	•	•	•
58	*Moruslactea*	+	÷	+	+	+	•	+	÷	•	+	•	•
59	*Chlorophoraexcelsa*	+	÷	+	+	+	•	+	÷	•	+	•	•
60	*Treculiaafricana*	+	•	+	+	+	•	÷	÷	÷	•	•	•
61	*Bosqueia phoberos*	•	+	+	•	•	•	•	•	•	•	•	•
62	*Craterogynekameruniana*	•	+	+	•	•	•	•	•	•	•	•	•
63	*Ficusexasperata*	+	÷	+	÷	÷	•	÷	÷	•	+	•	•
65	*F. vallis choudae*	•	+	+	÷	•	•	+	÷	•	+	•	•
66	*F. mucuso*	+	÷	+	•	÷	•	÷	÷	÷	÷	•	•
67	*F. congensis*	÷	÷	•	÷	•	•	÷	÷	•	÷	•	•
68	*F.urceolaris*	+	÷	+	•	•	•	÷	÷	÷	÷	•	•
69	*F. capensis*	+	+	+	÷	•	•	÷	÷	÷	÷	•	•
71	*F. brachypoda*	+	÷	+	•	•	•	÷	•	÷	÷	•	•
72	*F. brachylepis*	+	÷	+	÷	÷	•	÷	•	•	÷	•	•
73	*F. ingens*	•	•	•	•	•	•	•	•	•	+	•	•
74	*F. polita*	+	•	+	•	•	•	•	•	•	•	•	•
75	*F. eriobotryoides*	+	÷	+	÷	•	•	÷	÷	÷	÷	•	•
76	*F. vogeliana*	•	+	•	•	•	•	•	•	•	•	•	•
77	*F.cyathistipula*	÷	•	•	÷	•	•	•	•	+	•	•	•
79	*F.stipulifera*	÷	•	+	•	•	•	÷	•	+	+	•	•
81	*F. pilosula*	•	•	•	•	•	•	•	•	+	÷	•	•
82	*F. natalensis*	+	÷	+	÷	•	+	÷	÷	÷	÷	•	÷
83	*F. thonningii*	•	•	+	•	•	•	÷	÷	•	÷	•	•
84	*F.persicifolia*	•	÷	+	•	•	•	•	•	•	+	•	•
85	*F.pseudomangifera*	+	÷	+	÷	•	•	÷	÷	÷	÷	•	•
86	*Celtismildbraedii*	+	+	+	+	+	•	÷	•	•	+	•	•
87	*C. zenkeri*	+	÷	+	+	+	+	•	•	•	+	•	•
88	*C. durandii*	+	÷	+	+	+	•	+	÷	•	+	+	•
89	*C. africana*	+	÷	+	•	+	+	•	÷	•	+	+	•
90	*C. wightii*	•	+	+	÷	+	•	•	•	•	+	•	•
91	*C.adolfi-fridericii*	•	+	•	•	+	•	•	•	•	•	•	•
92	*Trentaorientalis*	+	÷	+	+	+	+	+	÷	+	+	+	÷
93	*Holopteleagrandis*	+	+	+	+	+	•	•	•	•	+	•	•
94	*Macarangaschweinfurthii*	÷	÷	+	+	+	+	+	÷	÷	÷	•	•
95	*M. angolensis*	+	•	•	•	•	•	•	•	•	•	•	•
96	*M. monandra*	•	•	•	+	•	+	+	•	+	÷	•	÷
97	*M. pynaertii*	•	•	•	•	•	•	+	•	÷	÷	•	•
98	*M. lancifolia*	•	•	•	÷	•	+	÷	•	÷	•	•	•

99	*M.kilimandscharica*	•	•	•	+	•	+	+	•	•	•	+	+
100	*Neoboutoniamacrocalyx*	+	•	•	+	+	+	+	÷	•	÷	+	+
101	*N. melleri*	+	•	+	+	•	•	+	•	÷	•	•	•
102	*Alchorneacordifolia*	•	•	+	+	•	•	+	•	+	÷	•	•
103	*A. laxiflora*	•	+	+	•	+	•	•	•	+	•	+	•
104	*Acalyphaneptunica*	+	+	+	+	•	•	•	÷	+	+	+	•
105	*A. ornata*	•	•	+	•	•	•	•	•	•	+	•	•
106	*Crotonmacrostachyus*	+	÷	+	+	+	+	+	÷	+	÷	+	÷
107	*C. sylvaticus*	+	•	+	•	•	+	÷	÷	÷	•	+	÷
108	*C. bukobensis*	•	•	•	•	•	+	•	•	•	•	•	•
109	*C.megalocarpus*	+	•	+	+	•	+	+	•	+	+	•	•
110	*Discoglypremnacaloneura*	•	•	+	•	•	+	•	•	•	•	•	•
111	*Alangium chinense*	+	÷	+	+	÷	+	+	÷	•	+	+	+
112	*Cordiamillenii*	+	+	+	÷	+	•	÷	÷	÷	+	•	•
113	*C.africana*	•	•	+	+	•	•	+	•	•	•	+	•
114	*Ehretiacymosa*	+	•	+	+	+	+	÷	÷	•	+	+	÷
115	*Pterygotamildbraedii*	+	÷	+	+	+	+	+	•	•	•	•	•
116	*Colagigantea*	+	÷	+	+	+	+	+	•	•	+	•	•
117	*C.bracteata*	+	•	•	+	•	+	•	+	•	•	•	•
118	*Sterculiadawei*	+	+	+	÷	+	•	+	÷	•	+	•	•
119	*Dombeya mukole*	+	+	+	÷	+	÷	÷	÷	•	+	+	•
120	*D. goetzenii*	•	•	•	•	•	+	•	•	•	•	+	+
121	*Leptonychiamildbraedii*	+	•	+	+	•	+	÷	+	•	÷	•	•
122	*Nesogordoniakabingaensis*	•	+	•	•	•	•	•	•	•	•	•	•
123	*Strombosia scheffleri*	+	•	+	+	+	+	+	÷	•	•	+	•
124	*Strombosiopsistetrandra*	•	•	•	•	•	+	•	•	•	•	•	•
125	*Heisteriaparvifolia*	•	•	•	•	•	•	•	•	+	•	•	•
126	*Brazzeialongipedicellata*	•	•	•	•	•	+	•	•	•	•	•	•
127	*Glyphaea brevis*	+	+	+	•	+	+	+	•	+	+	•	•
128	*Desplatsiadewevrei*	•	+	+	•	+	•	•	•	•	+	•	•
129	*D. chyrsochlamys*	+	+	+	•	+	•	•	•	•	•	•	•
130	*Grewia pubescens*	•	+	+	•	•	•	•	•	•	+	•	•
131	*G.mildbraedii*	•	•	•	•	•	+	•	•	•	•	•	•
132	*Caloncobaschweinfurthii*	•	÷	+	+	+	•	+	•	•	•	•	•
133	*Lindackeria bukobensis*	•	•	+	+	•	•	•	•	•	•	•	•
134	*L. bequaertii*	•	+	•	+	•	•	•	•	•	+	•	•
135	*L. mildbraedii*	+	+	+	+	+	+	+	•	•	+	•	•
136	*L. schweinfurthii*	•	+	+	÷	•	•	÷	•	•	+	•	•
137	*Dasylepiseggelingii*	+	•	+	+	•	+	•	+	•	•	•	•
138	*D. racemosa*	+	•	•	+	•	+	•	÷	•	•	•	•
139	*Rawsonia lucida*	+	•	+	+	•	•	+	÷	•	÷	+	•
140	*Scolopiarhamnophylla*	+	•	•	+	+	•	÷	•	+	+	•	•
141	*Flacourtiaindica*	•	•	+	•	•	•	+	•	•	÷	+	•
142	*Oncobaspinosa*	+	•	+	+	+	•	+	•	•	•	+	•
143	*O. routledgei*	+	•	•	•	•	+	•	÷	•	•	•	•
144	*Dovyalis macrocalyx*	+	•	+	+	•	•	+	÷	+	÷	+	•
145	*D. abyssinica*	•	•	+	+	•	•	•	÷	•	•	+	•
146	*D.macrocarpa*	+	•	•	+	•	•	÷	÷	•	•	•	•
147	*Trimeriabakeri*	+	•	•	•	÷	•	•	•	•	•	+	•
148	*Rinoreailicifolia*	+	÷	+	+	•	•	•	•	÷	+	•	•
149	*R. ardisiiflora*	+	+	+	÷	+	•	÷	•	•	+	•	•
150	*R. brachypetala*	+	+	+	•	•	•	÷	÷	÷	•	+	•
151	*R. dentata*	•	•	+	•	•	+	•	•	+	+	•	•
152	*R. oblongifolia*	•	•	•	•	•	•	+	•	•	•	+	•

153	*Ourateadensiflora*	+	•	+	•	•	•	•	•	+	+	•	•
154	*O. hiernii*	+	•	+	+	•	+	+	•	+	•	•	•
155	*Ochnamembranacea*	+	•	+	+	+	•	+	÷	•	+	•	•
156	*O. bracteosa*	•	+	+	+	•	•	•	•	•	+	•	•
157	*O. afzelii*	•	•	•	•	•	•	•	•	÷	+	•	•
158	*O. holstii*	+	•	•	+	•	•	•	•	•	•	+	•
159	*Hugoniaplatysepala*	•	•	+	+	•	•	+	•	•	•	•	•
160	*Cassineaethiopica*	+	•	+	+	+	+	+	•	•	•	+	+
161	*Maytenusundata*	+	•	•	+	•	+	÷	÷	÷	+	•	•
163	*M.acuminata*	•	•	•	+	•	+	•	•	•	•	+	+
164	*Maesalanceolata*	+	÷	+	+	•	+	+	÷	÷	•	•	+
165	*Ilex mitis*	+	•	•	•	•	+	•	•	+	•	+	+
166	*Myricakandtiana*	•	•	•	•	•	•	•	•	÷	•	•	•
167	*Aeglopsiseggelingii*	+	•	+	•	•	•	+	÷	•	•	•	•
168	*Rhamnus prinoides*	+	•	•	•	•	•	•	•	•	•	+	•
169	*Nidorellaarborea*	•	•	•	•	•	•	•	•	•	•	+	•
170	*Vernonia conferta*	+	•	•	•	•	•	÷	÷	•	•	•	•
171	*V. sp. aff. V. adolfi-friderici*	•	•	•	•	•	•	•	•	•	•	•	+
172	*Alchorneafloribunda*	•	÷	+	+	•	+	÷	•	÷	÷	•	•
173	*A. hirtella*	+	•	•	+	•	+	+	÷	+	÷	•	+
174	*Argomuelleramacrophylla*	+	+	+	+	•	•	+	•	+	+	•	•
175	*Pseudagrostistachysugandensis*	•	•	•	•	•	•	•	•	+	•	•	•
176	*Claoxylonhexandrum*	•	•	+	•	•	•	•	•	•	+	•	•
177	*Maesobotryapurseglovei*	•	•	•	•	•	+	•	•	•	•	•	•
178	*Securinegavirosa*	+	÷	+	+	+	•	+	÷	+	÷	+	•
179	*Sapiumellipticum*	+	÷	+	+	+	+	+	÷	+	+	•	•
180	*S.leonardii-crispi*	•	•	•	+	•	+	•	•	•	•	•	•
181	*Swegadaprocera*	+	÷	+	•	÷	•	•	÷	+	+	•	•
182	*Drypetesgerrardii*	+	÷	+	+	+	+	+	÷	•	+	+	÷
183	*Drypetes sp.*	•	•	+	+	•	+	•	•	•	•	•	•
184	*D. ugandensis*	+	•	+	•	•	•	•	•	•	+	•	•
185	*D. bipindensis*	+	+	+	+	•	+	•	•	•	•	•	•
186	*Paropsiaguineensis*	•	•	•	•	+	•	•	•	•	+	•	•
187	*Ficalhoalaurifolia*	•	•	•	•	•	+	•	•	•	•	•	•
188	*Melchioraschliebenii*	•	•	•	•	•	+	•	•	•	•	•	•
189	*Maesopsiseminii*	•	•	+	+	+	+	+	÷	+	+	•	•
199	*Prunusafricana*	+	•	+	+	+	+	+	÷	÷	÷	+	÷
200	*Parinariexcelsa*	+	•	+	+	+	+	+	÷	+	•	•	•
201	*Warburgiaugandensis*	+	•	+	+	+	•	+	÷	+	+	•	•
202	*Pycnanthusangolensis*	•	÷	+	+	+	•	+	•	÷	÷	•	•
203	*Staudtia/camerunensis*	•	•	+	•	+	•	•	•	•	+	•	•
204	*Beilschmiediaugandensis*	+	÷	+	+	•	+	+	÷	+	+	•	÷
205	*Ocoteausambarensis*	•	•	•	+	•	+	•	•	•	•	•	+
206	*Ocoteakenyensis*	•	•	•	•	•	+	•	•	•	•	•	•
207	*Caseariaengleri*	+	•	+	+	+	+	•	÷	÷	•	•	•
208	*C.battiscombei*	+	•	•	+	•	•	•	•	•	•	+	•
209	*Klainedoxagabonensis*	•	+	+	+	+	•	•	•	+	+	•	•
210	*Irvingiagabonensis*	•	•	+	•	•	•	•	•	•	+	•	•
211	*Diospyrosabyssinica*	+	÷	+	+	+	+	+	÷	+	+	+	•
212	*Uvariopsiscongensis*	+	÷	+	+	+	•	÷	÷	•	+	•	•
213	*Greenwayodendronsuaveolens*	•	•	+	•	+	•	•	•	÷	+	•	•
214	*Cleistopholispatens*	•	÷	+	+	+	•	•	•	•	•	•	•
215	*Isolonacongolana*	+	+	•	•	•	•	•	÷	•	•	•	•
216	*Xylopiaaethiopica*	•	•	•	•	•	•	•	+	+	•	•	•

217	*X. staudtii*	•	•	•	•	•	+	•	•	•	•	•	•
218	*X. parviflora*	•	+	•	•	÷	•	•	•	•	•	•	•
219	*Monodoramyristica*	+	•	+	+	+	•	+	÷	•	+	+	•
220	*M. angolensis*	•	•	+	+	•	•	÷	•	•	•	•	•
221	*Uvariodendronmagnificwn*	•	•	•	•	•	•	+	•	•	•	•	•
222	*Uvariaangolensis*	•	•	+	•	•	•	•	÷	•	•	•	•
226	*Turraeafloribunda*	+	•	+	•	•	•	•	•	•	+	•	•
227	*T. robusta*	+	•	•	+	+	•	+	•	÷	+	•	•
228	*T. vogelii*	+	+	+	•	•	•	•	•	•	•	•	•
229	*T. vogelioides*	+	÷	+	+	+	•	+	÷	+	+	•	•
230	*Baphiawollastonii*	•	+	+	+	•	•	+	•	•	•	•	•
231	*B. capparidifolia*	•	+	•	•	•	•	•	•	•	•	•	•
232	*Baphiopsisparviflora*	+	÷	•	+	+	•	+	•	+	+	•	•
233	*Maeruaduchesnei*	•	•	+	+	•	•	+	•	•	+	•	•
234	*Tapurafischeri*	+	÷	+	+	+	•	•	•	•	+	•	•
235	*Trichocladusellipticus*	•	•	•	•	•	•	•	•	+	•	+	•
236	*Barteriaacuminata*	•	•	•	•	•	•	•	•	+	•	•	•
237	*Apodytes dimidiata*	+	•	•	•	+	•	•	•	+	•	•	•
238	*Leptaulus daphnoides*	+	•	+	•	•	•	÷	•	+	+	•	•
239	*L. holstii*	•	•	•	+	•	•	+	•	+	•	•	•
240	*Uapacaguineensis*	•	•	•	+	•	•	÷	•	÷	•	•	•
241	*Spondianthus preusii*	•	•	+	•	•	•	•	÷	+	•	•	•
242	*Tetrorchidium didymostemon*	•	•	+	+	÷	+	+	÷	+	+	•	•
243	*Brideliamicrantha*	+	÷	+	+	+	+	+	÷	+	÷	+	+
244	*B. brideliifolia*	•	÷	•	+	•	•	+	•	÷	•	•	+
245	*Antidesmalaciniatum*	•	•	+	+	•	•	+	•	•	•	•	•
246	*A. membranaceum*	+	÷	+	•	•	+	•	÷	+	+	•	•
247	*Phyllanthus discoideus*	+	÷	+	+	+	+	+	÷	÷	÷	•	•
248	*P. sp. aff. P. inflatus*	•	•	+	+	•	•	+	•	•	+	•	•
249	*Thecacorislucida*	•	+	+	+	•	•	•	•	•	•	•	•
250	*Cleistanthuspolystachyus*	+	•	+	•	•	•	•	•	÷	÷	•	•
251	*Microdesmispuberula*	•	•	+	•	•	•	•	•	•	•	•	•
252	*Chaetacmearistata*	+	÷	+	+	+	•	+	÷	+	+	•	•
253	*Pittosporummannii*	+	•	•	+	•	+	÷	•	÷	•	•	•
254	*P. spathicalyx*	•	•	•	+	•	+	•	•	•	•	•	•
255	*P. viridiflorum*	•	•	•	•	•	•	•	•	•	•	+	•
256	*Peddieafischeri*	+	•	•	+	•	+	÷	÷	+	÷	+	+
257	*Erythroxylum fisheri*	•	•	•	+	•	•	•	•	•	•	•	•
258	*Myricasalicifolia*	•	•	•	+	•	+	•	•	•	•	•	•
259	*Faureasaligna*	•	•	•	+	•	+	+	•	•	•	•	+
260	*Proteakilimandscharica*	•	•	•	•	•	•	•	•	•	•	+	•
261	*Agauriasalicifolia*	•	•	•	+	•	+	•	•	•	•	+	•
262	*Rapanearhododendroides*	•	•	•	•	•	+	•	•	•	•	+	+
263	*Euclealatidens*	•	•	•	+	•	•	•	•	•	•	•	•
264	*Nuxia congesta*	•	•	+	•	•	+	•	•	•	•	+	•
266	*Premnaangolensis*	+	÷	+	+	+	+	+	÷	•	+	•	•
267	*Alstonia boonei*	•	÷	+	+	+	•	•	•	÷	+	•	•
268	*Rauvolfia oxyphylla*	+	÷	•	+	+	•	+	•	•	+	+	•
269	*R. vomitoria*	•	÷	+	+	•	•	+	•	÷	+	•	•
270	*Pleiocarpapycnantha*	+	•	•	+	•	+	÷	+	+	÷	•	•
271	*Funtumiaafricana*	+	•	+	+	+	+	+	+	÷	+	•	•
272	*F.elastica*	•	+	+	•	+	+	•	•	•	+	•	•
273	*Tabernaemontanaholstii*	+	•	+	+	+	+	+	÷	÷	+	•	+
274	*T. johnstonii*	+	•	•	•	•	•	•	•	•	•	+	•

275	*T. usambarensis*	+	+	•	+	÷	•	+	•	•	•	•	•
276	*T.odoratissima*	+	•	•	+	•	+	•	÷	•	•	•	•
277	*Picralimanitida*	+	+	+	•	•	•	•	•	•	+	•	•
278	*Voacangathouarsii*	+	÷	+	+	•	•	+	÷	÷	•	•	•
279	*Symphoniaglobulifera*	+	•	•	+	•	+	+	÷	÷	•	•	+
280	*Garciniahuillensis*	•	•	•	•	•	+	•	•	•	•	+	•
281	*Harunganamadagascariensis*	+	•	+	+	•	+	+	÷	÷	+	+	•
282	*Allanblackiakimbiliensis*	•	•	•	•	•	+	•	•	•	•	•	•
283	*Mammeaafricana*	•	•	+	•	•	•	•	•	•	•	•	•
284	*Hypericum keniense*	•	•	•	•	•	•	•	•	•	•	+	+
285	*H.bequaertii*	•	•	•	•	•	•	•	•	•	•	•	+
286	*H. revolutum*	•	•	•	•	•	•	•	•	•	•	+	+
287	*H.roeperianum*	•	•	•	•	•	•	•	•	•	•	+	•
288	*H. quartinianum*	•	•	•	•	•	•	•	•	•	•	+	•
289	*Anthocleistazambesiaca*	•	•	•	+	•	+	•	•	•	•	•	+
290	*A. vogelii*	•	•	•	+	•	+	+	•	•	•	•	•
291	*A. schweinfurthii*	+	+	•	•	•	+	•	÷	+	•	•	•
292	*Strychnos mitis*	+	÷	+	+	+	•	+	÷	÷	+	•	•
293	*Afrocraniavolkensii*	•	•	•	•	•	•	•	•	•	•	+	+
294	*Memecylonjasminoides*	•	÷	+	+	÷	+	÷	•	÷	÷	•	•
295	*Memecylon sp.*	•	•	•	•	•	+	•	•	•	•	•	•
296	*Dichaetantheracorymbosa*	•	•	•	+	•	+	÷	•	•	•	•	•
297	*Mallotusoppositifolius*	+	•	+	•	•	•	•	•	+	÷	•	•
298	*Cassipoureamalosana*	•	•	•	•	•	•	•	•	•	•	+	•
299	*C. ruwensorensis*	+	÷	+	+	•	+	+	÷	+	+	•	•
300	*C. congoensis*	•	•	•	+	•	+	÷	•	•	•	•	•
301	*C. gummiflua*	+	•	+	+	+	+	÷	÷	+	+	•	+
302	*Lasiodiscusmildbraedii*	+	+	+	+	+	•	•	•	+	+	•	•
303	*Mitragynastipulosa*	•	÷	+	•	+	•	÷	•	•	•	•	•
304	*M.rubrostipulata*	+	•	•	+	•	+	÷	÷	+	•	•	•
305	*Naucleadiderrichii*	•	+	•	•	•	•	•	•	•	•	•	•
306	*Oxyanthusunilocularis*	•	+	•	•	•	•	+	•	•	•	•	•
307	*Pauridianthacallicarpoides*	•	•	•	+	•	+	÷	+	•	•	•	•
308	*P.viridiflora*	•	•	•	•	•	•	•	•	+	•	•	•
309	*Coffealiberica*	•	+	•	+	•	•	•	+	•	•	•	•
310	*Craterispermumlaurinum*	+	•	+	+	•	•	•	÷	÷	•	•	•
311	*Vangueriaapiculata*	•	•	+	+	+	•	÷	•	•	÷	+	•
312	*Morindalucida*	•	÷	+	•	+	•	•	•	•	•	•	•
313	*Bertieraracemosa*	•	•	•	•	•	•	•	•	+	•	•	•
314	*Coffeacanephora*	+	•	+	•	•	•	÷	÷	+	÷	•	•
315	*Belonophorahypoglauca*	+	÷	+	+	+	•	•	•	+	+	•	•
316	*Dictyandraarborescens*	+	•	+	+	+	•	+	•	÷	+	•	•
317	*Oxyanthus speciosus*	+	•	+	+	+	+	÷	÷	÷	÷	•	+
318	*Pavettainsignis*	•	•	+	+	•	•	•	÷	•	+	•	•
319	*Tarennapavettoides*	+	+	+	+	•	+	+	•	÷	•	•	•
320	*Galinieracoffeoides*	+	•	+	+	•	+	+	÷	•	•	+	+
321	*Psychotriamegistosticta*	+	+	•	+	•	+	•	•	+	•	•	+
322	*Rothmanniaurcelliformis*	+	÷	+	+	+	•	+	÷	•	+	+	•
323	*R. whitfieldii*	+	•	+	•	•	•	•	•	•	•	•	•
324	*Heinseniadiervilleoides*	•	•	•	+	•	•	•	•	•	•	+	•
325	*Canthiumvulgare*	+	•	+	+	•	+	+	÷	÷	•	•	•
326	*Aidiamicrantha*	•	•	•	+	•	+	+	÷	÷	•	•	•
327	*Coffeaeugenioides*	+	•	+	+	•	•	+	•	+	•	•	•
328	*Xymalos monospora*	+	•	•	+	•	+	+	÷	÷	•	+	÷

329	*Cassinebuchananii*	+	•	•	÷	•	•	÷	+	•	•	+	•
330	*Cathaedulis*	•	•	•	•	•	•	•	•	•	•	+	•
331	*BuddleiaPolystachya*	•	•	•	•	•	•	•	•	•	•	+	•
332	*Schreberaarborea*	+	÷	+	+	+	•	+	•	+	+	•	•
333	*Oleawelwitschii*	+	•	+	+	+	+	+	÷	+	÷	+	•
334	*O. hochstetteri*	•	•	•	+	•	+	•	•	•	•	+	+
335	*O. africana*	•	•	•	•	•	+	•	•	+	•	+	+
336	*Linocierajohnsonii*	+	+	+	+	+	+	+	÷	+	+	+	•
337	*L. latipetala*	+	•	+	+	•	•	•	+	•	•	+	•
338	*Oliniausambarensis*	•	•	•	•	•	+	•	•	•	•	+	•
339	*Syzygium guineense*	•	•	•	•	•	+	•	•	+	•	+	•
340	*S. cordatum*	•	•	•	•	•	+	•	•	+	•	+	•
341	*Eugenia bukobensis*	•	•	•	+	•	•	•	•	÷	•	•	•
342	*Memecylon myrianthum*	•	•	•	•	•	•	•	•	+	÷	•	•
343	*Balaniteswilsoniana*	+	÷	+	+	+	•	+	÷	÷	+	•	•
344	*Erthrinaexcelsa*	+	+	+	+	+	•	+	•	÷	÷	•	•
345	*Erythrina sp.*	•	÷	+	•	•	•	•	•	•	•	•	•
346	*Balsamocitrusdawei*	+	•	+	+	+	•	+	•	•	+	•	•
347	*Tecleanobilis*	+	+	+	+	+	+	+	÷	+	+	+	÷
348	*T. grandifolia*	•	÷	+	•	+	•	•	•	•	•	•	•
350	*Diphasiaangolensis*	•	•	•	•	•	•	•	•	•	+	•	•
351	*Allophylus abyssinicus*	+	•	•	•	•	+	•	•	•	•	+	+
352	*A. macrobotrys*	+	÷	+	•	÷	+	÷	÷	•	+	+	•
353	*A. dummeri*	+	+	+	+	•	•	÷	•	÷	+	•	•
354	*Eudenia eminens*	+	•	+	+	•	•	+	÷	•	÷	•	•
355	*Ritchieaalbersii*	+	÷	+	+	+	+	÷	÷	+	+	+	+
356	*Cussonia holstii*	•	+	•	•	•	•	•	•	•	•	•	•
357	*C. spicata*	•	•	•	•	•	•	•	•	•	•	+	•
358	*Scheffleraabyssinica*	•	•	•	•	•	•	•	•	•	•	+	•
359	*S. volkensii*	•	•	•	•	•	•	•	•	•	•	+	•
360	*S. barteri*	•	÷	•	+	•	+	÷	•	+	•	•	•
361	*S. polyscidia*	•	•	•	•	•	•	•	•	•	•	•	+
362	*Ricinodendronheudelotii*	•	÷	+	+	+	•	•	•	•	+	•	•
363	*Bombax buonopozense*	•	+	+	+	+	•	•	•	•	+	•	•
364	*Myrianthusarboreus*	+	•	+	+	+	+	+	•	•	+	•	•
365	*M. holstii*	+	•	•	+	•	+	÷	÷	•	•	•	÷
366	*Musangacecropioides*	•	+	+	•	•	+	•	•	•	÷	•	•
367	*M. leo-errerae*	•	•	•	+	•	+	•	•	•	•	•	•
368	*Vitex amboniensis*	+	•	+	+	+	•	÷	•	÷	+	•	•
369	*Markhamiaplatycalyx*	+	÷	+	+	+	+	+	÷	+	+	•	+
370	*Spathodeacampanulata*	+	÷	+	+	+	•	+	÷	+	÷	+	÷
371	*Kigeliaafricana*	+	÷	+	+	+	•	+	÷	÷	÷	+	+
372	*Fagaropsisangolensis*	+	•	+	+	+	•	+	÷	•	+	+	+
373	*Fagaramacrophylla*	+	÷	•	+	+	+	+	÷	•	•	+	•
374	*F. rubescens*	•	•	+	+	+	+	÷	•	÷	+	•	•
375	*F. leprieurii*	+	÷	+	•	•	+	+	÷	+	+	•	•
376	*F. mildbraedii*	•	•	•	+	•	+	•	•	•	•	•	•
377	*Clausenaanisata*	+	÷	+	+	+	+	+	÷	+	÷	•	+
378	*Citropsisarticulata*	•	•	•	•	÷	•	•	÷	÷	÷	•	•
379	*Schreberaalata*	•	•	•	•	•	•	•	•	•	•	+	•
380	*Bersamaabyssinica*	+	+	+	+	+	+	+	÷	+	+	+	+
381	*Hageniaabyssinica*	•	•	•	•	•	+	•	•	•	•	+	+
382	*Harrisoniaabyssinica*	+	+	•	+	+	•	+	•	•	+	•	÷
383	*Hannoa longipes*	+	•	•	+	•	+	•	+	•	•	•	•

384	*Polyscias fulva*	+	•	•	+	•	+	+	÷	•	÷	•	÷
385	*Pseudospondiasmicrocarpa*	+	+	+	+	+	+	+	÷	+	+	•	•
386	*Tricoscyphasubmontana*	•	•	•	+	•	•	÷	•	•	•	•	•
387	*Lanneawelwitschii*	•	÷	+	+	+	÷	•	•	•	+	•	•
388	*Antrocaryonmicraster*	•	•	+	•	•	•	•	•	•	+	•	•
389	*Canariumschweinfurthii*	•	÷	+	+	•	+	•	•	+	÷	•	•
390	*Ekerbergiasenegalensis*	+	•	+	+	+	•	•	•	÷	÷	•	•
391	*E. capensis*	•	•	+	•	•	+	•	÷	÷	•	+	•
392	*Trichiliadregeana*	+	+	+	+	+	•	+	÷	+	÷	+	•
393	*T.martineaui*	•	•	+	÷	+	+	÷	•	•	+	•	•
394	*T.prieureana*	+	•	+	+	+	•	•	÷	•	+	•	•
395	*T. rubescens*	+	•	+	+	•	•	+	+	+	÷	•	•
396	*Lepidotrichiliavolkensii*	+	•	•	+	•	+	÷	÷	÷	•	+	+
397	*Carapagrandiflora*	+	•	•	+	•	+	+	÷	+	•	•	•
398	*Leplaeamayombensis*	•	•	•	•	•	+	•	•	•	•	•	•
399	*Entandrophragmautile*	•	•	+	•	+	•	•	•	•	+	•	+
400	*E. cylindricum*	+	÷	+	•	+	+	•	•	•	•	•	•
401	*E. angolense*	+	•	+	÷	+	•	÷	•	•	+	•	•
402	*E. excelsum*	+	•	•	+	•	+	+	+	÷	•	+	÷
403	*Khayaanthotheca*	•	+	+	•	+	•	•	•	•	•	•	•
404	*K.grandifoliola*	•	•	+	•	•	•	•	•	•	•	•	•
405	*Guareacedrata*	•	+	+	•	+	•	÷	•	+	+	•	•
406	*Lovoatrichilioides*	•	•	+	•	+	•	+	•	+	+	•	•
407	*L. swynnertonii*	+	÷	•	+	+	+	+	÷	•	÷	•	•
408	*Turraeanthusafricanus*	+	÷	•	•	•	•	÷	+	•	•	•	•
409	*Majideafosteri*	+	•	+	+	+	•	+	•	+	+	•	•
410	*Deinbolliafulvo-tomentella*	•	•	•	•	•	•	+	•	•	•	•	•
411	*D. kilimandscharica*	•	•	+	+	•	•	•	•	•	•	•	•
412	*Lychnodiscus cerospermus*	+	÷	+	+	+	•	•	•	+	+	•	•
413	*Lecaniodiscusfraxinifolius*	•	•	•	•	•	•	•	•	÷	+	•	•
414	*L. cupanioides*	•	+	•	•	•	•	÷	•	•	•	•	•
415	*Blighiawelwitschii*	+	÷	+	•	•	•	•	÷	+	÷	•	•
416	*Zanhagolungensis*	+	•	+	•	+	+	÷	•	•	÷	•	•
417	*Pancovia sp. near P. turbinata*	+	•	•	+	+	+	÷	÷	÷	÷	•	•
418	*Melanodiscus sp.*	•	•	+	•	+	•	•	÷	•	+	•	•
419	*Blighiaunijugata*	+	÷	+	+	+	÷	+	÷	÷	+	•	•
420	*Aphaniasenegalensis*	+	÷	+	+	+	+	÷	÷	•	÷	•	•
421	*Connaruslongistipitatus*	•	÷	+	+	•	•	•	÷	+	•	•	•
422	*Cnestisugandensis*	+	÷	+	•	•	•	÷	•	•	+	•	•
423	*Mildbraediodendronexcelsum*	•	÷	+	+	+	•	•	•	•	+	•	•
424	*Cassiamannii*	•	+	+	+	+	•	•	•	•	•	•	•
425	*Dialiumexcelsum*	•	+	+	•	+	•	•	+	•	•	•	•
426	*Afzelia bipindensis*	•	+	•	•	•	•	•	•	•	•	•	•
427	*Baikiaeainsignis*	•	•	•	+	+	•	÷	•	+	+	•	•
428	*Cynometraalexandri*	+	+	+	+	+	+	+	•	•	•	•	•
429	*Craibiabrownii*	+	÷	+	+	•	•	•	÷	•	+	+	•
430	*Milleniadura*	+	÷	•	+	•	+	+	÷	•	•	•	•
431	*M.eetveldeana*	•	+	•	•	•	•	•	•	•	•	•	•
432	*M.psilopetala*	•	+	•	•	•	+	•	•	•	•	•	•
433	*Erythrophleumsuaveolens*	•	•	+	•	+	•	•	•	•	+	•	•
434	*Piptadeniastrumafricanum*	+	•	+	+	+	+	+	•	•	÷	•	•
435	*Newtoniabuchananii*	+	•	•	+	+	+	+	÷	•	•	•	•
436	*Cathormionaltissimum*	•	•	+	•	+	•	•	•	•	•	•	•
437	*Acaciakirkii*	•	•	•	•	•	•	•	•	÷	•	•	•

438	*Dichrostachysglomerata*	•	+	+	•	+	•	•	•	•	+	•	•
439	*Tetrapleuratetraptera*	+	+	+	•	+	•	+	÷	+	+	•	•
440	*Parkiafilicoidea*	+	÷	+	+	+	+	+	•	+	÷	•	•
441	*Albiziaferruginea*	+	÷	+	+	+	•	+	÷	•	+	•	•
442	*A.coriaria*	•	÷	+	+	+	+	+	÷	•	÷	•	•
443	*A.glaberrima*	+	÷	+	•	+	•	•	•	+	+	•	•
444	*A. gummifera*	+	•	•	+	•	+	+	•	+	+	+	•
445	*A.adianthifolia*	•	•	•	+	•	+	+	÷	•	•	•	÷
446	*A. grandibracteata*	+	÷	+	+	+	+	+	÷	•	+	+	•
447	*A. zygia*	+	÷	+	+	+	•	+	+	+	+	•	•

Appendix B. List of bird species recorded from twelve of Uganda's principal forest reserves. + denotes species presence recorded in the literature prior to this study; ÷ denotes species recorded for the first time during this study; • denotes species not recorded. Forests are numbered as: 1 = Kibale, 2 = Semliki, 3 = Budongo, 4 = Kalinzu-Maramagambo, 5 = Bugoma, 6 = Bwindi, 7 = Kasyoha-Kitomi, 8 = Itwara, 9 = Sango Bay, 10 = Mabira, 11 = Mount Elgon, 12 = Rwenzori. Bird species numbers are those used in Britton (1980) and the Checklist of the Birds of Uganda (EANHS, 1984). Non-forest species are excluded.

	BIRD SPECIES	FOREST NUMBER											
		1	2	3	4	5	6	7	8	9	10	11	12
97	Banded Snake Eagle *Circaetus cinerascens*	+	•	•	•	•	•	•	•	•	÷	•	•
104	Chestnut-flanked Goshawk *Accipiter castanilius*	•	+	•	•	•	•	•	•	•	•	•	•
105	Western Little Sparrowhawk *A. erythropus*	•	+	•	•	•	•	•	•	•	•	•	•
106	Great Sparrowhawk *A. melanoleucus*	+	•	•	+	•	+	•	÷	÷	+	+	+
107	Little Sparrowhawk *A. minullus*	+	+	•	+	•	•	•	•	•	•	•	•
110	Rufous sparrowhawk *A. rufinventris*	•	•	•	•	•	+	•	•	•	•	•	•
111	African Goshawk *A. tachiro*	+	+	•	+	•	+	÷	÷	÷	÷	•	÷
124	Mountain Buzzard *Buteo tachardus*	+	•	•	+	•	+	•	•	•	•	+	+
125	Cassin's Hawk Eagle *Hieraaetus africanus*	+	•	•	+	•	+	•	•	•	+	•	•
126	Ayres' Hawk Eagle *H. dubius*	+	+	+	+	•	•	•	•	•	•	•	•
135	Crowned Eagle *Stephanoaetus coronatus*	+	+	+	+	•	+	•	•	•	+	•	•
136	Long-tailed Hawk *Urotriorchis macrourus*	•	+	•	•	•	•	•	•	•	•	•	•
173	Jackson's Francolin *Francolinus jacksoni*	•	•	•	•	•	•	•	•	•	•	•	•
174	Forest Francolin *F. lathami*	+	+	÷	•	+	•	•	•	•	+	•	•
178	Nahan's Francolin *F. nahani*	+	+	+	•	+	•	•	•	•	+	•	•
179	Handsome Francolin *F. nobilis*	•	•	•	•	•	+	•	•	•	•	•	+
184	Scaly Francolin *F. squamatus*	+	+	+	+	•	+	•	÷	+	+	+	•
188	Crested Guineafowl *Guttera edouardi*	+	+	+	+	+	+	÷	•	+	+	•	•
200	Nkulengu Rail *Himantornis haematopus*	•	+	•	•	•	•	•	•	•	•	•	•
211	Buff-spotted Pygmy Crake *Sarothrura elegans*	+	+	+	+	+	+	•	•	+	+	•	•
213	White-spotted Pygmy Crake 5. *pulchra*	+	+	+	+	+	+	•	•	+	+	•	•
337	Lemon Dove *Aplopelia larvata*	+	+	+	+	+	+	•	•	÷	+	•	+
338	White-naped Pigeon *Columba albinucha*	+	+	•	÷	•	•	÷	•	•	•	•	•
339	Olive Pigeon *C. arquatrix*	+	+	•	+	•	+	•	÷	•	•	+	+
340	Bronze-naped Pigeon *C. delegorguei*	•	•	•	•	•	•	•	•	•	•	+	•
343	Western Bronze-naped Pigeon *C. malherbii*	•	+	•	•	•	+	•	•	•	•	•	•
344	Afep Pigeon *C. unicincta*	+	+	+	+	+	+	÷	÷	+	+	•	•
363	Red-headed Lovebird *Agapornis pullaria*	•	+	+	+	+	+	•	•	+	+	+	•
364	Black-collared Lovebird *A. swinderniana*	•	+	+	+	•	•	•	•	•	•	•	•
366	Red-fronted Parrot *Poicephalus gulielmi*	•	•	•	•	•	+	•	•	•	+	•	•
367	Brown Parrot *P. meyeri*	•	+	•	+	•	+	•	•	•	•	+	•
371	Grey Parrot *Psittacus erithacus*	+	+	+	+	+	+	÷	•	÷	+	•	•
372	Great Blue Turaco *Corythaeola cristata*	+	+	+	+	+	+	÷	÷	+	+	•	•
377	Ross's Turaco *Musophaga rossae*	+	+	•	+	+	+	÷	÷	+	+	+	•
379	Hartlaub's Turaco *Tauraco hartlaubi*	•	•	•	•	•	•	•	•	•	•	+	•
380	Rwenzori Turaco *T. johnstoni*	•	•	•	+	•	+	•	•	•	•	•	+
381	White-crested turaco *T. leucolophus*	•	•	+	•	+	•	•	•	•	•	+	•
384	Black-billed Turaco *T. schuetti*	+	+	+	+	+	+	÷	÷	+	+	•	+
385	Dusky Long-tailed Cuckoo *Cercococcyx mechowi*	+	+	+	•	+	+	•	÷	+	+	•	•

386	Barred Long-tailed Cuckoo *C. montanus*	•	•	•	•	•	+	•	•	•	•	•	+
387	Olive Long-tailed Cuckoo *C. olivinus*	+	+	•	•	+	•	•	•	•	•	•	•
389	Emerald Cuckoo *C. cupreus*	+	+	+	+	+	+	÷	÷	+	+	+	+
390	Yellow-throated Green Cuckoo *C. flavigularis*	•	+	•	+	•	•	•	•	•	•	•	•
391	Klass' Cuckoo *C. klass*	+	+	+	+	+	+	•	÷	÷	÷	+	+
394	Levaillant's Cuckoo *C. levaillantii*	+	+	+	+	+	+	•	•	•	+	+	+
399	Red-chested Cuckoo *C. solltarius*	+	+	+	+	+	+	÷	•	+	+	•	+
401	Yellowbill *Ceuthmochares aereus*	+	+	+	+	+	+	÷	÷	+	+	•	•
415	Fraser's Eagle Owl *Bubo poensis*	•	•	•	•	•	+	•	•	•	•	•	•
416	African Wood Owl *Ciccaba woodfordii*	+	+	+	+	+	+	•	÷	•	÷	+	•
418	Chestnut Owlet *Glaucidium castaneum*	•	+	•	•	•	•	•	•	•	•	•	•
420	Red-chested Owlet *G. tephronotum*	+	+	•	+	•	+	÷	•	•	•	+	•
426	Bates' Nightjar *Caprlmulgus batesl*	•	+	•	•	•	•	•	•	•	•	•	•
436	Fiery-necked Nightjar *C. pectoralis*	+	+	•	•	+	+	•	•	•	÷	•	•
437	Montane Nightjar *C. pollocephalus*	•	•	•	•	•	+	•	•	•	•	+	+
453	Scarce Swift *Schoutedenapus myoptllus*	+	+	•	•	•	+	•	•	•	•	•	+
455	Cassin's Spinetail *Neafrapus cassinl*	•	•	+	•	•	•	•	•	•	•	•	•
456	Sabine's Spinetail *Rhaphidura sabinl*	+	+	+	+	•	•	•	•	•	+	+	•
457	Mottle-throated Spinetail *Telacanthura ussheri*	+	+	+	+	•	+	•	•	•	+	•	•
462	Narina's Trogon *Apaloderma narina*	+	+	+	+	+	+	÷	÷	+	+	+	•
463	Bar-tailed Trogon *A.vittatum*	+	•	•	•	•	+	•	•	•	•	+	•
464	Giant Kingfisher *Ceryle maxima*	+	+	+	+	+	+	•	•	+	•	+	÷
467	White-bellied Kingfisher *Alcedo leucogaster*	•	+	•	+	•	•	•	•	+	+	•	•
468	Shining-blue Kingfisher *A. quadribrachys*	+	+	+	+	•	+	÷	•	•	+	•	•
471	Chocolate-backed Kingfisher *Halcyon badia*	•	+	+	+	+	•	•	•	•	•	•	•
474	Blue-breasted Kingfisher *Halcyon chelicuti*	+	+	+	+	+	+	÷	•	+	+	•	•
475	Woodland Kingfisher *H. senegalensis*	+	+	+	+	•	•	•	•	÷	+	•	•
477	Dwarf Kingfisher *Ispidina lecontei*	•	+	+	+	•	•	•	•	÷	+	•	•
478	Pygmy Kingfisher */. picta*	+	+	+	+	÷	•	÷	•	+	÷	•	•
484	Black Bee-eater *Merops gularis*	+	+	•	+	+	+	÷	•	•	•	•	•
500	Broad-billed Roller *Eurystomus glaucurus*	+	+	•	+	+	+	÷	•	+	÷	•	•
501	Blue-throated Roller *E. gularis*	+	+	+	+	+	+	÷	÷	•	+	•	•
503	White-headed Wood Hoopoe *Phoeniculus bollei*	+	+	+	+	+	+	÷	•	•	+	+	•
504	Forest Wood Hoopoe *P. castaneiceps*	+	+	•	•	+	+	•	•	•	+	+	•
508	Green Wood Hoopoe *P. purpureus*	+	•	•	+	•	•	•	•	÷	•	+	•
511	White-thighed Hornbill *Bycanistes cylindricus*	•	+	+	+	+	+	•	•	•	•	•	•
512	White-tailed Hornbill *B. fistulator*	•	+	+	•	•	•	•	•	•	•	•	•
513	B & W Casqued Hornbill *B. subcylindricus*	+	+	+	+	+	+	÷	÷	+	+	+	•
514	Black-wattled Hornbill *Ceratogymna atrata*	•	+	•	•	•	•	•	•	•	•	•	•
515	Crowned Hornbill *Tockus alboterminatus*	+	+	•	+	+	+	÷	÷	+	÷	•	•
516	Red-billed Dwarf Hornbill *Tockus camurus*	•	+	•	•	•	•	•	•	•	•	•	•
519	Pied Hornbill *T. fasciatus*	+	+	+	•	•	•	•	•	•	+	•	•
521	Black Dwarf Hornbill *T. hartlaubi*	•	+	•	•	•	•	•	•	•	•	•	•
526	White-crested Hornbill *Tropicranus albocristatus*	•	+	•	•	•	•	•	•	•	•	•	•
529	Yellow-spotted Barbet *Buccanodon duchaillui*	+	•	+	+	•	+	÷	÷	+	+	•	•
533	Grey-throated Barbet *Gymnobucco bonapartei*	+	+	•	+	+	+	÷	÷	•	+	+	•
538	Hairy-breasted Barbet *Lybius hirsutus*	+	+	+	+	+	+	÷	÷	+	+	•	•
547	Red-rumped Tinkerbird *Pogoniulus atroflavus*	•	+	•	•	•	•	•	•	•	•	•	•
548	Yellow-rumped Tinkerbird *P. bilineatus*	+	+	+	+	+	+	÷	÷	+	+	+	+
550	Western Green Tinkerbird *P. coryphaeus*	+	•	•	•	•	+	•	•	•	•	•	+
553	Speckled Tinkerbird *P. scolopaceus*	+	+	+	+	+	+	÷	•	•	+	+	•
555	Yellow-throated Tinkerbird *P. subsulphureus*	•	+	+	+	+	+	•	•	•	+	+	•
556	Yellow-billed Barbet *Trachylaemus purpuratus*	+	+	+	+	+	+	•	÷	•	+	+	•
561	Thick-billed Honeyguide *Indicator conirostris*	+	+	+	+	+	+	•	•	•	•	+	•

562	Least Honeyguide *I. exilis*	+	+	•	+	•	+	•	•	+	+	•	•
564	Spotted Honeyguide *I. maculatus*	•	+	•	•	•	•	•	•	•	•	•	•
566	Lesser Honeyguide *I. minor*	•	+	•	+	+	+	•	•	•	•	+	+
568	Dwarf Honeyguide *I. pumilio*	•	•	•	•	•	+	•	•	•	•	•	•
569	Scaly-throated Honeyguide *I. variegatus*	•	+	+	+	+	+	•	•	+	+	+	•
570	Willcocks' Honeyguide *I. willcocksi*	+	•	•	+	•	+	•	•	•	•	•	•
000	Lyre-tailed Honeyguide *Melichneutes robustus*	•	+	•	•	•	•	•	•	•	•	•	•
571	Zenker's Honeyguide *Melignomon zenkeri*	•	+	•	•	•	•	•	•	•	•	•	•
572	Cassin's Honeybird *Prodotiscus insignis*	•	+	+	+	+	+	•	•	•	÷	•	•
577	African Piculet *Sasia africana*	•	+	•	•	•	•	•	•	•	•	•	•
578	Golden-tailed Woodpecker *Campethera abingoni*	•	+	•	•	•	•	•	•	•	•	•	•
580	Little Spotted Woodpecker *C. cailliautii*	•	+	•	+	•	•	•	•	+	+	•	•
581	Brown-eared Woodpecker *C. caroli*	+	+	+	+	+	+	÷	÷	+	+	•	•
582	Buff-spotted Woodpecker *C. nivosa*	+	+	+	+	+	+	÷	•	+	+	+	•
584	Fine-banded Woodpecker *C. tullbergi*	+	•	•	+	•	+	÷	•	•	+	+	•
586	Gabon Woodpecker *Dendropicos fuscescens*	•	+	•	•	•	•	•	•	•	•	•	•
589	Elliot's Woodpecker *Mesopicos elliotii*	+	+	•	+	•	+	•	•	•	•	+	•
591	Olive Woodpecker *M. griseocephalus*	•	•	•	•	•	+	•	•	•	•	•	+
592	Yellow-crested Woodpecker *M. xantholophus*	+	+	+	+	+	+	÷	÷	+	+	+	•
594	Bearded Woodpecker *Thripias namaquus*	•	•	•	+	•	•	÷	•	÷	•	•	•
595	African Green Broadbill *P. granuri*	•	•	•	•	•	+	•	•	•	•	•	•
596	African Broadbill *Smithornis capensis*	+	+	+	+	•	+	÷	÷	÷	÷	+	•
597	Red-sided Broadbill *Smithornis rufolateralis*	•	+	+	•	+	•	•	•	•	•	•	•
598	African Pitta *Pitta angolensis*	+	•	+	+	+	•	•	•	•	•	•	•
599	Green-breasted Pitta *P. reichenowi*	+	+	+	+	+	+	•	•	•	+	•	•
640	Black Rough-wing *Psalidoprocne pristoptera*	•	+	•	+	•	+	÷	•	•	•	•	÷
645	Square-tailed Drongo *Dicrurus adsimilis*	+	•	+	+	•	•	÷	÷	•	•	•	•
647	Western Black-headed Oriole *O.brachyrhynchus*	+	+	+	+	+	+	÷	÷	+	+	+	•
649	Black-headed Oriole *O. larvatus*	•	•	+	+	+	+	÷	÷	•	•	•	•
650	Black-winged Oriole *O. nigripennis*	•	+	•	÷	•	•	•	•	•	•	•	•
652	Montane Oriole *O. percivali*	+	•	•	•	•	•	•	•	•	•	+	•
662	Stripe-breasted Tit *Parusfasciiventer*	•	•	•	•	•	+	•	•	•	•	•	+
664	Dusky Tit *P. funereus*	+	•	+	+	+	+	÷	÷	•	+	+	•
671	African Hill Babbler *Alcippe abyssinica*	+	•	•	•	•	+	•	•	•	•	+	+
672	Grey-chested Illadopsis *Kakamega poliothorax*	•	•	•	•	•	+	•	•	•	•	+	+
673	Capuchin Babbler *Phyllanthus atripennis*	•	+	•	•	•	+	•	•	•	•	•	•
674	Scaly-breasted Illadopsis *Trichastoma albipectus*	+	+	+	+	+	+	÷	÷	+	+	+	•
675	Brown Illadopsis *T. fulvescens*	+	+	+	+	+	+	÷	•	+	+	•	•
676	Mountain Illadopsis *T. pyrrhopterum*	•	•	•	+	•	+	•	•	•	•	+	+
677	Pale-breasted Illadopsis *T. rufipennis*	÷	+	+	+	+	•	÷	÷	+	+	+	•
688	Black Cuckoo Shrike *Campephaga flava*	•	÷	+	•	•	+	•	÷	•	•	+	•
689	Petit's Cuckoo Shrike *C. petiti*	+	•	•	+	•	+	÷	÷	•	•	•	•
690	Red-shouldered Cuckoo Shrike *C. phoenicea*	•	+	•	+	•	+	•	•	•	•	•	•
691	Purple-throated Cuckoo Shrike *C. quiscalina*	•	•	•	•	•	•	•	•	+	+	+	•
693	Grey Cuckoo Shrike *C. caesia*	•	•	•	+	•	+	•	•	•	•	+	+
694	Grauer's Cuckoo Shrike *C. graueri*	•	•	•	•	•	•	•	•	•	•	•	+
697	Cameron Sombre Greenbul *A. curvirostris*	+	+	+	+	+	+	÷	÷	+	+	+	•
698	Slender-billed Greenbul *A. gracilirostris*	+	+	+	+	+	+	•	•	+	+	+	•
699	Little Grey Greenbul *A. gracilis*	•	+	+	+	+	•	•	÷	+	+	+	•
701	Yellow-whiskered Greenbul *A. latirostris*	+	+	+	+	+	+	÷	÷	+	+	+	+
702	Shelley's Greenbul *A. masukuensis*	•	•	•	+	•	+	•	•	•	•	+	•
704	Mountain Greenbul *A. tephrolaemus*	+	+	•	÷	•	+	•	•	•	•	+	+
705	Little Greenbul *A. virens*	+	+	+	+	+	+	÷	÷	+	+	+	•
706	Honeyguide Greenbul *Baeopogon indicator*	+	+	+	+	+	+	÷	÷	•	+	+	•

707	Green-tailed Bnstlebill *Bleda eximia*	•	+	+	•	+	•	•	•	+	+	•	•
708	Bristlebill *B. syndactyla*	+	+	+	+	+	+	÷	÷	+	+	+	•
709	Yellow-throated Leaflove *Chlorocichla flavicollis*	•	+	+	•	+	•	•	•	+	+	•	•
711	Joyful Greenbul *C. laetissima*	+	÷	•	+	•	+	•	•	•	+	+	•
712	Simple Greenbul *C. simplex*	•	+	•	•	•	•	•	•	•	•	•	•
713	Bearded Greenbul *Criniger barbatus*	•	+	•	•	•	•	•	•	•	•	•	•
714	Red-tailed Greenbul *C. calurus*	+	+	+	+	+	+	÷	•	•	+	+	•
715	Spotted Greenbul *Ixonotus guttatus*	•	•	+	•	+	•	•	÷	+	•	•	•
716	Nicator *Nicator Chloris*	+	+	+	+	+	+	÷	÷	+	+	+	•
717	Yellow-throated Nicator *Nicator vireo*	•	+	•	•	•	•	•	•	•	•	•	•
718	White-throated Greenbul *P. albigularis*	+	•	+	•	+	•	÷	÷	•	+	+	•
719	Toro Olive Greenbul *P. baumanni*	+	+	+	+	+	+	÷	÷	+	+	+	•
724	Yellow-streaked Greenbul *P. flavostriatus*	•	•	•	•	•	•	•	•	•	•	•	•
725	Icterine Greenbul *P. icterinus*	•	+	+	•	+	•	•	•	+	•	•	•
726	Sassi's Olive Greenbul *P. lorenzi*	•	+	•	•	•	•	•	•	•	•	•	•
727	Olive Mountain Greenbul *P. placidus*	+	+	•	+	+	+	•	÷	•	+	+	+
728	Leaflove *P. scandens*	•	+	•	•	+	•	•	•	•	+	•	•
731	Xavier's Greenbul *P. xavieri*	•	+	+	+	+	•	÷	÷	+	•	•	•
733	White-tailed Greenbul *T. leucopleurus*	•	+	•	•	•	•	•	•	•	•	•	•
734	Fire-crested Alethe *Alethe diademata*	+	+	+	+	+	+	•	•	+	+	•	+
736	Brown-chested Alethe *A.poliocephala*	+	+	+	+	+	+	÷	÷	+	+	+	+
737	Red-throated Alethe *A. poliophrys*	•	•	•	•	•	+	•	•	•	•	•	+
745	Northern Bearded Scrub Robin *C. leucosticta*	•	+	•	•	•	•	•	•	•	•	•	•
749	Robin Chat *Cossypha caffra*	•	•	•	•	•	•	•	•	•	•	+	•
750	Blue-shouldered Robin Chat *C. cyanocampter*	+	+	+	+	+	+	÷	÷	+	+	+	•
752	Red-capped Robin Chat *C. natalensis*	+	+	+	+	+	+	•	÷	÷	+	+	•
753	Snowy-headed Robin Chat *C. niveicapilla*	+	+	+	+	+	+	÷	•	+	+	+	+
754	White-bellied Robin Chat *C. roberti*	•	•	•	•	•	+	•	•	•	•	•	•
757	Archer's Ground Robin *Dryochichloides archeri*	•	•	•	•	•	+	•	•	•	•	•	+
761	Grey-winged Ground Robin *D. poliopterus*	+	•	•	•	•	+	•	•	•	+	+	•
772	White-tailed Ant Thrush *Neocossyphus poensis*	+	+	+	+	+	+	÷	÷	+	•	•	•
773	Red-tailed Ant Thrush *N. rufus*	+	+	+	+	÷	•	•	+	•	•	•	•
782	White-starred Forest Robin *Pogonocichla stellata*	•	•	•	•	•	+	•	•	•	•	•	•
785	Equatorial Akalat *Sheppardia aequatorialis*	+	+	+	+	•	+	•	÷	÷	•	+	•
786	Akalat *Sheppardia cyornithopsis*	•	+	•	•	•	•	•	•	+	•	+	•
789	Forest Robin *Stiphrornis erythrothorax*	+	+	+	+	+	•	•	•	+	+	•	•
790	Rufous Thrush *Stizorhina fraseri*	+	+	+	+	+	+	÷	•	+	+	•	•
793	Northern Olive Thrush *Turdus abyssinicus*	•	+	+	•	•	+	•	•	•	•	+	+
794	Black-eared Ground Thrush *T. camaronensis*	•	•	+	•	+	•	•	•	•	•	•	•
797	Prigogine's Ground Thrush *T. kibalensis*	+	•	•	•	•	•	•	•	•	•	•	•
800	Forest Ground Thrush *T. oberlaenderi*	•	+	•	•	•	•	•	•	•	•	•	•
801	African Thrush *T. pelios*	+	÷	+	+	+	+	÷	÷	÷	÷	+	•
802	Abyssinian Ground Thrush *T. piaggiae*	•	•	•	•	•	+	•	•	•	•	+	+
803	Kivu Ground Thrush *T. tanganyicae*	•	•	•	•	•	+	•	•	•	•	•	•
815	Masked Apalis *Apalis binotata*	+	•	•	•	•	+	•	÷	+	•	+	+
817	Grey Apalis *A. cinerea*	+	•	+	•	•	+	÷	•	•	•	+	•
819	Black-throated Apalis *A. jacksoni*	+	•	+	+	+	+	÷	÷	+	+	+	•
823	Black-capped Apalis *A. nigriceps*	•	•	+	•	+	•	•	•	•	+	•	•
824	Chestnut-throated Apalis *A. prophyrolaema*	•	•	•	•	•	+	•	•	•	•	+	+
826	Buff-throated apalis *A. rufogularis*	+	+	+	+	+	+	÷	÷	+	+	+	•
827	Collared apalis *A. ruwenzori*	+	•	•	•	•	+	•	•	•	•	•	+
829	Black-faced Rufous Warbler *B. cerviniventris*	+	+	•	+	•	+	•	÷	+	+	+	+
831	Bamboo Warbler *Bradypterus alfredi*	•	•	•	•	+	•	•	•	•	•	•	+
833	Evergreen Forest Warbler *B. barratti*	•	•	•	•	•	+	•	•	•	•	•	+

835 Cinnamon Bracken Warbler *B. cinnamomeus*	•	•	•	•	•	+	•	•	•	•	+	+
836 Grauer's Rush Warbler *B. graueri*	•	•	•	•	•	+	•	•	•	•	•	•
837 Grey-backed Camaroptera *C. brachyura*	+	+	+	+	+	+	÷	÷	+	+	+	÷
838 Olive-green Camaroptera *C. chloronota*	+	+	+	+	+	+	÷	•	+	+	+	•
841 Yellow-browed Camaroptera *C. superciliaris*	•	+	+	•	+	+	•	•	•	+	•	•
844 Mountain Yellow Warbler *C. similis*	•	•	•	•	•	+	•	•	•	•	+	+
861 Hunter's Cisticola *Cisticola hunteri*	•	•	•	•	•	•	•	•	•	•	+	•
882 Grauer's Warbler *Graueria vittata*	•	•	•	•	•	+	•	•	•	•	•	•
884 Short-tailed Warbler *Hemitesia neumanni*	•	•	•	•	•	+	•	•	•	•	•	•
889 Green Hylia *Hyliaprasina*	+	+	+	+	+	+	÷	÷	+	+	+	•
895 Grey Longbill *Macrosphenus concolor*	•	•	+	•	+	•	•	•	•	+	•	•
896 Yellow Longbill *M.flavicans*	•	+	+	•	+	•	•	•	+	+	•	•
901 Tit Hylia *Pholidornis rushiae*	•	•	•	•	•	•	•	•	•	+	•	•
903 Uganda Woodland Warbler *P. budongoensis*	•	•	+	+	•	•	•	•	•	•	+	•
905 Red-faced Woodland Warbler *P. laetus*	+	•	•	•	•	+	•	•	•	•	•	+
909 Brown Woodland Warbler *P. umbrovirens*	•	•	•	•	•	•	•	•	•	•	+	+
910 Banded Prinia *Prinia bairdii*	+	+	•	•	•	+	•	•	•	•	+	+
911 White-chinned Prinia *P. leucopogon*	+	+	+	+	+	+	÷	+	+	+	+	+
923 White-browed Crombec *Sylvietta leucophrys*	+	•	•	+	•	+	•	•	•	•	+	+
924 Green Crombec 5. *virens*	+	+	+	+	+	+	÷	•	+	+	+	•
926 Sooty Flycatcher *Artomyias fuliginosa*	+	+	+	+	+	•	÷	÷	•	+	•	•
931 Forest Flycatcher *Fraseria ocreata*	•	•	+	+	+	•	•	•	•	•	•	•
932 Yellow-eyed Black Flycatcher *M. ardesiaca*	•	•	•	•	•	+	•	•	•	•	•	•
933 White-eyed Slaty Flycatcher *M. chocolatina*	+	•	•	•	•	+	•	÷	•	•	+	+
936 Dusky Flycatcher *Muscicapa adusta*	•	•	•	+	•	+	÷	÷	+	+	+	+
939 Cassin's Grey Flycatcher *M. cassini*	+	+	+	•	•	+	+	•	•	•	•	•
940 Dusky Blue Flycatcher *M. comitata*	+	+	+	+	•	+	÷	•	•	+	•	•
942 Grey-throated Flycatcher *M. griseigularis*	+	+	+	+	+	+	÷	•	+	+	•	•
943 Chapin's Flycatcher *M. lendu*	•	•	•	•	•	+	•	•	•	•	•	•
944 Yellow-footed Flycatcher *M. sethsmithi*	•	•	+	•	•	•	•	•	•	•	•	•
948 Rwenzori Batis *Batis diops*	•	•	•	•	•	+	•	•	•	•	•	+
955 Black and White Flycatcher *Bias musicus*	+	+	•	+	•	+	÷	•	+	+	•	•
956 Shrike flycatcher *Megabyas flammulata*	+	+	+	+	+	+	÷	÷	+	+	•	•
957 Jameson's Wattle-eye *Platysteira blissetti*	+	+	+	+	+	+	÷	÷	+	+	+	•
958 Chestnut Wattle-eye *Platysteira Castanea*	+	+	+	+	+	+	÷	÷	+	+	+	•
959 Yellow-bellied Wattle-eye *P. concreta*	•	+	•	+	•	•	÷	•	•	•	•	•
962 White-tailed Blue Flycatcher *Erannornis albicauda*	•	•	•	•	•	+	•	•	•	•	•	•
963 Blue Flycatcher *E. longicauda*	•	+	+	+	÷	+	÷	•	+	+	+	+
966 Chestnut-capped Flycatcher *E. mccalli*	•	+	+	•	•	•	•	•	•	•	•	•
967 Red-bellied Paradise Flycatcher *T. rufiventer*	+	+	+	+	+	•	•	÷	+	+	•	•
968 Paradise Flycatcher *T. viridis*	+	+	+	+	+	+	÷	•	÷	•	+	+
969 White-bellied Crested Flycatcher *T. albiventris*	+	•	•	•	•	+	•	•	•	•	•	•
970 White-tailed Crested Flycatcher *T. albonotatus*	+	+	•	•	•	+	•	•	•	•	+	+
971 Crested Flycatcher *T. cyanomelas*	+	•	•	•	•	•	÷	÷	÷	•	•	•
972 Dusky Crested Flycatcher *T. nigromitratus*	•	+	+	+	+	+	÷	•	+	+	+	•
973 Blue-headed Crested Flycatcher *T. nitens*	•	+	•	•	•	•	•	•	÷	+	•	•
998 Pink-footed Puffback *Dryoscopus angolensis*	+	•	+	+	•	+	÷	•	+	+	+	•
1000 Northern Puffback *D. gambensis*	•	+	•	+	+	+	•	•	•	•	+	+
1002 Red-eyed Puffback *D. senegalensis*	•	+	•	•	•	•	•	•	•	•	•	•
1004 Tropical Boubou *Laniarius ferrugineus*	+	+	+	+	+	•	•	•	÷	+	+	+
1005 Fulleborn's Black Boubou *L. fuelleborni*	•	•	•	•	•	+	•	•	•	•	•	+
1007 Sooty Boubou *L. leucorphynchus*	•	+	•	•	•	•	•	•	•	+	•	+
1008 Luhder's Bush Shrike *L. luehderi*	+	+	•	+	•	+	•	÷	•	+	+	÷
1013 Grey-green Bush Shrike *Malaconotus bocagei*	+	+	•	+	+	+	•	•	•	+	•	•

1014	Fiery-breasted Bush Shrike *M. cruentus*	•	+	•	•	•	•	•	•	•	•	•	•
1015	Doherty's Bush Shrike *M. dohertyi*	•	•	•	•	•	+	•	•	•	•	+	•
1016	Lagden's Bush Shrike *M. lagdeni*	•	•	•	•	•	+	•	•	•	•	•	+
1017	Many-coloured Bush Shrike *M. multicolor*	+	•	•	•	•	+	•	•	•	•	+	•
1019	Sulphur-breasted Bush Shrike *M. sulfureopectus*	•	•	•	•	+	•	•	•	•	•	+	+
1042	Red-billed Helmet Shrike *Prionops caniceps*	•	+	•	•	+	•	•	•	•	•	•	•
1048	Violet-backed Starling *Cinnyricinclus leucogaster*	+	+	+	+	•	+	•	•	÷	+	+	•
1049	Sharpe's Starling *C. sharpii*	•	•	•	•	•	+	•	•	•	•	+	+
1058	Purple-headed Glossy Starling *L. purpureiceps*	+	+	+	+	+	+	÷	÷	÷	+	+	•
1061	Splendid Glossy Starling *L. splendidus*	+	+	+	+	+	•	÷	÷	+	+	+	•
1063	Chestnut-winged Starling *Onychognathus fulgidus*	+	+	+	•	+	•	•	•	•	+	•	•
1066	Slender-billed Chestnut-winged Starling *O.tenuirostris*	•	•	•	•	•	+	•	•	•	•	•	+
1067	Waller's Chestnut-winged Starling *O. walleri*	+	•	•	+	•	+	÷	•	•	•	+	•
1069	Narrow-tailed Starling *Poeoptera lugubris*	+	+	•	+	•	+	•	÷	•	•	•	•
1070	Stuhlmann's Starling *P. stuhlmanni*	+	•	+	+	•	+	•	•	•	•	+	•
1080	Collared Sunbird *Anthreptes collaris*	+	+	+	+	+	+	÷	÷	+	+	+	+
1081	Grey-headed Sunbird *A. fraseri*	+	+	+	+	+	+	÷	•	•	+	+	•
1087	Green Sunbird *A. rectirostris*	+	+	+	+	+	+	•	•	+	+	+	•
1090	Blue-headed Sunbird *Nectarinia alinae*	+	•	•	•	•	+	•	•	•	•	•	+
1093	Orange-tufted Sunbird *N. bouvieri*	+	+	•	+	+	•	•	•	+	+	•	•
1094	Olive-bellied Sunbird *N. chloropygia*	+	+	+	+	+	+	÷	•	+	+	+	•
1097	Blue-throated Brown Sunbird *N. cyanolaema*	+	+	+	+	+	+	÷	÷	•	+	•	•
1105	Montane Double-collared Sunbird *N. ludovicensis*	•	•	•	•	•	+	•	•	•	•	•	•
1109	Tiny Sunbird *N. minula*	+	+	•	•	•	•	•	•	•	•	•	•
1112	Olive Sunbird *N. olivacea*	+	+	+	+	+	+	÷	÷	+	+	+	÷
1115	Northern Double-collared Sunbird *N. preussi*	•	+	•	•	•	+	•	•	•	•	+	+
1117	Purple-breasted Sunbird *N. purpureiventris*	•	+	•	+	•	+	•	•	•	•	•	+
1118	Regal Sunbird *N. regia*	•	•	•	•	•	+	•	•	•	•	•	+
1119	Golden-winged Sunbird *N. reichenowi*	•	•	•	•	•	•	•	•	•	•	+	+
1120	Green throated Sunbird *N. rubescens*	+	+	+	+	+	+	÷	÷	•	+	•	•
1121	Little Green Sunbird *N. seimundi*	•	+	+	+	+	+	÷	•	+	÷	•	÷
1124	Stuhlmann's Double-collared Sunbird *N. stuhlmanni*	•	•	•	•	•	•	•	•	•	•	•	+
1125	Superb Sunbird *N. superba*	+	+	+	+	+	+	÷	•	+	+	•	•
1126	Tacazze Sunbird *N. tacazze*	•	•	•	•	•	•	•	•	•	•	+	•
1128	Variable Sunbird *N. venusta*	+	+	+	+	+	+	•	÷	+	÷	+	+
1130	Green-headed Sunbird *N. verticalis*	+	+	+	+	+	+	÷	÷	+	+	+	+
1133	Yellow White-eye *Zosterops senegalensis*	+	+	+	+	+	+	÷	÷	÷	÷	•	+
1152	Red-bellied Malimbe *Malimbus erythrogaster*	•	+	•	•	•	•	•	•	•	•	•	•
1153	Crested Malimbe *M. malimbicus*	•	+	+	+	+	•	•	•	+	•	•	•
1154	Blue-billed Malimbe *M. nitens*	•	+	•	•	•	•	•	•	•	•	•	•
1155	Red-headed Malimbe *M. rubricollis*	+	+	+	+	+	+	÷	÷	+	+	+	•
1156	Maxwell's Black Weaver *Ploceus albinucha*	•	+	•	•	•	•	•	•	•	•	•	•
1157	Strange Weaver *P. alienus*	•	•	•	•	•	+	•	•	•	•	•	+
1159	Stuhlmann's Weaver *P. baglafecht*	+	+	+	+	•	+	÷	•	+	+	+	+
1161	Dark-backed Weaver *P. bicolor*	+	+	+	+	•	•	•	•	•	•	+	•
1169	Brown-capped Weaver *P. insignis*	+	•	+	+	•	+	•	•	•	•	+	+
1174	Black-billed Weaver *P. melanogaster*	+	•	•	+	•	+	÷	•	•	+	+	•
1175	Vieillot's Black Weaver *P. nigerrimus*	+	+	+	+	+	+	÷	÷	+	+	+	•
1177	Spectacled Weaver *P. ocularis*	+	+	+	+	÷	•	•	•	+	•	+	+
1179	Slender-billed Weaver *P. pelzelni*	+	+	•	+	•	•	•	•	+	•	•	•
1184	Compact Weaver *P. superciliosus*	+	+	+	+	+	+	÷	÷	+	+	+	•
1186	Yellow-mantled Weaver *P. tricolor*	+	+	+	+	+	+	•	•	•	+	•	•

1188 Weyns' Weaver *P. weynsi*	•	•	+	•	+	•	•	•	+	+	+	•
1220 Dusky Twinspot *Clytospiza cinereovinacea*	•	•	•	•	•	+	•	•	•	•	•	•
1221 Brown Twinspot *C. monterii*	•	•	+	•	÷	•	•	•	•	•	•	•
1222 Dusky Crimson-wing *Cryptospiza jacksoni*	•	•	•	•	•	+	•	•	•	•	•	+
1223 Red-faced Crimson-wing *C. reichenovii*	+	•	•	•	•	+	•	•	•	•	•	+
1224 Abyssinian Crimson-wing *C. salvadorii*	•	•	•	•	•	+	•	•	•	•	+	+
1225 Shelley's Crimson-wing *C. shelleyi*	•	•	•	•	•	+	•	•	•	•	•	+
1227 Black-headed Waxbill *Estrilda atricapilla*	•	•	•	•	•	+	•	•	•	•	+	•
1242 Green-backed Twinspot *Mandingoa nitidula*	+	+	+	+	+	+	÷	÷	+	+	•	•
1244 Grey-headed Olive-back *Nesoaiaris ansorgei*	+	•	+	•	•	•	•	•	•	•	•	•
1245 Chestnut-breasted Negrofinch *Nigrita bicolor*	•	+	+	+	•	•	•	•	•	•	•	•
1246 Grey-headed Negrofinch *N. canicapilla*	+	+	+	+	+	+	÷	÷	+	+	+	+
1247 White-breasted Negrofinch *N. fusconota*	+	+	+	+	+	+	•	•	•	+	+	•
1248 Pale-fronted Negrofinch *N. luteifrons*	•	+	•	•	•	•	•	•	•	•	•	•
1252 Red-fronted Antpecker *Parmoptila woodhousei*	+	+	+	+	•	+	÷	•	•	•	•	•
1254 Black-bellied Seed-cracker *Pyrenestes ostrinus*	+	+	+	+	+	•	•	•	+	+	•	•
1258 Grant's Bluebill *Spermophaga poliogenys*	•	+	•	•	•	•	•	•	•	•	•	•
1259 Red-headed Bluebill *S. ruficapilla*	+	+	+	+	+	+	÷	+	+	+	+	÷
1265 Black and White Mannikin *Lonchura bicolor*	+	+	+	+	+	+	÷	÷	+	+	+	+
1267 Magpie Mannikin *L. fringilloides*	•	+	•	•	•	•	•	•	•	•	•	•
1279 Oriole Finch *Linurgus olivaceus*	•	•	•	•	•	+	•	•	•	•	+	•
1281 Thick-billed Seed-eater *S. burtoni*	•	•	•	+	•	+	÷	÷	•	•	+	+

Appendix C. List of diurnal forest primate species recorded from twelve of Uganda's principal forest reserves. + denotes species presence recorded in the literature prior to this study; + denotes species recorded for the first time during this study; • denotes species not recorded. Forests are numbered as: 1 = Kibale, 2 = Semliki, 3 = Budongo, 4 = Kalinzu-Maramagambo, 5 = Bugoma, 6 = Bwindi, 7 = Kasyoha-Kitomi, 8 = Itwara, 9 = Sango Bay, 10 = Mabira, 11 = Mount Elgon,

PRIMATE SPECIES	FOREST NUMBER 1	2	3	4	5	6	7	8	9	10	11	12
Black and white colobus, *Colobusguerezaoccidentalis*	+	+	+	+	+	+	+	+	•	•	+	•
Black and white colobus, *Colobusangolensisruwenzorii/adolfi-friederici*	•	•	•	•	•	•	•	•	+	•	•	+
Red colobus, *Colobus badius tephrosceles*	+	•	•	•	•	•	•	•	•	•	•	•
Black mangabey, *Cercocebusalbigenajohnstoni*	+	+	•	•	+	•	•	•	+	+	•	•
Baboon, *Papio anubis*	+	+	+	+	+	+	+	+	÷	•	•	•
Red-tail monkey, *Cercopithecusascaniusschmidti*	+	+	+	+	+	+	+	+	+	+	•	•
L'Hoests monkey, *Cercopithecusl'hoesti*	+	•	•	+	•	+	÷	÷	•	•	•	+
Blue monkey, *Cercopithecusmitisstuhlmanni/doggetti*	+	+	+	+	+	+	+	+	+	•	+	+
De Brazza's monkey, *Cercopithecusneglectus*	•	+	•	•	•	•	•	•	÷	•	•	•
Mona monkey, *Cercopithecuspogonias*	•	+	•	•	•	•	•	•	•	•	•	•
Chimpanzee, *Pan troglodytes*	+	+	+	+	+	+	+	+	•	•	•	+
Mountain gorilla, *Gorillagorillaberingei*	•	•	•	•	•	+	•	•	•	•	•	•

Appendix D. List of forest butterflies of the family Papilionidae, and the *Charaxes* genus of the family Nymphalidae, from twelve of Uganda's principal forest reserves. + denotes species recorded in the literature and/or represented in collections at the National Museums of Kenya, Kawanda Agricultural Research Station, British Museum of Natural History, and the private collections of Mr S. C. Collins of Nairobi and Mr D. Pasteur of Bromsgrove; + denotes species recorded for the first time during this study; • denotes species not recorded. Forests are numbered as: 1 = Kibale, 2 = Semliki, 3 = Budongo, 4 = Kalinzu-Maramagambo, 5 = Bugoma, 6 = Bwindi, 7 = Kasyoha-Kitomi, 8 = Itwara, 9 = Sango Bay, 10 = Mabira, 11 = Mount Elgon, 12 = Rwenzori. Non-forest members of the taxa are excluded, as are species of 'black *Charaxes'* which are difficult to distinguish.

BUTTERFLY SPECIES OF THE FAMILY PAPILIONIDAE	FOREST NUMBER 1	2	3	4	5	6	7	8	9	10	11	12
Papilio antimachus	+	+	+	+	•	+	•	•	•	•	•	•
P. leucotaenia	+	+	+	+	+	+	÷	÷	+	+	•	•
P. cynorta	+	+	+	+	÷	+	•	÷	+	+	+	•
P. jacksoni	•	+	•	•	•	+	•	•	•	•	+	+
P. rex	+	+	•	•	÷	+	•	•	+	+	+	+
P. charopus	+	•	•	+	÷	+	÷	•	•	•	•	•
P. mackinnoni	+	•	•	+	•	+	•	÷	•	•	+	+
P. sosia	+	+	+	+	+	•	•	•	•	+	•	•
P. nireus	+	+	+	+	+	+	•	•	+	+	+	+
P. bromius	+	+	+	+	+	+	÷	÷	+	+	+	÷
P. mechowi	+	+	+	•	•	+	÷	•	÷	+	•	•
P. zenobia	+	+	•	÷	•	+	•	•	+	•	•	•
P. lormieri	+	+	+	+	+	+	÷	÷	+	+	+	÷
P. demodocus	+	+	+	+	+	+	÷	÷	+	+	+	•
P. phorcas	+	+	+	+	+	+	÷	÷	+	+	+	•
P. dardanus	+	+	+	+	+	+	÷	÷	+	+	+	•
P. heperus	+	+	+	+	•	+	•	•	+	+	•	•
P. nobilis	+	•	•	+	÷	+	•	÷	+	+	+	•
Graphium ridleyanus	•	+	•	+	•	+	•	•	+	•	•	•
G. almansor	+	+	+	+	÷	+	•	•	+	•	+	•
G. ucalegon	+	+	•	•	+	•	•	•	•	•	•	•
G. leonidas	+	+	+	+	÷	+	•	•	+	+	+	•
G. latreillanus	•	+	•	•	•	•	•	•	•	•	•	•
G. policenes	+	+	+	+	+	+	÷	÷	+	+	+	•
G. antheus	+	+	+	+	+	+	÷	•	+	+	•	•
G. gudenusi	•	•	•	•	•	+	•	•	•	•	•	•
CHARAXES SPECIES												
C. varanes	+	+	+	+	÷	+	•	•	+	+	+	•
C. fulvescens	+	+	+	+	+	+	÷	÷	+	+	+	•
C. acuminatus	•	+	•	•	•	+	•	•	•	•	+	+
C. candiope	+	+	+	÷	÷	+	÷	÷	+	+	+	+

C.protoclea	+	+	+	+	÷	+	•	÷	+	+	•	•
C. boueti	•	•	•	•	•	+	•	•	•	•	•	+
C. cynthia	+	+	+	•	+	+	•	÷	+	+	+	•
C. lucretius	+	+	+	•	÷	+	+	•	+	+	•	•
C. castor	+	+	+	+	+	+	•	÷	+	+	+	•
C. brutus	+	+	+	+	+	+	÷	÷	+	+	+	÷
C. ansorgei	•	•	•	•	•	+	•	•	•	•	+	+
C. pollux	+	+	•	+	÷	+	÷	÷	+	•	+	•
C. druceanus	•	•	•	•	•	+	•	•	•	•	+	+
C. eudoxus	+	+	+	+	•	+	•	•	+	•	+	•
C. numenes	+	+	+	+	+	+	÷	÷	+	+	+	•
C.smaragdalis	+	+	+	+	+	+	÷	•	+	+	+	•
C. tiridates	+	+	+	+	+	+	÷	÷	+	+	+	•
C. bipunctatus	+	+	+	+	+	+	•	•	•	+	+	•
C. xiphares	•	•	•	•	•	+	•	•	•	•	•	•
C. ameliae	+	+	+	+	+	•	•	•	+	+	•	•
C. imperialis	•	+	+	+	•	+	•	•	+	•	•	•
C. pythodorus	+	•	+	•	÷	+	•	•	+	+	+	•
C. hadrianus	•	+	•	•	•	•	•	•	+	•	•	•
C. nobilis	•	•	•	+	•	•	•	•	+	•	•	•
C. fournierae	•	•	•	•	•	+	•	•	•	•	•	•
C. kahldeni	•	+	•	•	+	+	•	÷	•	•	•	•
C. zoolina	+	•	+	•	+	+	•	÷	+	•	+	+
C. eupale	+	+	+	÷	÷	+	÷	÷	+	+	+	+
C. subornatus	•	+	+	•	+	+	•	•	+	+	•	•
C. montis	•	•	•	•	•	+	•	•	•	•	•	+
C. pleione	+	+	+	+	+	+	•	÷	+	+	+	•
C. paphianus	+	+	+	+	+	+	•	÷	+	+	+	•
C. zingha	•	+	+	•	+	•	•	•	+	+	•	•
C. etesipe	+	+	+	+	÷	+	•	÷	+	+	+	•
C.anticlea	+	+	+	÷	+	+	÷	•	+	+	+	•
C. opinatus	•	•	•	•	•	+	•	•	•	•	•	+
C.hildebrandti	•	+	•	•	•	+	•	•	•	•	•	•
C. nichetes	•	•	•	•	•	•	•	•	•	•	•	•
C. porthos	+	•	+	•	÷	•	•	•	+	+	•	•
C. zelica	•	+	+	•	•	•	•	•	•	+	•	•
C. laodice	•	+	•	•	•	•	•	•	•	•	•	•

Forest Profiles: Introduction and Explanation

In the following pages I provide a profile of each of the twelve principal forests, which summarizes the most important features from a conservation perspective, and documents the results of survey work carried out under this programme. The format adopted is based on that used for the protected areas database of the World Conservation Monitoring Centre, Cambridge, UK, and the profiles are intended as a reference source for those with an interest in particular forests. It must be emphasized however, that it has not been possible to include reference to all relevant previous work, and readers who require a more comprehensive understanding of any particular forest will find the 'principal reference material' listed a useful starting point.

I am aware of a number of inaccuracies and inconsistencies in these profiles, which it has been difficult to eliminate or reconcile. This is because much of the information is based on previous works, which frequently disagree one with another. Whilst every effort has been made to ensure accuracy, the following explanation of information sources, methods, and criteria used in the compilation of these profiles will help the reader appreciate these shortcomings. I refer to the subheadings used throughout the profiles:

Date Established: This is the date when the forest was first legally gazetted as a Forest Reserve. Information is from the latest Working Plan for the forest concerned.

Geographical Location: The location of the forest is described in terms of administrative districts and counties, as well as longitude and latitude. The best available maps of the forest (at 1:50,000 or larger) are listed. Location maps are provided within the forest types map, and elsewhere.

Area: The areas of the gazetted Forest Reserve (in km2), and details of boundary demarcation as described in the Working Plan are given, together with comments on the present state of the boundaries as determined by personal observation and the reports of Forest Department staff. Adjacent land use is noted, and where the Reserve adjoins other protected areas, these are listed.

Altitudinal Range: The total range, in metres, is derived from examination of 1:50,000 scale maps of the forest. A map is included to show contour intervals of 250m, and the area of the reserve lying within each interval has been estimated by counting squares (or parts thereof) of the national grid.

Physical features: The physical geography, geology, and climate are summarised from the forests' Working Plan. In several cases temperature and rainfall figures are based on observation at one recording station, and may not reflect the range of conditions experienced in different parts of a reserve.

Survey work conducted under the project: A list of work undertaken in the reserve as part of this project is provided, together with a map showing the survey routes followed, transects established, vegetation sampling plots and mistnetting locations. Maps depict lines of the national grid, and all fieldwork locations are shown within 500m of their true location.

The results of project survey work are presented as (a) maps depicting presence/absence of particular species of large mammal or human activity in each 1 km2 compartment that was surveyed (b) tabulated results of line transect primate censuses, and (c) graphs depicting tree species-area relationships. The methods used are described in the main body of the report (Chapters Two, Three), and their limitations discussed in Appendix Q.

Vegetation: The vegetation is described in terms of the amount of the Forest Reserve that is covered by forest as opposed to other vegetation types, and in terms of the forest types and their characteristic species. In most profiles, a Table is included which shows the area of each forest type: the figures here are taken from the relevant forest Working Plan, and are based on Forest Department interpretation of 1950s aerial photographs. Forest-type maps have been produced by Forest Department for most of the major forests, and the areas of different forest types shown in the Working Plans (and these profiles) were calculated from planimeter measurements of these maps.

Where assessments of tree species-area relationships were made, the results are presented.

Acomprehensive list of the tree species recorded in each forest is provided elsewhere (Appendix A), and the forest profile serves to highlight the total number of species recorded (and the corresponding proportion of Uganda's total represented), and draw attention to those species that occur in a particular forest as part of a very limited Ugandan distribution. Only species which are recorded from a maximum of four of the principal forests are considered for mention here.

Species that are listed in FAO's (1986) "Databook on endangered tree and shrub species and provenances" are mentioned, although they may be locally abundant and in no immediate danger of extinction. Mention is also made of non-timber tree species that are of economic importance.

Fauna: A comprehensive list of the bird, primate and (selected) butterfly species recorded in each forest is provided elsewhere (Appendices B,C,D), and the forest profiles serve to highlight the total number of species recorded in each group (and the corresponding proportion of Uganda's total represented), and draw

attention to those species that occur in a particular forest as part of a very limited Ugandan distribution. Only species that are recorded from a maximum of four of the principal forests are considered for mention here.

Species that are regarded internationally as being threatened with extinction (or nearly so), and are listed in IUCN's Red Data Books are given special mention.

Large mammal records made during the ground survey are summarized in terms of the proportion of survey compartments in which any given species was recorded, and primate census data arising from this study are presented.

Economic Importance: The principal economic activities including, in particular, the history of timber extraction, are outlined. Wherever any timber inventory work has been carried out, the results are reported, as an indication of perceived (historical) timber values. Most of the information presented in this section is taken from the forest's Working Plan, together with other documentary sources, Forest Department records, and personal observations.

Present Status: The best available information on the present status of each reserve is summarized with the help of a map and Table showing the areas of each forest type that have been affected to varying degrees by different human activities. Definitions of the various categories of human disturbance are provided in Chapter Three (Section 2). Here I am concerned only with the status of the forest vegetation, not the forest fauna (which is much more difficult to assess).

The quality of the information available for different forests is highly variable, and closely correlated with the amount of fieldwork carried out on this project in each area. This can easily be evaluated by reference to the maps depicting ground survey routes in each forest profile. Clearly, where I did not reach a particular part of a forest (or overfly it) the information I include on that area's status is based on second hand information (of unknown accuracy), or worse still, extrapolation. Generally speaking, I have tended to assume that an area is 'undisturbed' unless these is evidence to the contrary - which means that I am reporting a 'best case scenario'. Nevertheless, despite these caveats, I believe that the information presented is generally accurate, and certainly the best available for the mid-1980s.

The proportion of survey compartments in which evidence of hunting was found is noted, as a crude indication of hunting pressure. The relative abundance of the principal large mammals (expressed in terms of the proportion of survey compartments in which the species was recorded) may provide a useful basis for the future monitoring of some large mammal populations.

Management: Information on the infrastructure and staffing of each reserve in early 1988 was obtained from the relevant District Forest Officer. Reference is made to the latest Working Plan (management plan), and the specified objectives of management, although these are all now out-of-date. Access routes are described, and where I have specific knowledge of timber trials, these are mentioned (N.B. a very incomplete record). Designated Nature Reserves are mentioned and shown on accompanying maps, as depicted on the original management maps held at Forest Department headquarters.

Conservation Importance: This section provides a summary of the importance of the forest for biological conservation by reference to the following considerations:

-the number of species of different taxa recorded;
-the number of species unique to this forest, or restricted to this forest in the Ugandan part of their ranges;
-the area's potential as a tourist destination;
-the occurrence of species considered to be under worldwide threat of extinction;
-the altitude at which it occurs;
-its proximity to other protected areas;
-its proximity to the site of postulated Pleistocene forest refugia.

Threats: The various threats to each forest are reviewed in the light of my own experience of the areas concerned, and (rather subjective) assessments of the pressures they were under in mid-1988.

Recommendations: Specific recommendations are made for each forest on the establishment and siting of Nature Reserves, and other important conservation actions.

Principal Reference Material: Reference is made to major works of broad relevance to the conservation and management of the forest concerned. Highly specialized works (including some theses) and short scientific papers are not listed.

Appendix E. Profile of the Kibale Forest Reserve

Date Established: 1932

Geographical Location: Southeast of Fort Portal in western Uganda. The reserve is located in Burahya, Kibale and Mwenge Counties in the administrative district of Kabarole, 0°12'-0°40' N, 30°20'-30°35' E. Covered by Uganda Department of Lands and Surveys maps sheets 56/IV, 57/III, 66/II, 66/IV, and 67/I (Series Y732) at 1: 50,000.

Area: 560 km^2, originally demarcated with cut and cairned boundary lines, except in the northwest between Sebitoli and Isunga where approximately 48 km of boundary was marked with live tree markers. The boundary line has received little or no maintenance for at least a decade. The reserve is contiguous with the Kibale Forest Corridor Game Reserve (340 km^2, of which 134 km^2 has dual status and lies within the Kibale Forest Reserve) along 32 km of boundary, which is itself contiguous with a network of other protected areas via the Queen Elizabeth National Park (1978 km^2). Most of the boundary adjoins agricultural smallholdings.

Altitudinal Range: 1,110-1,590 m. 69 km^2 of the reserve lies below 1,250 m, 464 km^2 at 1,250-1,500 m and 27 km^2 above 1,500 m (Fig. E1.1).

Physical Features: The reserve occupies undulating terrain on the main Uganda plateau and is drained by the Mpanga and Dura rivers in a southerly direction towards Lake George. The underlying rocks are sedimentary, strongly folded and metamorphosed, overlain by red ferralitic sandy loams of low to moderate fertility except for a small area in the west where fertile eutrophic soils occur on volcanic ash. The climate is tropical with two rainfall peaks from March to May and September to November. Annual mean temperature range, minimum: 14-15° C, maximum: 26-27° C. Annual rainfall: 1,100-1,600 mm.

Survey Work Conducted under this Project:

- seventy primate censuses, and associated vegetation sampling along five 4-6 km line transects located in mechanically harvested and undisturbed forest types (see Fig. E1.1 and Table E2).

Vegetation: Seventy-seven percent of this reserve is occupied by various types of forest vegetation, that can be broadly classified as medium altitude moist evergreen forest in the north, and medium altitude moist semi-deciduous forest at lower altitudes in the south (Langdale-Brown *et al*, 1964; Osmaston, 1959; Wing and Buss, 1970). The remaining 23% of the reserve is occupied by grassland and swamp communities, some of which have now been planted with exotic conifers (Table E1). In many parts the grassland is being colonised by natural forest.

Mixed forest communities, in which species such as *Olea welwitschii*, *Aningeria altissima*, *Strombosia scheffleri*, *Newtonia buchanani*, *Chrysophyllum* spp., *Celtis* spp., *Diospyros abyssinica* and *Markhamia platycalyx* are characteristic, occupy about 29% of the reserve at intermediate altitudes in the centre (Fig. E1). The higher-lying areas in the north support *Parmari*-dominated forest, which may represent the typical successional climax type at this altitude in Uganda. At lower altitudes in the south the most mature forest is dominated by *Pterygota mildbraedii* (9% of the reserve) or *Cynometra alexandri* (2% of the reserve). Along the forest margins, particularly in the northeast and the south are various colonising and poor types of forest which together account for 25% of the reserve's area.

Trees exceeding 10 cm dbh were enumerated in 20x20 m quadrats located at 200 m intervals along five line transects (see Fig. E1.1 for transect locations) representing disturbed and undisturbed mixed, *Parmari*-dominated and Pterygota-dominated forest types. Tree species-area relationships derived from these enumerations are shown in Fig. E2.

The trees of Kibale are now reasonably well known. Two hundred and nine forest species (49% of the country's total) have been recorded. All are known from at least one other Ugandan locality, but the following are noteworthy as species that occur in Kibale as part of a very limited range in western Uganda: *Elaeophorbia* sp. nov., *Cola bracteata, Dasylepis racemosa, Oncoba routledgei, Dovyalis macrocarpa, Isolona congolana, Tabernaemontana odoratissima,* and *Hannoa longipes.* Four important timber species from this reserve are listed as endangered: *Chlorophora excelsa, Cordia millenii, Entandrophragma angolense* and *Lovoa swynnertonii* (FAO, 1986). Non-timber trees of economic importance include wild robusta coffee, *Coffea canephora.*

Fauna: The fauna of this reserve is much better known than any other in Uganda, and includes 177 species of forest bird (54% of the country's total), 8 species of diurnal forest primate (67% of the country's total), and 45 species of forest swallowtail and *Charaxes* butterfly (66% of the country's total). Of these, the red colobus monkey *(Colobus (badius) tephrosceles)* occurs nowhere else in Uganda, and Prigogine's ground thrush *(Turdus kibalensis)* is endemic to this forest. Otherwise, all species are known from elsewhere in Uganda, although the following are noteworthy on account of their rather limited distributions: olive long-tailed cuckoo *(Cercococcyx olivinus),* western green tinkerbird *(Pogoniulus coryphaeus),* Willcock's honeyguide *(Indicator willcocksi),* collared apalis *(Apalis ruwenzori),* red-faced woodland warbler *(Phylloscopus laetus),* white-bellied crested flycatcher *(Trochocercus albiventris),* narrow-tailed starling *(Poeoptera lugubris),* blue-headed sunbird *(Nectarinia alinae),* and tiny sunbird *(Nectarinia minulla).* Threatened or near-threatened species that are known to occur in this reserve are: elephant *(Loxodonta africana),* leopard *(Panthera pardus),* chimpanzee *(Pan troglodytes),* red colobus monkey *(Colobus badius)*, l'hoest's monkey *(Cercopithecus l'hoesti)* , Prigogine's ground thrush *(Turdus kibalensis)* (known from two specimens collected in 1966, but not recorded since), Nahan's francolin *(Francolinus nahani),* white-naped pigeon *(Columba albinucha)* and African giant swallowtail butterfly *(Papilio antimachus).*

There are no large mammal distribution records for this forest, because no ground survey was undertaken here. The population densities of primates calculated from census statistics at five sites are given in Table E2.

Economic Importance: The forest has been exploited as a source of commercial timber since 1950 when a sawmill was established in the north of the forest. This mill operated more-or-less continuously until 1985, and felled approximately 74 km^2 of forest, chiefly of the *Parinari* and mixed types. Based on a 1% enumeration carried out in the north and central blocks of the forest in 1954-56, it is estimated that this area of the forest carried 62 m^3 of standing timber exceeding 50 cm dbh per hectare. The block to the south of the Fort Portal - Kamwenge road was enumerated in the early 1970s and estimated to contain 69 m^3 per hectare (Lockwood Consultants, 1973). There is no information available on the number of pitsawyers operating in this forest. Wild coffee has been harvested for many years, the first licence being issued in 1932. During the early years the Kibale crop averaged about 40 tons per annum, but very little is thought to be harvested at present. The forest is used by local people as a source of bushmeat, building poles, medicinal compounds and other products, although some of these materials are still relatively freely available in small pockets of forest which remain on public land outside the reserve. Illegal agricultural crops are grown in the reserve.

Present Status: Fig. E1.2 and Table E1 show the areas of different vegetation types which have been felled to supply the sawmill; which have been severely affected by agricultural encroachment; and those the status of which is unknown. Since no survey of this forest was carried out under this project, information is based on survey work carried out in 1982 by Van Orsdol (1983). The status of 67% of the forested land within the reserve remains unknown, while 17% has been felled by the sawmill and 16% has been affected by encroachment. Substantial areas of all forest types may remain in a relatively undisturbed state, except for the *Parinari*-foiesl type, 82% of which has been felled.

Agricultural encroachment affects approximately 100 km^2 of this reserve, principally in the lower-lying southern portion along its western boundary with the Kibale Forest Corridor Game Reserve (Fig. E1.1). A census of encroachers was carried out by the Forest Department in March 1987, from which it was determined that 876 households were established within the Forest Reserve (Okech-Okot, pers. comm.) (a much greater number was in the adjacent Game Reserve). Based on Van Orsdol's figure for an average household cultivation area of 2.8 ha, this would mean a total cultivation area of approximately 25 km^2, or active cultivation of 25% of the land shown as affected by encroachment in Fig.E1.1 and Table E1. Van Orsdol estimated the number of households within the reserve at 640-960 in 1982, so it appears that the encroachment problem did not worsen over the 1982-87 period.

There are two nature reserves, which together account for 62 km^2 or 11% of the forest reserve's total area. In addition a research plot, covering 16 km^2 of mostly undisturbed mature forest (representing 3% of the reserve) is protected from human exploitation adjacent to the Kanyawara Forest Station. These specially protected areas are patrolled by staff of the Game Department (supported by the Kibale Forest Project) which significantly reduces hunting pressure here. As a result, animals such as red duiker *(Cephalophus callipygus),* which are rarely seen elsewhere, are quite frequently encountered. A small population of elephant *(Loxodonta africana)* survives, although their traditional migration route to the lowlands of the Queen Elizabeth National Park is now 'blocked' by illegal settlement of the Kibale Forest Corridor Game Reserve.

Management: The reserve is managed from the Kabarole District Forest Office, Fort Portal. Two foresters, two forest rangers and about six forest guards are assigned to protect the reserve, stationed at Sebitoli and Kanyawara Forest Stations and Bigodi and Kamwenge Guard Posts. There is good access provided by the main Kampala-Fort Portal road which passes through the reserve for 4 km, by the Fort Portal-Kamwenge road which passes through it for 8 km, and by means of several other smaller roads.

The latest Working Plan was prepared in 1967 and prescribes for the conversion of the bulk of the forest to a uniform system by clear felling (or nearly so) on a 70-year rotation; and for the establishment of plantation softwoods in the grasslands. Secondary management objectives are the production of wild coffee and wood-fuel, the preservation of the forest's beneficial environmental qualities, research, and the preservation of nature reserves and amenity values.

The Kanyawara Forest Station has provided a headquarters for the New York Zoological Society's Kibale Forest Project. This project has sponsored research work on various aspects of forest ecology, particularly primatology, over a period of 17 years, and represents one of the most comprehensive long-term research programmes yet undertaken in the African rainforest. Under the terms of a recent agreement between New York Zoological Society and Makerere University, a biological field station is to be constructed at Kanyawara.

Conservation Importance:

- this reserve supports an exceptionally diverse and abundant primate fauna.
- by virtue of the forest's accessibility, and its large number of primates, it offers considerable scope for the development of tourism.
- the forest's location close to the site of a postulated Pleistocene forest refugium in the Semliki valley (Hamilton, 1981) has resulted in a diverse present-day community of forest species, including many Congo basin species on the eastern limits of their ranges.
- the reserve supports nine species of animal considered to be globally threatened, or nearly so. The list includes Prigogine's ground thrush, a bird unique to this forest.
- the reserve probably includes one of the more extensive tracts of relatively undisturbed forest remaining at this altitude in Uganda.
- because it adjoins other large protected areas, it provides an opportunity to preserve a complete forest ecosystem including the larger and rarer animals, such as elephants and leopards, that are vulnerable to extinction in smaller isolated reserves.

Threats: Continuing agricultural encroachment and timber felling represent the most serious threats to the integrity of this forest. The present encroachment problem results from the settlement of immigrants from over-populated Kabale District, and encroachment by indigenous Batoro is not considered to be an immediate threat since their density at the time of the last population census in 1980 was between 70 and 125 persons/km^2 in the agricultural lands of neighbouring subcounties. There is an intention to reactivate the Sebitoli sawmill, and recommence felling of the natural forest in Kibale (L. Kiwanuka, pers. comm.). As in all Uganda's forests, excessive hunting threatens ground-dwelling large mammals, although here some control is exercised by the Game Department, supported by the Kibale Forest Project.

Recommendations Specific to this Forest:

This reserve should be considered for Forest Park status, involving the designation of about 50% of the area for strict protection. Kibale, more than any other forest in Uganda, represents an opportunity to demonstrate options in sustainable forest resource management in which the powerful economic and social forces which have led to heavy timber exploitation and extension agricultural encroachment of this forest are reconciled with the longer-term objectives of maintaining its natural diversity and environmental services.

A number of recommendations were made by Van Orsdol (1983), which I endorse. These are discussed fully in his report, and include proposals to:

- evict encroachcrs;
- resurvey and demarcate the reserve boundary;
- strengthen the legal status of the reserve;
- suspend all felling and charcoal operations.

Two considerations which, in my view, are not given adequate attention by Van Orsdol are:

- the need to establish a nature reserve in the lower-lying *Cynometra* forest in the south of the reserve.
- the need to protect all of the little remaining *Parinari* forest from exploitation, as this represents the most ecologically mature, and least replaceable of Kibale's forest communities, and a forest type which has been especially hard-hit by timber felling operations throughout its limited range in Uganda.

Principal Reference Material:

Butynski, T.M. (1990). Comparative ecology of blue monkeys *(Cercopithecus mitis)* in high- and low-density subpopulations. *Ecological Monographs* 60(1): 1-26.

Friedmann, H. (1966). A contribution to the ornithology of Uganda. Scientific results of the 1963 Knudsen-Machris expedition to Kenya and Uganda. Bulletin of the Los Angeles County Museum of Natural History Science No. 3.

Friedmann, H. and J.G. Williams (1970). Additions to the known avifauna of the Bugoma, Kibale, and Impenetrable forests, West Uganda. Los Angeles County Museum, Contributions in Science No. 198. 20pp.

Ghiglieri, M.P. (1984). The chimpanzees of Kibale Forest. New York: Columbia University Press.

Kalina, J. (1988). Ecology and behaviour of the black-and-white casqued hornbill *(Bycanistes subsylindricus subquadratus)* in Kibale Forest, Uganda. PhD thesis. Michigan State University.

Kasenene, J.M. (1987). The influence of mechanized selective logging, felling intensity and gap-size on the regeneration of a tropical moist forest in the Kibale Forest Reserve. PhD thesis. Michigan State University.

Kingston, B. (1967). Working Plan for the Kibale and Itwara Central Forest Reserves. Entebbe: Uganda Forest Department.

Osmaston, H.A. (1959). Working Plan for the Kibale and Itwara forests. First revision: Period 1959 to 1965. Entebbe: Uganda Forest Department.

Rudran, R. (1978). Socioecology of the blue monkey *(Cercopithecus mitis stuhlmanni)* of the Kibale Forest, Uganda. Smithsonian Contributions to Zoology 249.

Skorupa, J.P. (in prep). The effects of habitat disturbance on primate populations in the Kibale Forest, Uganda. PhD thesis. University of California.

Skorupa, J.P. and J.M. Kasenene (1984). Tropical forest management: can rates of natural treefalls help guide us? *Oryx* 18(2): 96-101.

Struhsaker, T.T. (1975). The red colobus monkey. Chicago: University of Chicago Press.

Struhsaker, T.T. (1978). Food habits of five monkey species in the Kibale Forest, Uganda. In: Chivers, D.J. and Herbert, J. (Eds). Recent advances in primatology, Vol. I: Behaviour. London: Academic Press.

Van Orsdol, K.G. (1983). The status of Kibale Forest Reserve in western Uganda, and recommendations for its conservation and management. Unpublished report.

Wing, L.D. and Buss, I.O. (1970). Elephants and forests. *Wildlife Monographs* 19.

Table E1. Areas (km2) of different vegetation types and their condition in Kibale Forest Reserve

	Vegetation types								
Condition	Grass-land, swamp, undiff.	Mixed forest (types K1,K3)	*Pipta.* forest (type K6A	*Parinari* forest (types K2,KF)	*Cynometra* forest (type K6)	*Pterygota* forest (type K4)	Poor forest (types K5,K7)	Colon-ising (types K9, K10, KW)	TOTAL
Undisturbed	99	135	7	12	11	31	70	24	387
Mechanically harvested	0	10	0	56	0	0	8	0	74
Severely encroached	29	11	1	0	1	20	9	28	99
TOTAL	128	154	8	68	12	51	87	52	560

* Forest Department forest type codes, as shown on map reference T059B

Table E2. The number of primate groups seen per kilometre of census route (mean ± SE), and, in parentheses, the estimated population densities (number of groups/km2) of each species along five transects. Transect locations are shown in Fig. E1.1. Data are from Kisubi (in prep.)

Census route	Length (km)	Estimated strip width (km)	No. of censuses	Primate species: *C. ascanius*	*C. mitis*	*C. l'hoesti*	*Cguereza*	*C. badius*	*C. albigena*	*P. anubis*	*P. troglodytes**
A	4.1	0.06	8	0.67 ± 0.01 (11.2)	0.06 ± 0.04 (1.0)	0.06 ± 0.04 (10)	0.06 ± 0.04 (10)	0.27 ± 0.03 (4.5)	0.34 ± 0.08 (5.7)	0.18 ± 0.08 (3.0)	0.00 ± 0.00 (0.0)
B	4.1	0.08	27	0.53 ± 0.06 (6.6)	0.31 ± 0.04 (3.9)	0.00 ± 0.00 (0.0)	0.10 ± 0.03 (1.3)	0.92 ± 0.08 01.5)	0.09 ± 0.03 (1.1)	0.01 ± 0.01 (0.1)	0.05 ± 0.02 (0.6)
C	4.2	0.10	8	0.78 ± 0.14 (7.8)	0.31 ± 0.09 (3.1)	0.07 ± 0.04 (0.7)	0.71 ± 0.07 (7.1)	0.78 ± 0.14 (7.8)	0.17 ± 0.06 0.7)	0.00 ± 0.00 (0.0)	0.24 ± 0.13 (2.4)
D	5.0	0.12	8	0.33 ± 0.07 (2.8)	0.27 ± 0.04 (2.2)	0.00 ± 0.00 (0.0)	0.58 ± 0.06 (4.8)	0.55 ± 0.05 (4.6)	0.03 ± 0.02 (0.2)	0.05 ± 0.03 (0.4)	0.05 ± 0.03 (0.4)
E	6.1	0.10	19	0.51 ± 0.07 (5.1)	0.27 ± 0.05 (2.7)	0.00 ± 0.00 (00)	0.72 ± 0.09 (7.2)	0.41 ± 0.04 (4.1)	0.02 ± 0.01 (0.2)	0.00 ± 0.00 (0.0)	0.00 ± 0.00 (0.0)

* Data for chimpanzees refer to the number of individuals, not groups

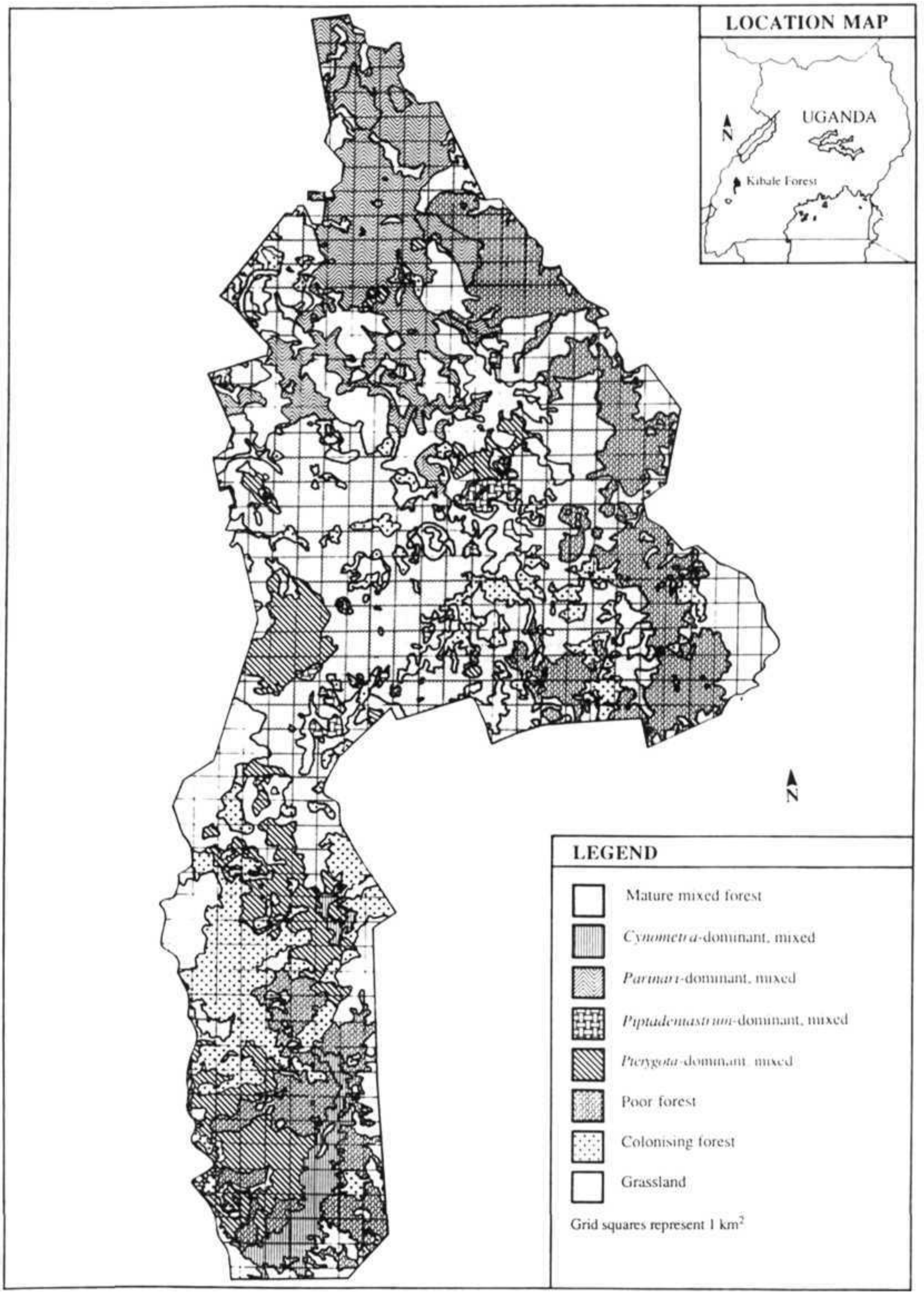


Fig. E1 *Kibale forest types*

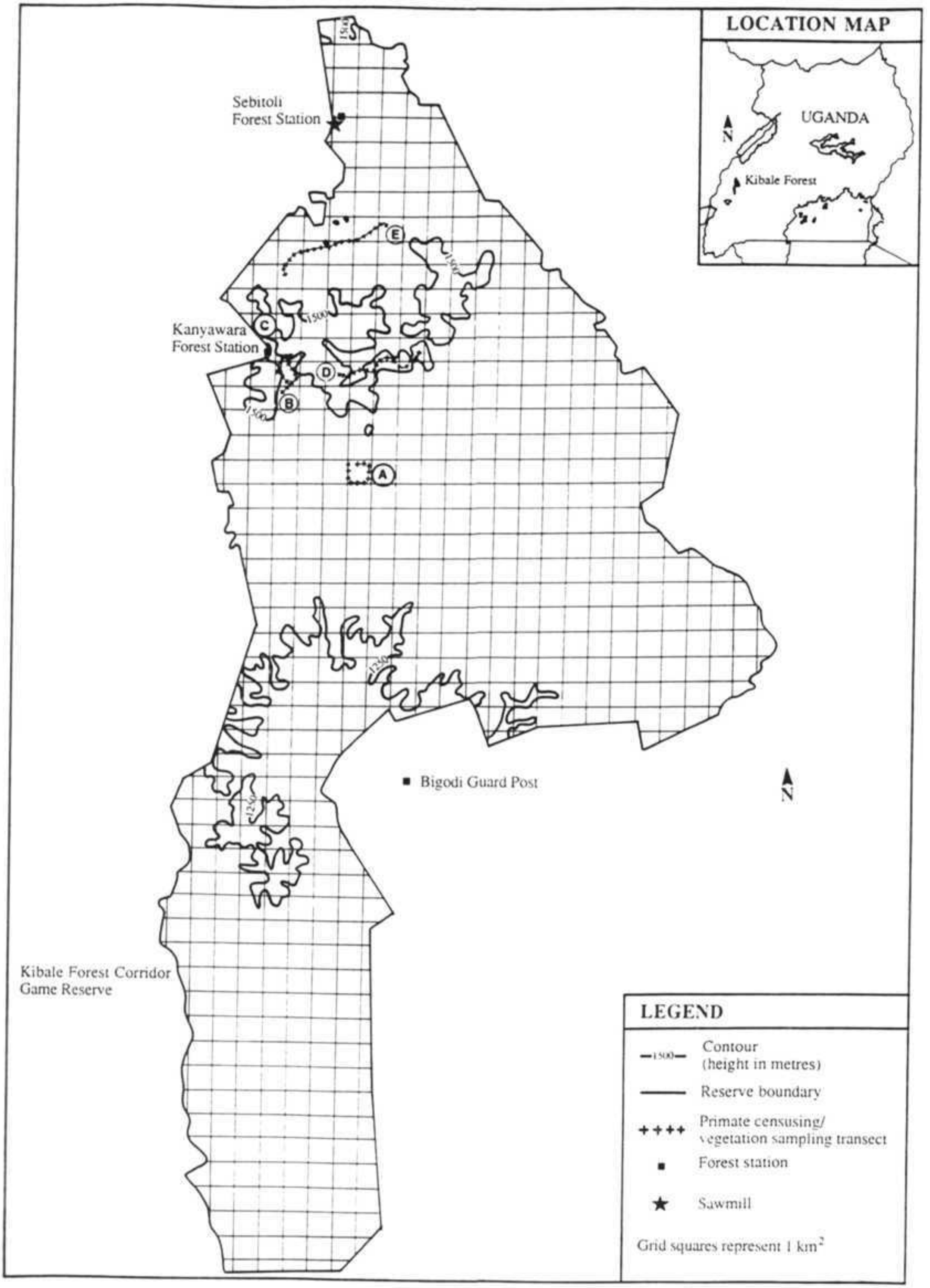


Fig. E1.1 *Kibale Forest transect locations and altitudinal zones*

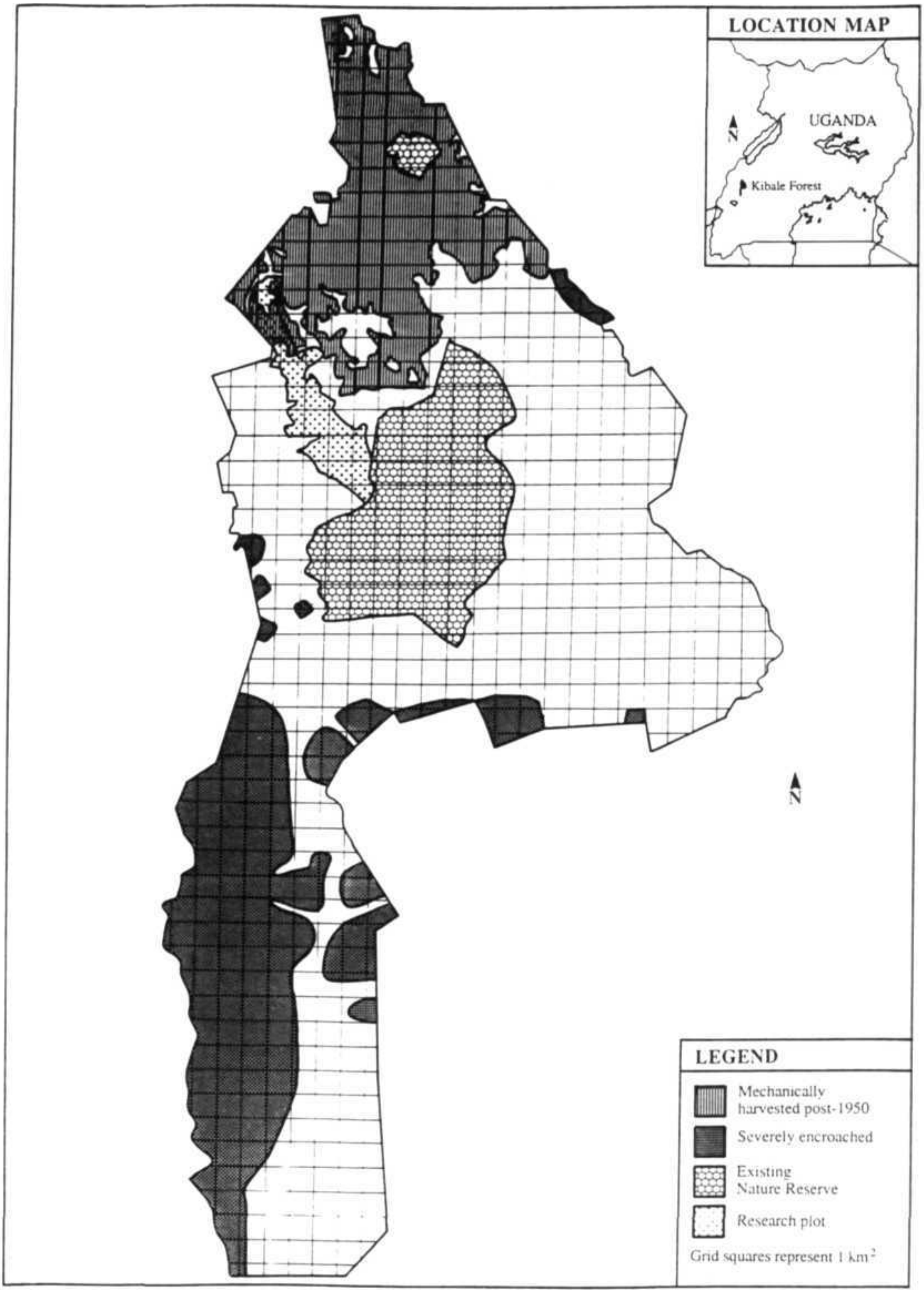


Fig. E1.2 *Present status of Kibale Forest, including the location of the existing Nature Reserves and Research Plot. (Note that pitsawing activity is not shown, although it is believed to be widespread in this forest).*

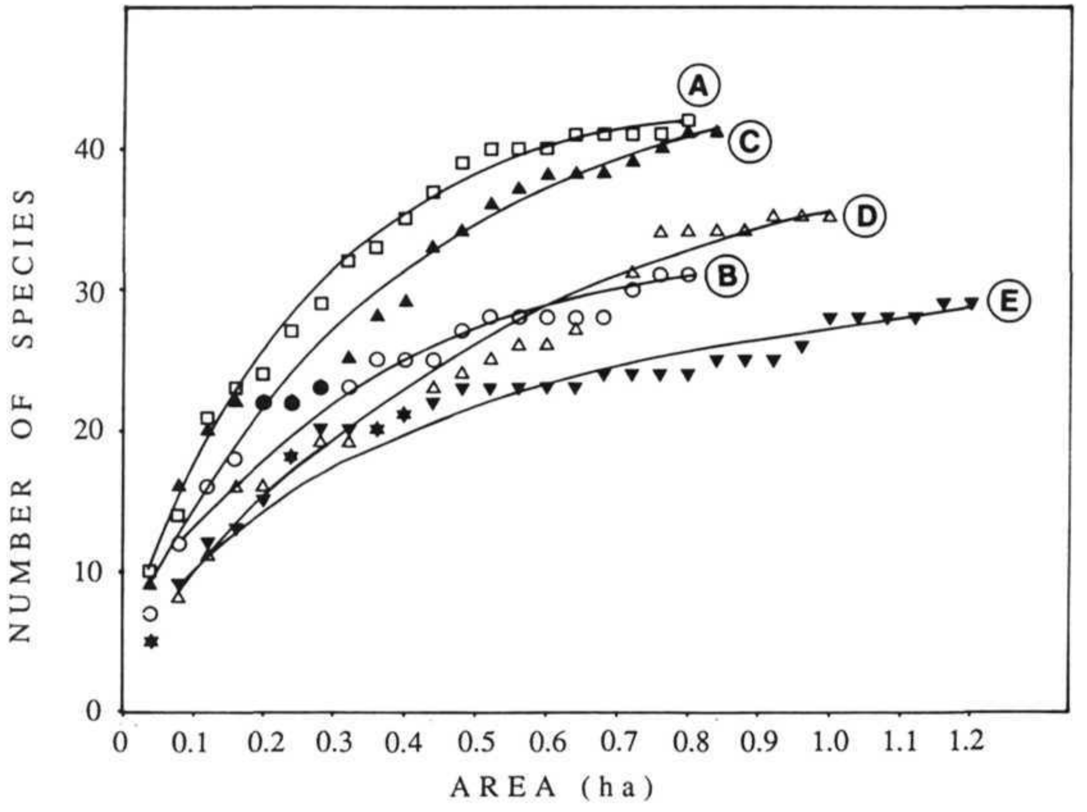


Fig. E2 *The cumulative number of tree species exceeding 10cm dbh. recorded as a function of area enumerated at Kibale Forest. (Data are from 20m x 20m plots positioned at 200m intervals along primate census routes, see text).*

Appendix F. Profile of the Semliki Forest Reserve

Date Established: 1932

Geographical Location: Northwest of the Rwenzori Mountains in the western rift valley. It lies entirely within Bwamba County in the administrative district of Bundibugyo, 0°44'-0°53' N, 29°57'-30°11' E. Covered by Uganda Department of Lands and Surveys maps sheets 56/I, 56/III (Series Y732) at 1:50,000.

Area: 219 km^2, bounded by the Lamia and Semliki rivers to the west and north, and by a line of planted *Cassia siamea* and the main Fort Portal-Bundibugyo road to the east and south. The reserve is contiguous with Zaire's Virungas National Park (7,800 km^2) along 10km of boundary, and with the North Rwenzori Forest Reserve (35 km^2) along 1 km of boundary.

Altitudinal Range: 670-760 m. 10 km^2 is land above 750 m.

Physical Features: The reserve occupies flat to gently undulating land, much of which is poorly drained, and overlies grey alluvial clay soils that tend to be saline and of poor fertility. The climate is tropical with two rainfall peaks from April to May and September to November. Annual mean temperature range, minimum: 18° C, maximum: 30° C. Annual rainfall: 1,250 mm.

Survey Work Conducted under this Project:
- an initial ground survey over two weeks in June/July 1985 (routes followed are shown in Fig. F1.1);
- a re-survey of encroached areas over one week in April 1986;
- an aerial survey in August 1986;
- six censuses of primates along a 5 km purpose-cut line transect, together with vegetation sampling along the same route, during June 1986 (see Fig. F1.1 for location);
- examination of tree species-area relationships in two plots of 0.25 ha during August 1987 (see Fig. F1.1 for locations);
- compilation of a preliminary tree species list for the reserve based on four days of survey and collecting work in August 1987;
- ornithological survey work, including 2,800 metre-net-hours of mist-netting over two weeks in August 1987
- natural resources assessment and related sociological research conducted in the neighbouring agricultural lands of Bwamba County by an agriculturalist, a forester and sociologist over the period July 1986 to December 1987 (summarised in Chapter Five).

Vegetation: The forest is an easterly extension of Zaire's Ituri forest, and its flora and fauna show strong affinities with the Congo basin forests. Many species reach the eastern limit of their ranges in the Semliki valley. The forest is classified as moist semi-deciduous forest, and is dominated by a single tree, *Cynometra alexandri*, which forms almost pure stands varying in height from 10 m to 30 m. (Fig. F1, Table F1). Mixed forest of a more evergreen nature formerly occupied about 13%

of the reserve on the more fertile soils, but this has been seriously degraded by agricultural activity. Swamp forest communities are still relatively intact and occupy about 7% of the area, dominated by species such as *Mitragyna stipulosa, Elaeis guineensis* and *Ficus vogeliana.* Tree species-area relationships were examined at three sites within the reserve (Fig. F2), and show considerable variation. The richest of these sites supports an estimated 60-70 tree species exceeding 10 cm dbh per hectare, whilst the poorest supports only 11 species. In a Ugandan context, these sites represent exceptionally rich and exceptionally poor forest types in close proximity.

The richest site was in a small patch of mixed forest that may be representative of the forest that occupied the more fertile parts of the reserve before these were cleared for agriculture (see below). Very little of this forest now remains. A few mixed forest fragments were also examined qualitatively outside the reserve, and appeared to be even richer than anything seen within the reserve. For example, 59 species of tree (including seedlings) were identified from a site of approximately 0.3 ha in the former Nyaburongo local forest reserve, four kilometres to the south of the Semliki reserve.

One hundred and sixty-eight forest tree species (39% of the country's total) have been recorded in the area, including 93 species added to the list during this study: clearly a lot of work remains to be done before the list can be considered comprehensive. Trees restricted to this forest in the East African part of their ranges, or shared only with one or two neighbouring forests include: *Euphorbia sp.* (Eggeling 3368), *Chrysophyllum beguei, Ficus vogeliana, Nesogordonia kabingaensis, Isolona congolana, Baphia capparidifolia, Nauclea diderrichii, Lecaniodiscus cupanioides, Afzelia bipindensis, Milletia eetveldeana, Milletia psilophetala, Elaeis guineensis.* Three species of tree from this reserve are considered to be endangered: *Chlorophora excelsa, Cordia millenii* and *Lovoa swynnertonii* (FAO, 1986). Non-timber trees of commercial interest include the oil palm, *Elaeis guineensis* and Shari coffee, *Coffea liberica.*

Fauna: The fauna of this reserve is outstandingly rich, and includes 216 species of forest bird (66% of the country's total), 8 species of diurnal forest primate (66% of the country's total), and 51 species of forest swallowtail and *Charaxes* butterfly (75% of the country's total). Amongst these, 31 species of bird, one species of primate and a butterfly are only recorded from this area in the East African part of their ranges (see Appendices B, C and D for species names). Nine species (or sub-species) of mammal occur nowhere else in East Africa: Elliot's red colobus monkey *(Colobus badius ellioti),* Mona monkey *(Cercopithecus mona denti),* forest buffalo *(Syncerus nanus),* bay duiker *(Cephalophus dorsalis),* Beecroft's flying squirrel *(Anomalurus beecrofti),* Pygmy flying squirrel *(Idiurus zenkeri),* Little collared fruit bat *(Myonycteris wroughtoni),* Water chevrotain *(Haemoschus aquaticus),* Target rat *(Aethomys longicaudatus);* and a further ten species are known from only a few other localities (Kingdon, 1971). Threatened and near-threatened species which occur in the reserve are: elephant *(Loxodonta africana),* leopard *(Panthera pardus),* chimpanzee *(Pan troglodytes),* forest ground thrush *(Turdus oberlaenderi),* white-naped pigeon *(Columba albinucha),* chestnut barred owlet *(Glaucidium castaneum),* Sassi's olive greenbul *(Phyllastrephus lorenzi)* and African giant swallowtail butterfly *(Papilio antimachus).*

Fifteen species of large mammal were recorded from the forest during the ground survey, either by direct sighting or auditory cues (in the case of seven species of primate and warthog) or by distinctive spoor (in the case of seven other species). The distributions of records are shown in Fig. F3. Buffalo *(Syncerus nanus* (?)*)* were recorded in 8% of the 1 km^2 compartments covered by the survey, sitatunga *(Tragelaphus spekei)* in 3%, a large duiker *(Cephalophus* sp.) in 3%, a small antelope fitting the description of Bate's pygmy antelope *(Neotragus batesi)* in 8%, bushpig *(Potamochoerus porcus)* in 6%, warthog *(Phacochoerus aethiopicus)* in 1%, elephant in 6%, and hippopotamus *(Hippopotamus amphibius)* in 5%. Of the primates, redtail monkeys *(Cercopithecus ascanius)* were recorded in 12% of compartments, blue monkey *(Cercophithecus mitis)* in 6%, De Brazza's monkey *(Cercopithecus neglectus)* in 2%, chimpanzee in 3%, baboon *(Papio anubis)* in 5%, black and white colobus *(Colobus guereza)* in 5%, and mangabey *(Cercocebus albigena)* in 5%. The population densities of primates calculated from census statistics are given in Table F2. No mona monkeys or red colobus were seen, although a troup of 'unusual' primates which could have been the latter was reported from the reserve in July 1985.

Most of the reserve's fauna is yet to be recorded, but existing knowledge of the more conspicuous species suggests an exceptional diversity in all groups. Haddow (1960, in Leggat, 1961), for example, recorded ten new species of mosquito from this reserve.

Economic Importance: The forest is of little value as a source of timber, because *Cynometra* wood is too hard to work and there is consequently no market for it at present. Even if a market were developed, the wood could be more easily obtained from other reserves in western Uganda. A very limited enumeration was carried out in 1944, which suggested that there may have been about 27 m^3 of standing timber per hectare, but much of this has been lost to recent agricultural encroachment (see below). A sociologist working on this project determined that 14% of householders in Bwamba County collect firewood from the Semliki and Rwenzori forest reserves, 12% collect building poles, 8% medicinal compounds, 1% oil palm nuts and 5% use these areas for hunting. A few (20-30) people fish the Semliki river from within the reserve. Illegal agricultural crops are grown in the reserve.

Present status: Fig. F4 shows the distribution of human activities recorded during the ground survey. Derived from these results, local interviews and the August 1986 aerial survey, Fig. F1.2 and Table F1 show the areas of different forest types affected by varying degrees of disturbance. The area to the east of the Kirimia river (about 84 km^2) is designated as a Nature Reserve and Animal Sanctuary and is relatively undisturbed. The remainder of the reserve has been seriously degraded by agricultural activity following the Forest Department's decision to adopt a Taungya management system in this area in 1971. Under this system the area was to be cleared of natural vegetation by local people who would be permitted to cultivate crops on the forest land until this was made impossible by the growth of commercially important trees planted in the same plot by the Forest Department. In accordance with this policy many people moved in to the reserve during the seventies, but no trees were planted. R. Malpas (pers. comm.) counted about 1,500 huts in the reserve during an aerial survey in 1982. The cultivators were evicted in 1983, but an estimated 290 families remained or had returned by April 1986 (Howard, 1986). Today, most of the cultivation plots have been abandoned and the forest is regenerating. However 30% of the reserve was severely encroached (with more than 31 % loss of forest cover), including most of the better mixed forest types.

Hunting was recorded in 4% of the survey compartments, and seems to be most commonly carried out by use of a bow and poisoned arrow. No snares were seen nor was the use of nets recorded. This is one of the very few reserves in Uganda where primates are hunted. A few small groups of Batwa pygmies, numbering perhaps 20-40, live and hunt within the reserve, but most hunting activity is undoubtedly carried out by the majority Amba population.

Management: The reserve is managed from the Bundibugyo District Forest Office. One forest ranger, two guards and three patrolmen are assigned to protect the reserve. There is no infrastructure. Some timber trials were established in the reserve along the roadside west of the Kirimia river crossing in the early 1960s. The latest Working Plan covers the period 1.7.61 to 30.6.71.

Conservation Importance:

- although there may be some doubt as to whether the reserve can support the diversity of flora and fauna reported by earlier workers, it is of exceptional importance for its diverse bird and primate faunas.
- by virtue of its scenic location, the cultural interest of Bwamba's people (including pygmies), and the proximity of additional attractions such as Hot Springs and an impressive navigable river through the forest wilderness, it offers considerable scope for the development of tourism.
- the forest's location close to the site of a postulated Pleistocene forest refugium (Hamilton, 1981) has resulted in a diverse present-day community of forest species, including many Congo basin species on the eastern limits of their ranges.
- the reserve supports eight species of animal considered to be globally threatened, or nearly so.
- the reserve protects the only lowland forest in the country, most of it lying below 750 m.
- because it adjoins other large protected areas, it provides an opportunity to preserve a complete forest ecosystem, including the larger and rarer animals such as elephants and leopards, that are vulnerable to extinction in smaller isolated reserves.

Threats: Agricultural encroachment poses the greatest threat to the forest, as the adjoining public lands of Bwamba County are populated at a density of over 300 people/km^2, increasing at 3.4% p.a. Unregulated use of forest resources, including hunting of the larger mammals, is already causing serious damage. There will be increasing pressure on the forest for direct economic returns, and as this is unlikely to be provided by the existing trees, there will be pressure to replace the forest with commercially more important species. In some areas of the reserve, cocoa is being grown (illegally, but quite successfully) as an understorey crop, and the possible spread of this practice threatens to replace the rich natural forest community with a somewhat 'sterile' plantation of a very few species.

Recommendations Specific to this Forest:

This reserve should be considered for Forest Park status, involving the designation of about 60% of the area for strict protection. The areas recommended for protection (mentioned in Chapter Five, Section 5.6) are:

- the whole of the area east of the Kirinia river, presently designated as a Nature Reserve;
- a strip of land 3 km wide along the entire length of the Lamia and Semliki rivers north of the point at which the boundary of Zaire's Virungas National Park joins the opposite bank of the Lamia river at 0°47'N. This strip of land will protect the species-rich swamp and mixed evergreen forests characteristic of the riverside margins and provide a corridor for animals and plants moving between Zaire's National Park and the Nature Reserve; and
- a strip of land 1 km wide along the west bank of the Kirimia river, which will protect an area capable of regenerating into mixed evergreen forest.

It is important that all remaining settlements and cultivation plots within the reserve are abandoned.

Research should be carried out in the areas that are not preserved, on the regeneration of forest damaged by agricultural encroachment, and on possible ways to improve its commercial value without loss of wildlife.

The possibility of planting a belt of fast-growing trees suitable for firewood and building poles, along the reserve's southern boundary, should be examined.

Principal Reference Material:

Friedmann, H. and J.G. Williams (1971). The birds of the lowlands of Bwamba, Toro Province, Uganda. Los Angeles County Museum, Contributions in Science No. 211, 70 pp.

Hamilton, A.C. (1981). The quaternary history of African forests: its relevance to conservation. *Afr. J. Ecol.* 19: 1-6.

Howard, P.C. (1986). Agricultural encroachment in the Semliki Forest Reserve, Western Uganda. WWF Project 3235 unpublished report, 8pp.

Howard, P.C. (Ed.) (in prep). Conservation and development of natural resources in Bundibugyo District, Uganda. WWF Project 3235 Research Publication. Gland: WWF International.

Kingdon, J. (1971). Appendix 1. Bwamba Forest. pp. 45-50 In: East African Mammals. An atlas of evolution in Africa. Vol. 1. London: Academic Press.

Leggat, G.J. (1961). A working plan for Semliki Central Forest Reserve, Toro District, Uganda. First revision, for the period 1st July 1961 - 30th June 1971. Entebbe: Uganda Forest Department.

Van Orsdol, K.G. (1983). Survey report on the Semliki (Bwamba) Forest Reserve of western Uganda. Kibale Forest Project unpublished report. 6pp.

Van Someren, V.G.L. and G.R.C. Van Someren (1949). The birds of Bwamba. *Uganda J.* 13 (Special suppl.): 1-111.

Table F1. Areas (km2) of different vegetation types and their condition in Semliki Forest Reserve

Condition	Grass-land	Swamp forest	Mixed forest	Cynometra forest	Scrub	TOTAL
Undisturbed	7	4	3	50	0	64
Severely encroached (> 30% of forest cleared)	0	6	22	32	5	65
Moderately encroached (5-30% of forest cleared)	10	6	4	70	1	91
TOTAL	17	16	29	152	6	220

Table F2. The number of primate groups seen per kilometre of census route (mean ± SE) and, in parentheses, the estimated population densities (number of groups/km2) of each species. The transect location is shown in Fig. F1.1. Data are from Kisubi (in prep.).

				Primate species			
Census route	Length (km)	Estimated Strip width (km)	No. of censuses	*C.ascanius*	*C. mitis*	*C.guereza*	*C.albigena*
A	5.0	0.06	7	0.26 ± 0.08 (4.3)	0.03 ± 0.03 (0.5)	0.10 ± 0.04 (1.6)	0.23 ± 0.05 (3.8)

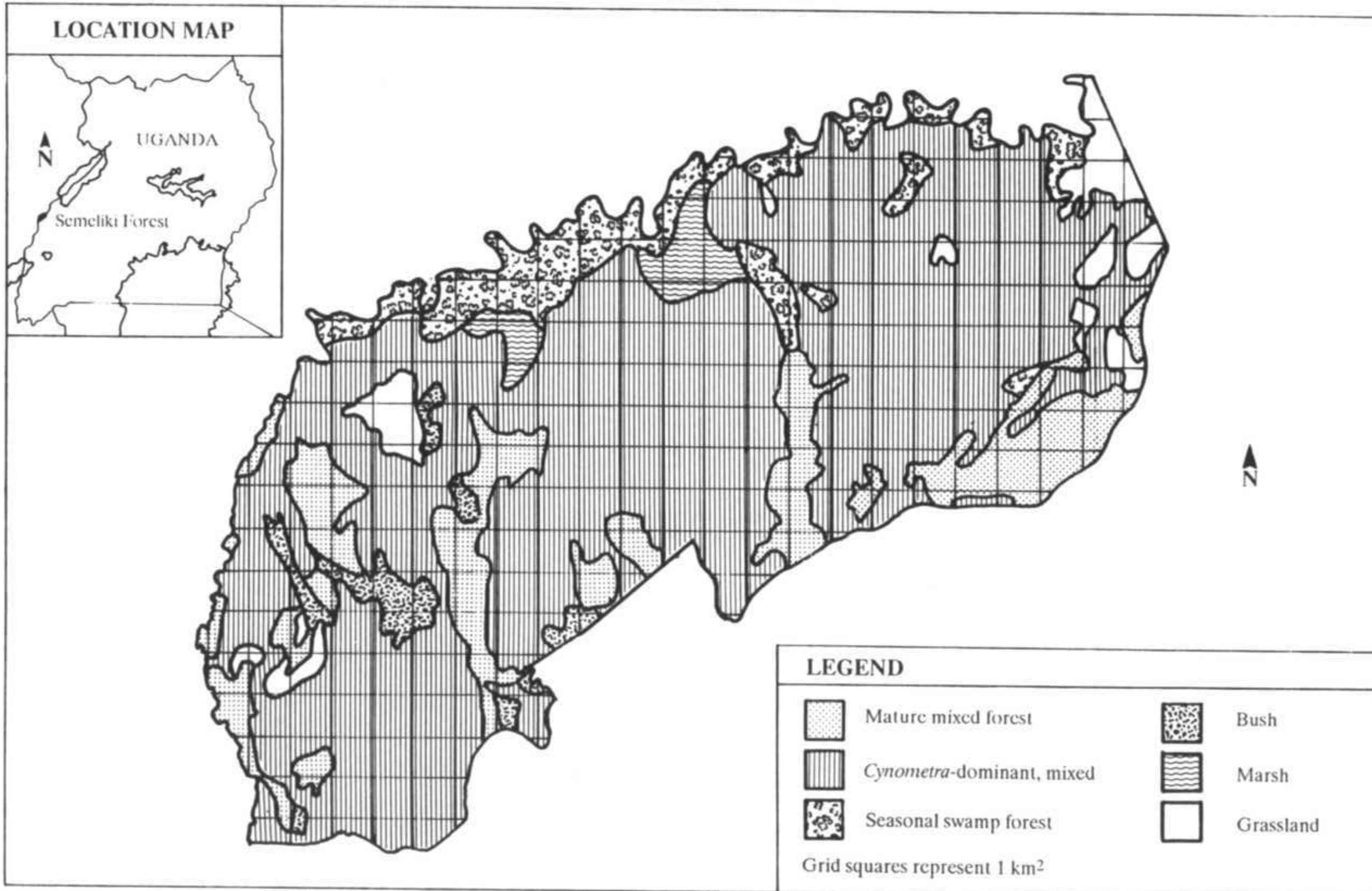


Fig. F1 *Semliki forest types*

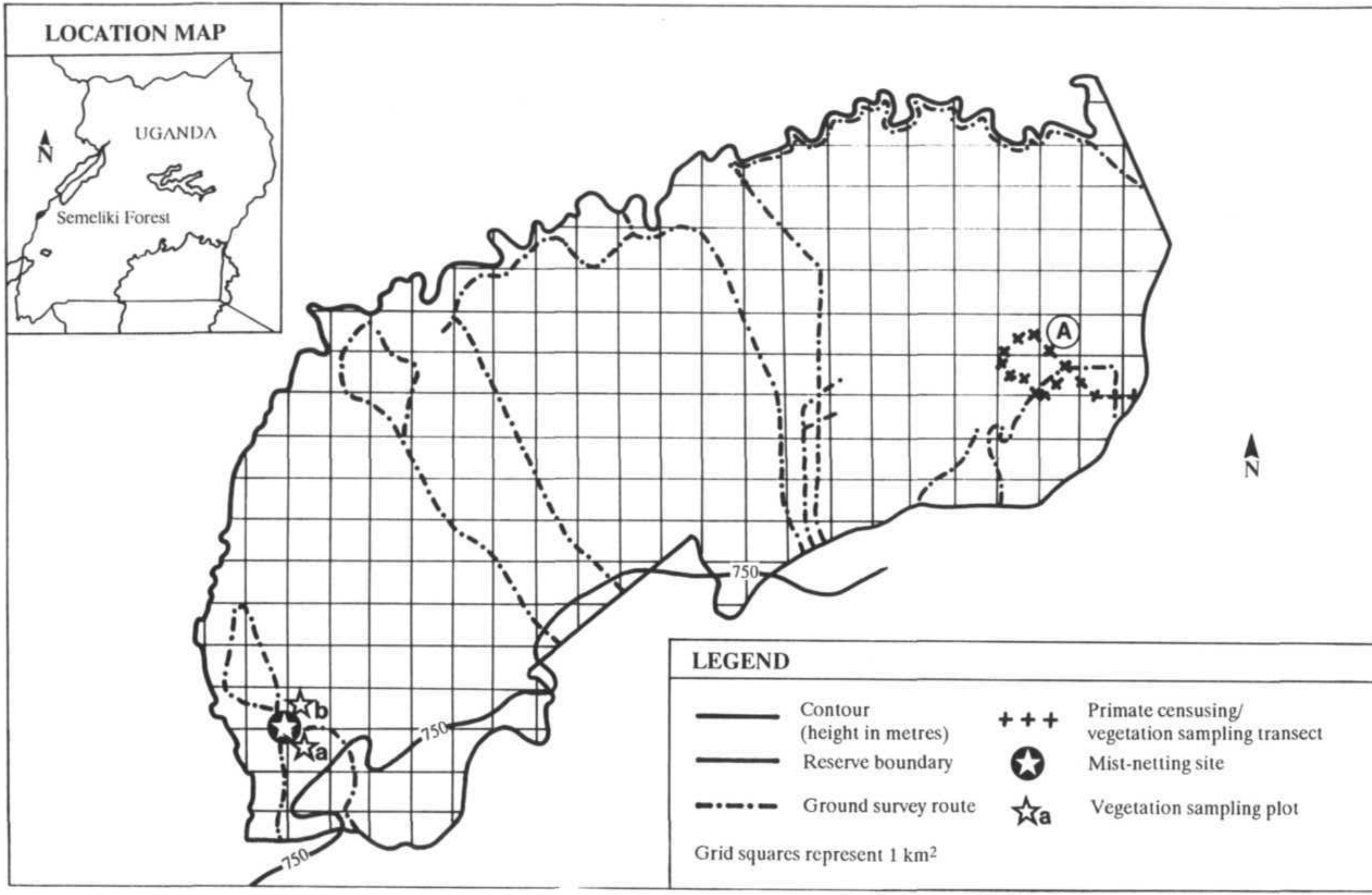


Fig. ***F1.1*** *Semliki Forest ground survey routes, transects, vegetation sampling sites and mist netting sites*

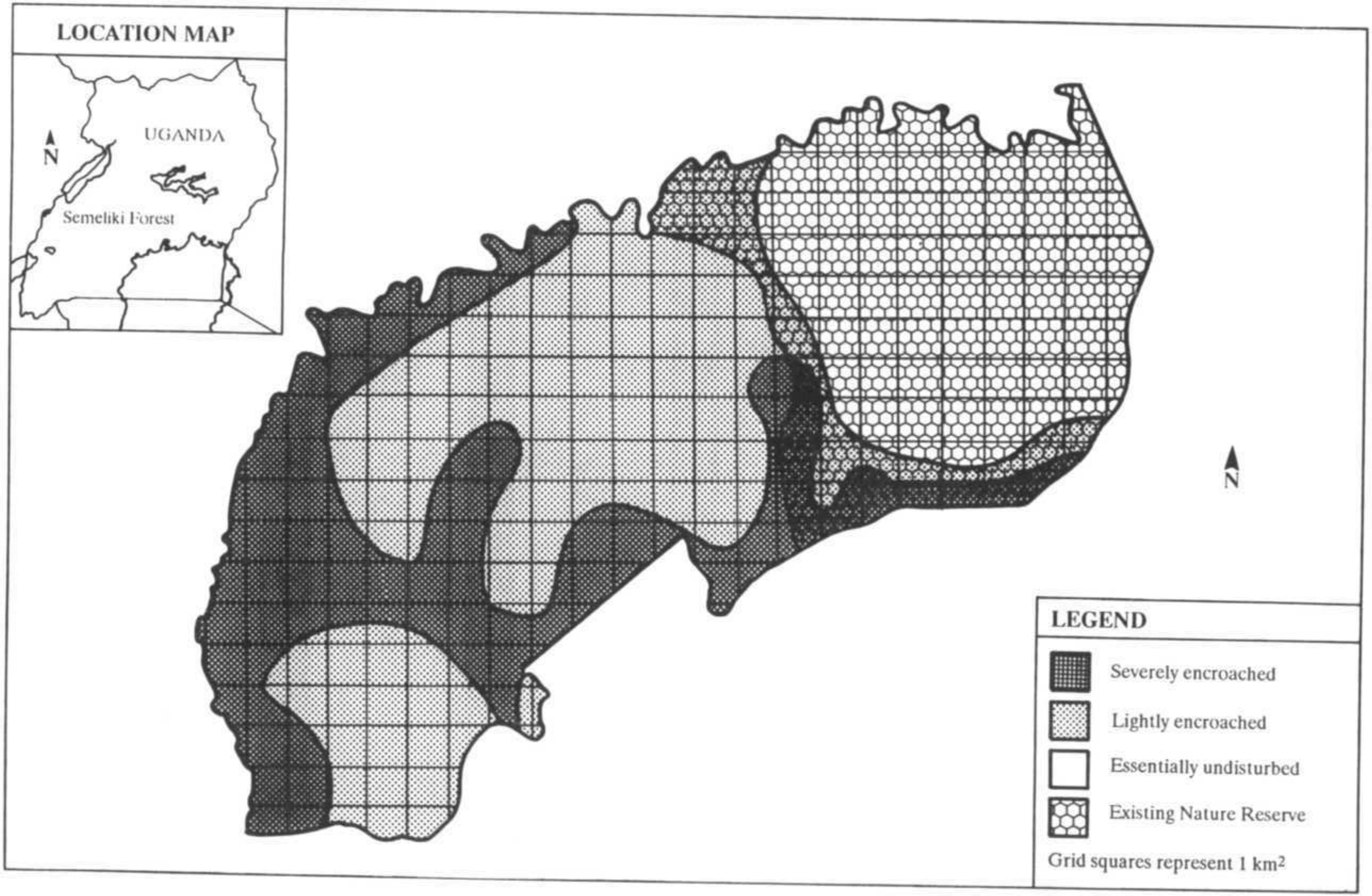


Fig. F1.2 *Present status of Semliki Forest, including the location of the existing Nature Reserve*

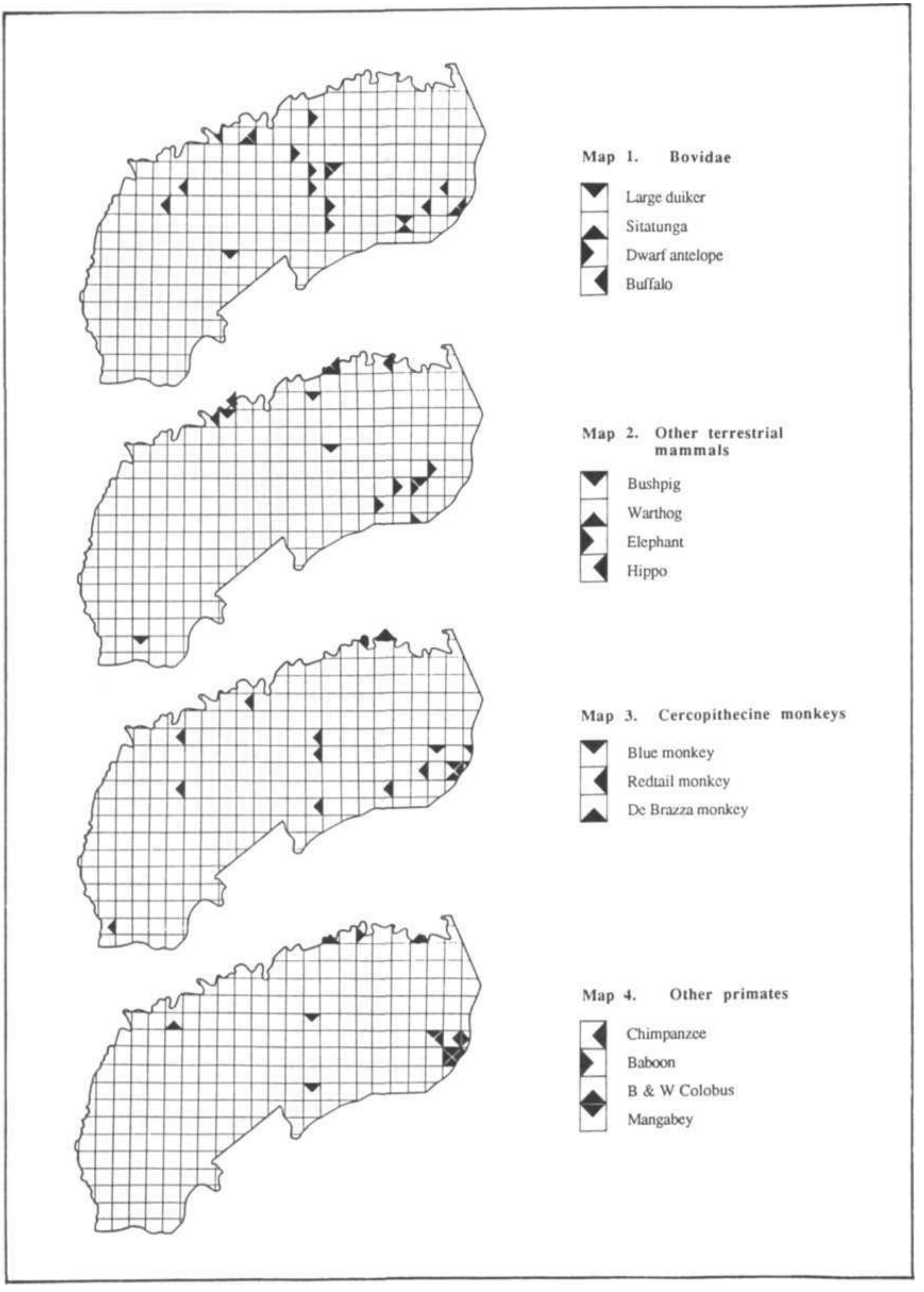


Fig. F3 *Distribution of large mammal records made during the ground survey of Semliki Forest*

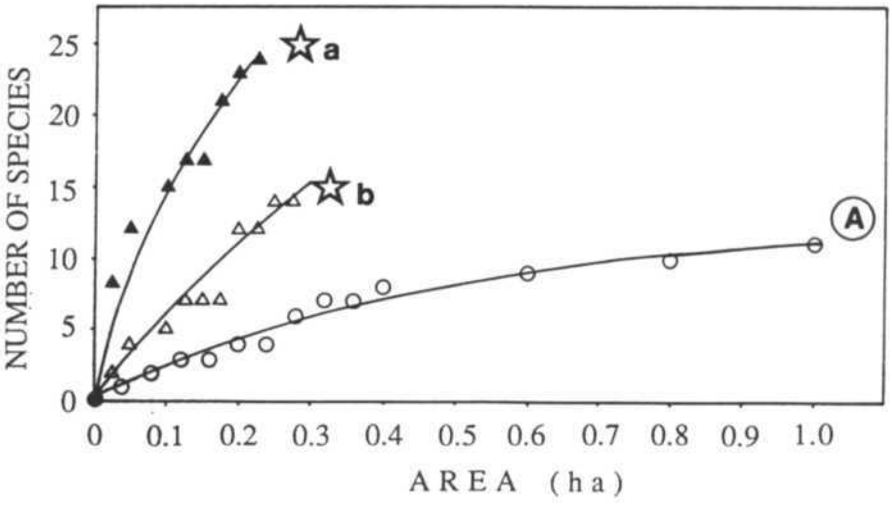


Fig. F.2 *The cumulative number of tree species exceeding 10cm dbh, recorded as a function of area enumerated at Semliki Forest. (Data for the lower curve are from 20m x 20m plots positioned at 200m intervals along a primate census route. The other two are from 50m x 10m plots positioned at 50m intervals perpendicular to a central transect line, alternately to the left and right of the line).*

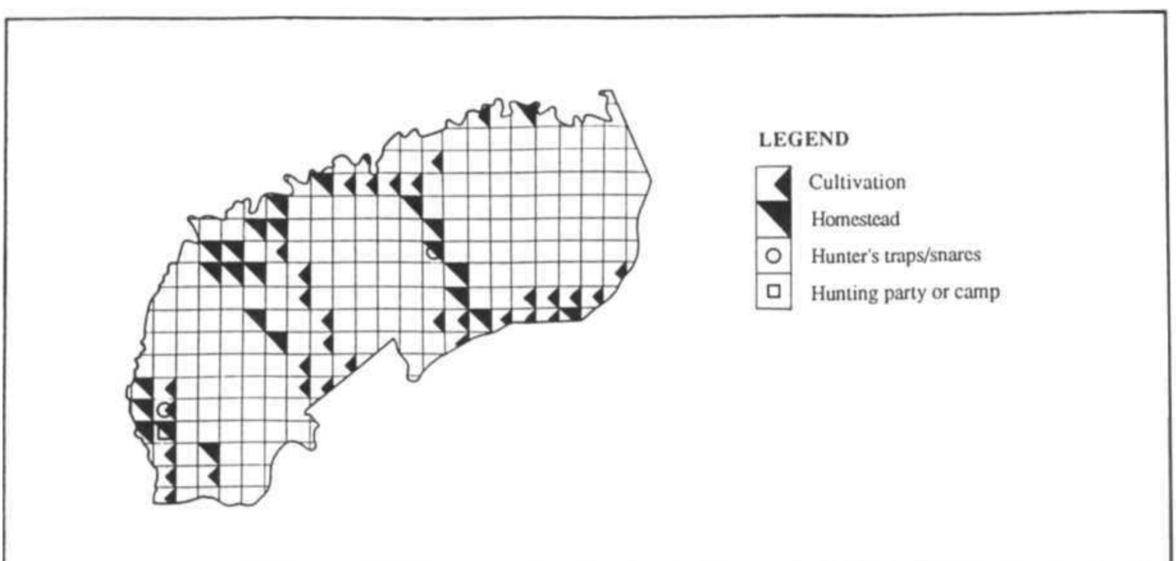


Fig. F4 *Distribution of human activities recorded during the ground survey of Semliki Forest*

Appendix G. Profile of the Budongo Forest Reserve

Date Established: Different parts of the forest were gazetted at various times from 1932-39.

Geographical Location: On the top of the escarpment east of Lake Albert on the edge of the western rift valley. The forest straddles the counties of Bugahya in Hoima District, and Buliisa, Bujenje and Buruli in Masindi District, 1°37'-2°03' N, 31°22'-31°46' E. Covered by Uganda Department of Lands and Surveys maps sheets 30AII, 30/IV, 38/II, 39/I, 39/II, 38/IV, 39/III (Series Y732) at 1: 50,000.

Area: 793 km^2; comprising blocks of 364 km^2 (Budongo), 66 km^2 (Siba), 95 km^2 (Kitigo) and 268 km^2 (Kaniyo-Pabidi). The reserve is contiguous with the Murchison Falls National Park (3,840 km^2), Bugungu Game Reserve (748 km^2) and Karuma Game Reserve (713 km^2). The boundaries follow rivers, streams and other natural features wherever possible, and elsewhere they have been marked with numbered concrete posts at all corners, as well as direction trenches and cairns. Boundary line cutting and maintenance has lapsed during the past decade or so.

Altitudinal Range: 700-1,270 m. 0.2 km^2 of the reserve lies below 750 m, 385 km^2 at 750-1,000 m, 408 km^2 at 1,000-1,250 m and 0.1 km^2 above 1,250 m.

Physical Features: The reserve occupies gently undulating terrain with an easy general slope NNW to the edge of the escarpment. It is drained by two small rivers, the Sonso and Waisoke. The underlying rocks are ancient gneisses, schists and granulites of the Basement Complex, overlain by Bunyoro Series sediments in a small area of the Siba block. The soils are ferralitic mainly sandy or sandy clay loams of low to moderate fertility. The climate is tropical with two rainfall peaks from March to May and September to November. Annual mean temperature range, minimum: 17-20° C, maximum: 28-29° C. Annual rainfall: 1,150-1,500 mm.

Survey Work Conducted under this Project:
- a three-day reconnaissance of the area was made during July 1986.

Vegetation: The 428 km^2 forested portion of this reserve supports a variety of different forest types, but can be broadly classified as medium altitude moist semi-deciduous forest, since several of the dominant species are, at least briefly, deciduous (Langdale-Brown *et al.,* 1964). Table G1 shows the areas of different vegetation communities within the reserve, based on 1985 aerial photography by Gitec Consultants (1985). A large portion of the reserve (47%), including most of the Kaniyo-Pabidi and Kitigo blocks, comprises grassland communities thought to be capable of supporting forest. The remainder (53%) is forest with approximately equal amounts of *Celtis*-dominated, *Khaya*-dominated and *Cynometra*-dominated types. More than three-quarters of the forest has been radically altered through timber exploitation, but the original cover was considered to be of exceptional quality both in terms of community richness and commercial value. Its ecology has been described in some detail by Eggeling (1947).

Tree species-area relationships for stems exceeding 10 cm dbh were examined by Eggeling (1947) in eight plots which he considered representative of swamp, mixed, colonising and *Cynometra*-forest types. Since these data are directly comparable with the tree species-area relationships established for other Ugandan forests during the course of this study, his (1947) data are reproduced as Fig. G2. In common with my own results from elsewhere, the number of tree species per hectare at Budongo is greatest in swamp communities (67 species) and least in *Cynometra* - forest (16 species), with mixed and colonising forest types intermediate in species richness with 50 and 31 tree species/ha respectively.

The trees of Budongo are better known than those of most of Uganda's forests. Two hundred and forty species (56% of the country's total) have been recorded, including three that are not known from elsewhere in the country: *Discoglypremna caloneura, Microdesmis puberula* and *Mammea africana.* The following species occur in Budongo as part of a Ugandan range limited to a few forests in the west of the country: *Chrysophyllum pruniforme, Drypetes bipindensis, Khaya anthotheca, Khaya grandifoliola, Dialium excelsum, Cynometra alexandri* and *Cathormion altissimum.* Four tree species from this reserve are listed as endangered (FAO, 1986): *Chlorophora excelsa, Cordia millenii, Irvingia gabonensis,* and *Entandrophragma angolense.* Wild robusta coffee, *Coffea canephora,* is amongst the non-timber species of commercial importance.

Fauna: The fauna of this reserve is reasonably well known, and includes 159 species of forest bird (48% of the country's total), 5 species of diurnal forest primate (42% of the country's total), and 42 species of forest swallowtail and *Charaxes* butterfly (62% of the country's total) (See Appendices B, C, D for species lists). Of these the Cassin's spinetail *(Neafrapus cassini)* and yellow-footed flycatcher *(Muscicapa striata)* are not known from elsewhere in Uganda, and the following are restricted to Budongo and a few other forests in the extreme west of the country: black-collared lovebird *(Agapornis swinderniana),* chocolate-backed kingfisher *(Halcyon badia),* white-thighed hornbill *(Bycanistes cylindricus),* white-tailed hornbill *(Bycanistes fistulator),* red-sided broadbill *(Smithornis rufolateralis),* black-eared ground thrush *(Turdus camaronensis),* forest flycatcher *(Fraseria ocreata),* Cassin's grey flycatcher *(Muscicapa cassini),* chestnut-capped flycatcher *(Erythrocercus mecalli),* grey-headed olive-back *(Nesocharis capistrata)* and chestnut-breasted negrofinch *(Nigrita bicolor).* Threatened or near-threatened species that are known to occur in this reserve are: elephant *(Loxodonta africana),* leopard *(Panthera pardus),* chimpanzee *(Pan troglodytes),* Nahan's francolin *(Francolinus nahani)* and African giant swallowtail butterfly *(Papilio antimachus).*

Economic Importance: This is Uganda's most important timber forest, which once supported 28% of the country's standing timber resources on only 6% of its forest land (Langdale-Brown *et ah,* 1964). Lockwood Consultants (1973) estimated an average of 192 m^3 of standing timber exceeding 50 cm dbh per hectare in the unexploited parts of the main Budongo block, more than twice the stocking in Uganda's next best stocked forest (Kalinzu). However, when Gitec Consultants carried out a limited enumeration in 1985, they estimated that only 40.2 km^2 of the entire forest remained stocked at a level exceeding 70 m^3/ha (trees exceeding 50 cm dbh).

Budongo has been commercially exploited since about 1910, the first sawmill being established in 1925. Exploitation has been more or less continuous since that time, so that today some 77% of the forest has been cut at least once (Table G1). Four timber concessions covering the whole of the forest, with the exception of one small nature reserve, have been granted and are being worked. The little remaining unexploited forest in Budongo is being cut to supply Uganda's most up-to-date sawmill, commissioned in 1985. A large number of pitsawyers have been operating in the forest throughout most of this century, but it has recently become Forest Department policy to reserve tne timber for mechanical harvesting and pitsawyers have been directed to cut elsewhere.

Budongo has been used as a source of wild rubber, and a little over 40 tons were collected in 1942-44. There is a small local demand for rattan cane for craftwork, and large specimens of *Cordia millenii* are (or perhaps were) used to build dug-out canoes for use on Lake Albert. Local people use the forest as a source of bushmeat, building poles and other products.

Present Status: Fig. G1.2 and Table G1 show the locations and approximate sizes of areas affected by timber harvesting operations. Only about 22% of the forested part of Budongo remains unaffected by these operations. Initially felling was undertaken at modest levels with the intention of creating a 'two-tier system' in which the largest trees in any management compartment would be harvested at approximately 40-year intervals, but this was abandoned in 1959 in favour of a monocyclic system in which the forest was to be virtually clear-felled on an 80-year rotation. A system of 'refinement', involving the poisoning of 'weed' species of tree was begun in 1957, with the intention of improving the growth and production of 'desirable' species. By 1964, 120 km^2 of the forest had been treated in this way, and although arboricide refinement was abandoned in the mid-1970's, most of the forest shown as harvested in Fig. G1.2 had by then been treated. Thus, the majority of the forest can be considered to be in a state of serious degradation.

Management: The reserve is managed from the Masindi District Forest Office, and two stations at Nyakafunjo and Biiso. There are a few Game Department staff stationed at Busingiro. The national forestry training school is located at Nyabyeya on the southern edge of the forest.

Vehicular access is possible along the Masindi-Butiaba road, which passes through, or alongside the forest for 5 km; along 10 km of forest track between the Sonso sawmill and Kihura; and along two other forest tracks which run through the Waibira block for a total distance of 22 km SW and W of the Sonso sawmill. Access to the eastern edge of the forest is provided by a number of tracks leading off the main Masindi-Paraa road.

The reserve has had a series of four ten-year Working Plans, the latest being for the period 1964-74. It prescribes for the maximum sustained yield of hardwood timber and the maintenance of representative areas of Budongo's characteristic natural communities. There are a number of permanent inventory plots and timber trails, but there has been no active research programme since 1970.

Conservation Importance:

- this forest is of exceptional interest botanically, probably the most important in Uganda for tree species conservation.
- it includes the only sizeable area of forest in Uganda at altitudes of 750-1,000 m, and represents the only opportunity to preserve a representative sample of forest characteristic of this altitude.
- it supports several plant and animal species not found elsewhere in Uganda.
- it supports five species of animal considered to be globally threatened, or nearly so, including sizeable populations of chimpanzees.
- because it adjoins other large protected areas, it provides an opportunity to preserve a complete forest ecosystem including the larger and rarer animals, such as elephants and leopards, that are vulnerable to extinction in smaller isolated reserves.
- the area has considerable potential for the development of tourism because of the impressive size of its trees, ease of access, and proximity to Murchison Falls National Park.

Threats: The greatest threat is undoubtedly posed by the dependence of the two operational sawmills on the natural forest as a source of roundwood supply.

Aerial photography undertaken by Gitec consultants in 1985 revealed a few small areas of agricultural encroachment in the southwestern Siba block. Although this is not yet a widespread problem, it does represent a long-term threat to the integrity of the forest. Population densities in the populated areas of Kigoronya, Biiso, Budongo, Karujubu and Pakanyi subcounties, which surround the forest, at the time of the last population census in 1980, were approximately 80, 140, 100, 160 and 50 persons/km^2 respectively.

There is no information available on the level of hunting activity in this forest, but it is to be expected that it has already reduced the populations of many of the larger mammals, and will continue to threaten these species.

Recommendations Specific to this Forest:

Nature Reserves should be established in representative areas of undisturbed forest to protect viable examples of the major communities. Suitable sites need to be identified through appropriate field surveys, accounting for approximately 15-20% of the forested part of the reserve (see Chapter Six, Recommendation 9).

As an immediate measure, a second Nature Reserve should be established in the lower-lying parts of the forest. The area selected should be as large as possible, but as a bare minimum, the whole of compartments W17 and W30 should be included (Fig. G1.2). This would protect 11 km^2 of forest in addition to the 7.5 km^2 already designated as Nature Reserve, representing a total of 4.3% of the forested land within the reserve. Other areas should be identified as a result of survey work.

Every effort should be made to ensure that timber harvesting is practised in a sustainable manner. Controls over the existing timber concessions should be rigidly enforced, and they should not be renewed until a detailed inventory of timber and biological resources has been completed, and Nature Reserves established.

Principal Reference Material:

Buechner, H.K. and H.C. Dawkins, (1961). Vegetation change induced by elephants and fire in Murchison Falls National Park, Uganda. *Ecology* 42(4).

Eggeling, W.J. (1940). Budongo - an East African mahogany forest *Emp. For. J.* 19: 179-196.

Eggeling, W.J. (1947). Observations on the ecology of the Budongo rain forest, Uganda. *J. Ecol.* 34: 20-87.

Eggeling, WJ. (1948). Epiphytes in the Budongo Forest. *Uganda Journal* 12(1): 106-114.

Friedmann, H. and J.G. Williams (1973). The birds of Budongo forest, Bunyoro Province, Uganda. *J.E. Afr. Nat. Hist. Soc.* 14: 1-18.

Gitec Consult Gmbh (1985). Feasibility Study for plywood and veneer factory, Budongo, Uganda. Phase la: Preliminary assessment of forest resources. Entebbe: Ministry of Agriculture and Forestry.

Philip, M.S. and A. Beaton (1964). Working Plan for Budongo Central Forest Reserve, for the period 1.7.1964 to 30.6.1974. Entebbe: Forest Department.

Reynolds, V. (c. 1964). The chimpanzees of Budongo Forest.

Table G1. Areas (km2) of different vegetation types and their condition in Budongo Forest Reserve

	Vegetation types						
Condition	Grass-land	*Celtis* forest	*Khaya* forest	*Cassia* forest	*Cynometra* forest	Undiff. forest	Total
Undisturbed	(381)	3	50	0	40	2	95
Mech. harvested pre-1950	-	13	27	0	50	0	90
Mech. harvested post-1950	-	111	52	34	30	0	223
Pitsawn	-	0	6	0	10	0	16
TOTAL (including Busaju)	(381)	127	135	34	130	2	428

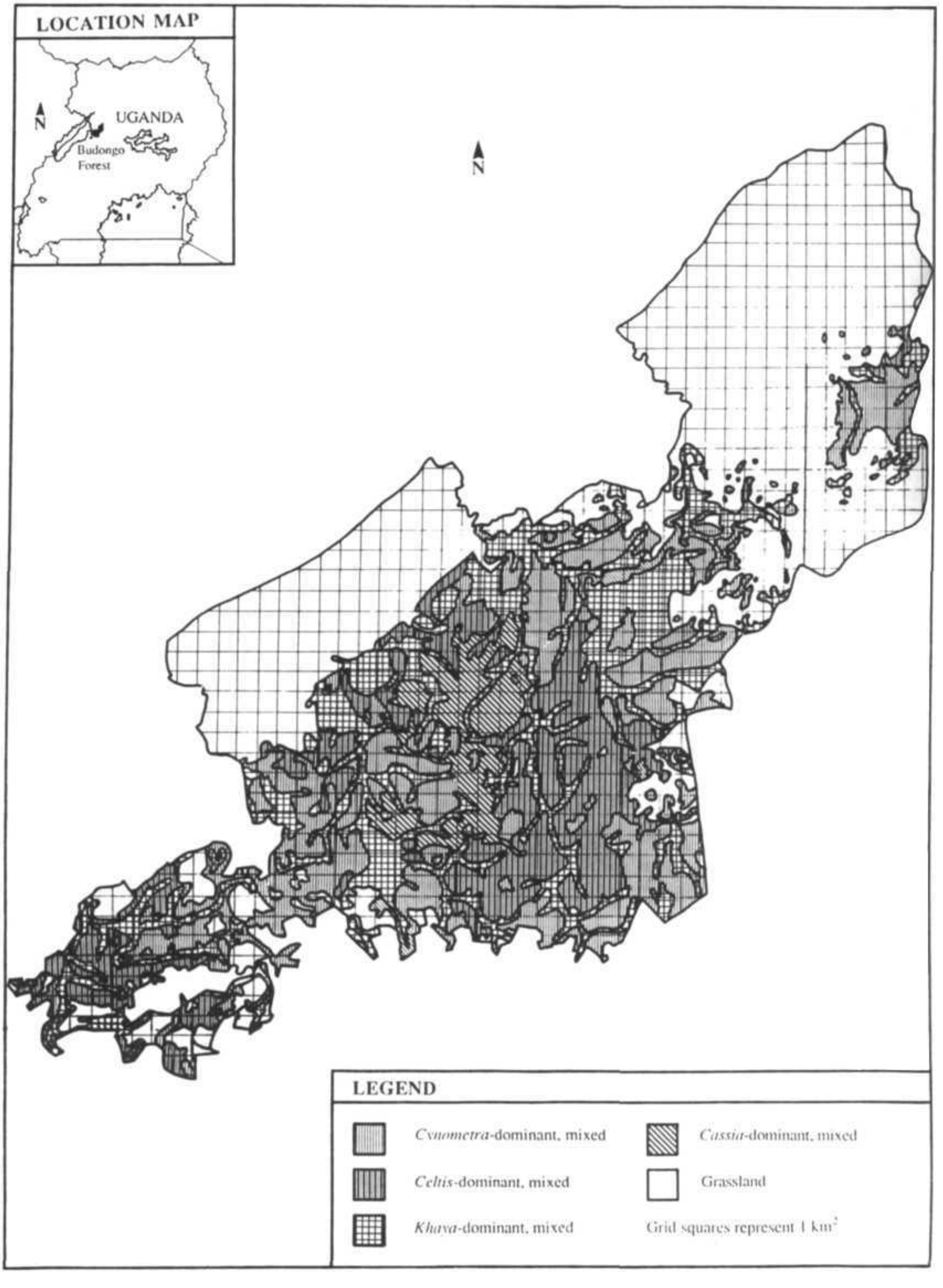


Fig. G1 *Budongo forest types*

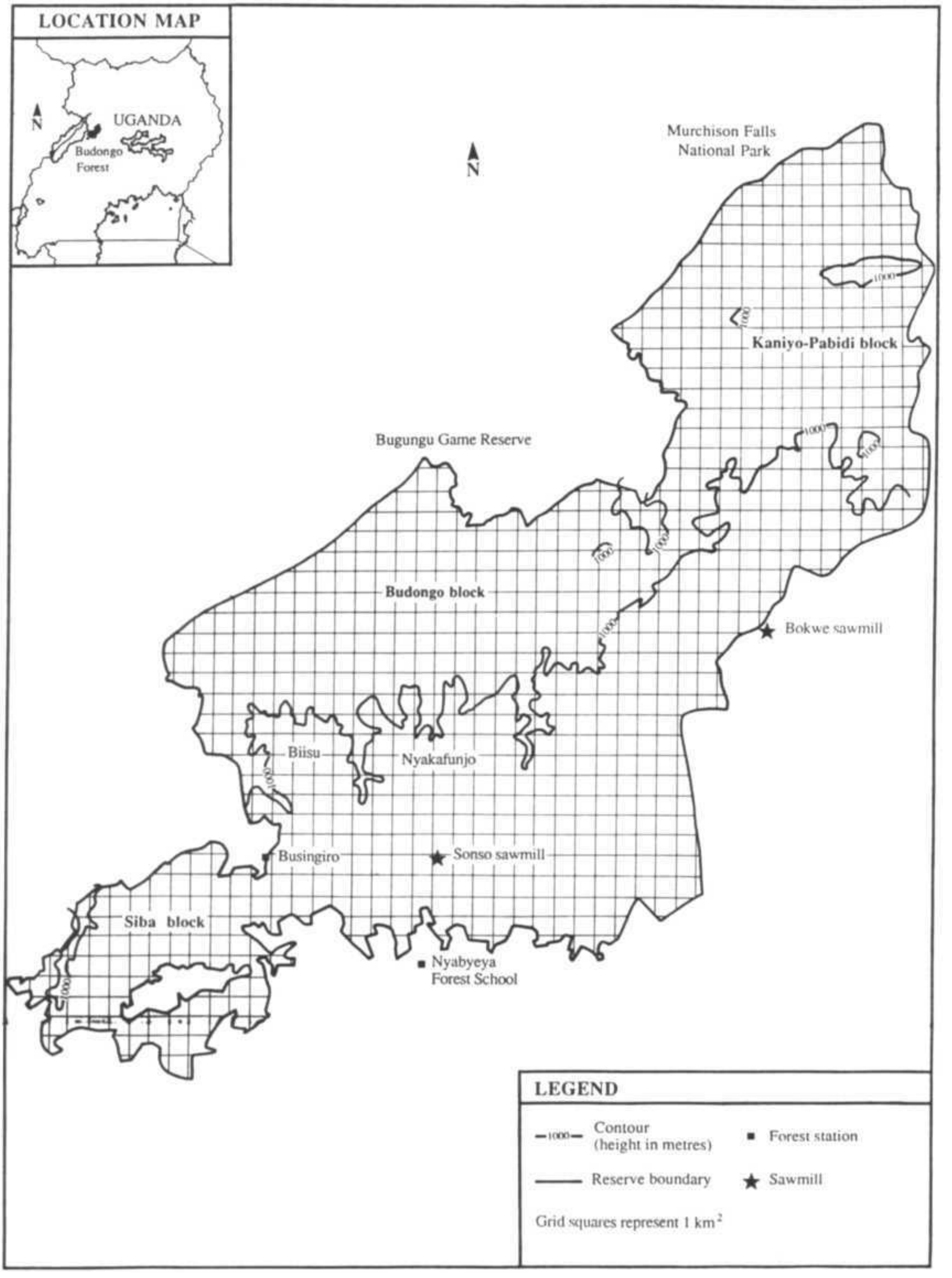


Fig. G1.1 Budongo Forest altitudinal zones

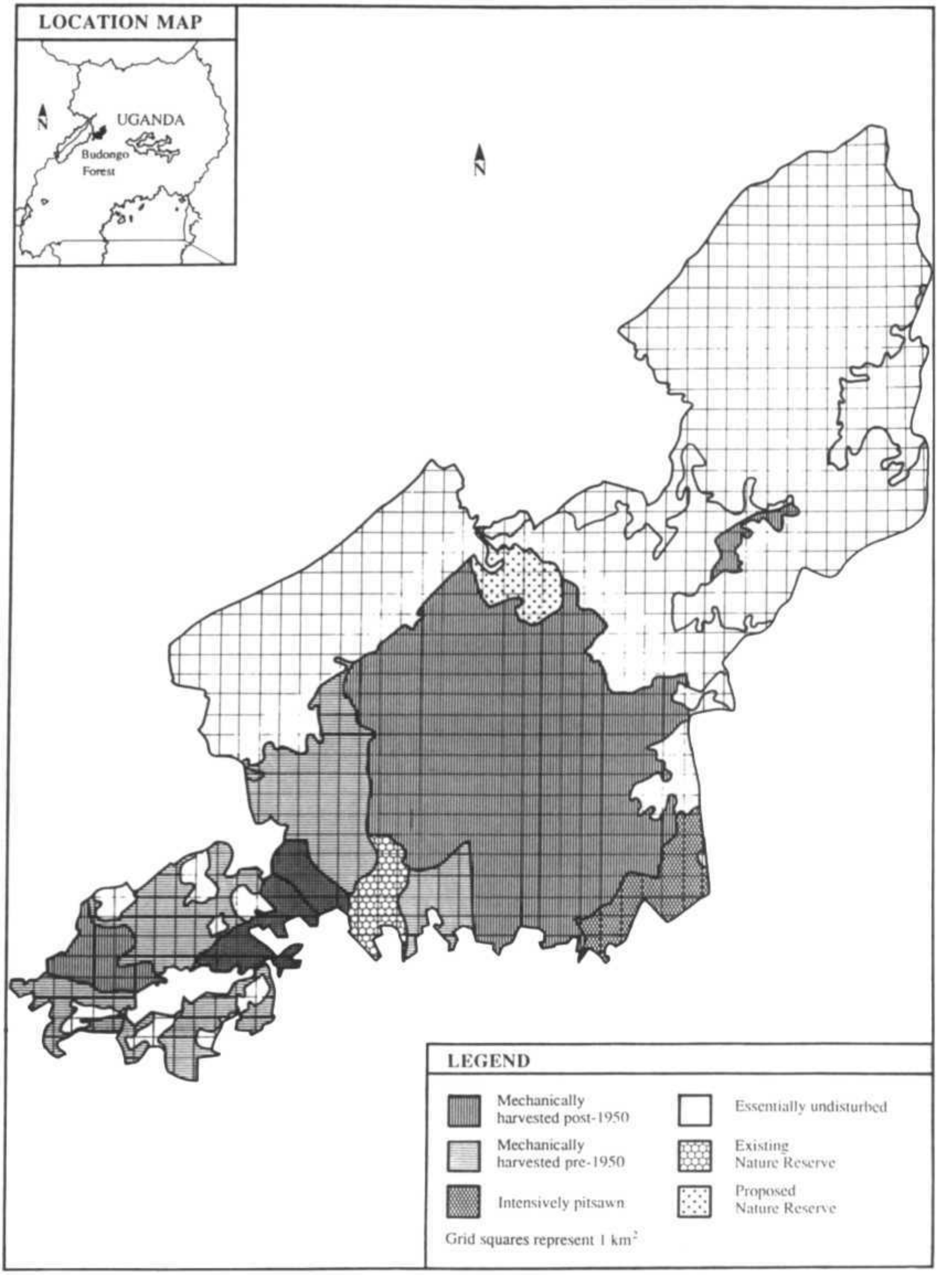


Fig. G1.2 *Present status of Budongo Forest, including the location of the proposed and existing Nature Reserves*

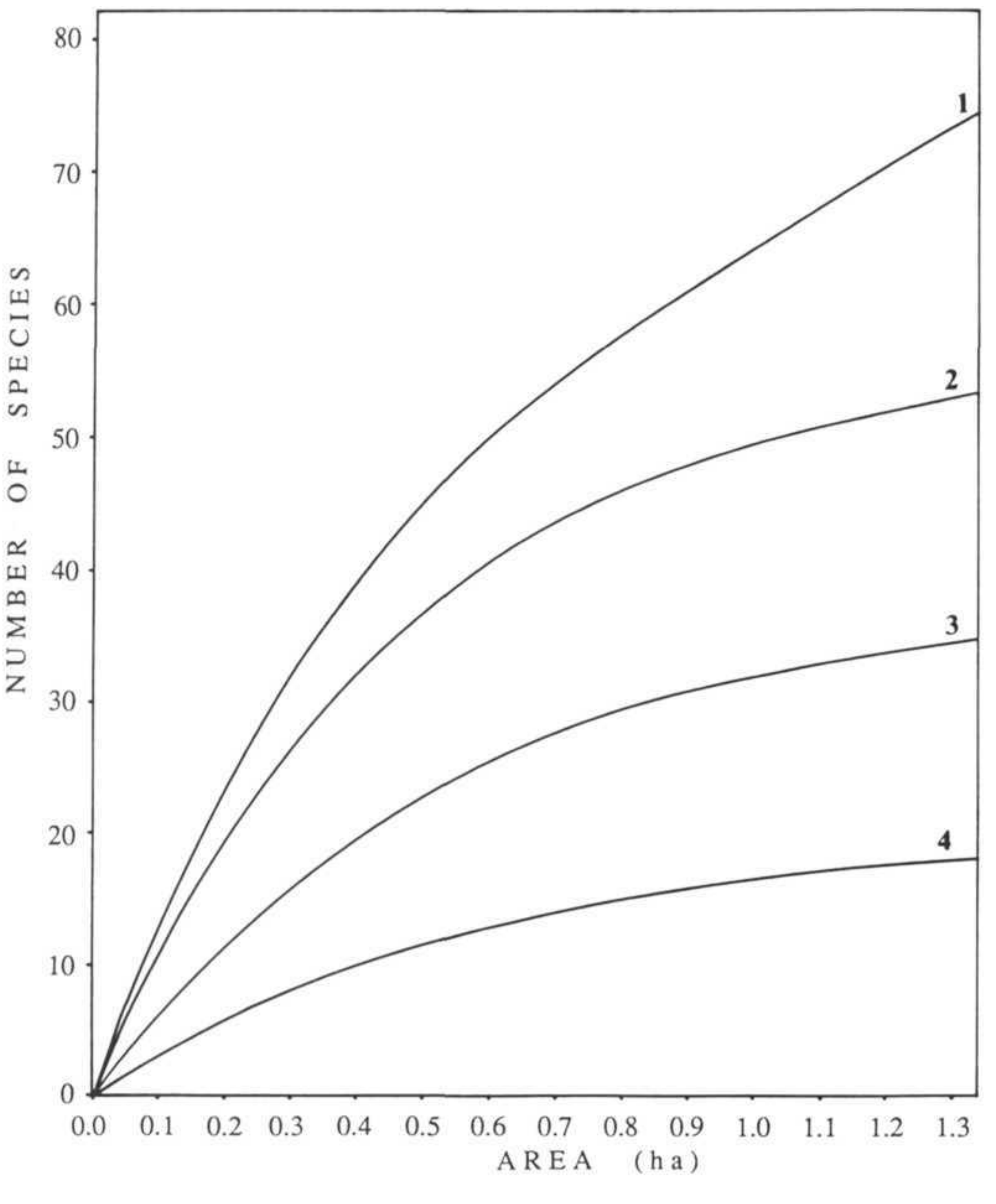


Fig. G2 *The cumulative number of tree species exceeding 10cm dbh, recorded as a function of area enumerated, at Budongo Forest. (Data are from Eggeling, 1947. Curve 1 represents a swamp forest plot, curve 2 mean values for two mixed forest plots, curve 3 mean values for three colonising forest plots, and curve 4 mean values for two Cynometra forest plots).*

Appendix H. Profile of the Maramagambo and Kalinzu Forest Reserves

Date Established: 1932

Geographical Location: On the floor of the western rift valley to the east of Lake Edward, stretching in a continuous belt up the escarpment and onto the plateau overlooking the valley. This large block of forest is gazetted as the North Maramagambo, South Maramagambo, and Kalinzu Forest Reserves. It straddles Bunyaruguru, Igara and Ruhinda Counties in the administrative district of Bushenyi, and Rujumbura County in Rukungiri District, 0°17'-0°36' S, 29°49'-30°07' E. Covered by Uganda Department of Lands and Surveys maps sheets 75/III, 75/IV and 84/II (Series Y732) at 1: 50,000.

Area: 580 km^2; comprising 291 km^2 (North Maramagambo), 152 km^2 (South Maramagambo) and 137 km^2 (Kalinzu). 299 km^2 of the area lies within the Queen Elizabeth National Park, which forms part of a very large transnational network of adjoining protected areas including Zaire's Virungas National Park (7,800 km^2), Rwanda's Volcanoes National Park (125 km^2), and Uganda's Rwenzori Forest Reserve (996 km^2), Semliki Forest Reserve (220 km^2), Kibale Forest Corridor Game Reserve (340 km^2), Kibale Forest Reserve (424 km^2, not included above), Chambura Game Reserve (157 km^2) and Kigezi Game Reserve (330 km^2). The Kalinzu Forest Reserve is also contiguous with the Kasyoha-Kitoma Forest Reserve (399 km^2) along 3 km of boundary. Approximately 75 km of boundary adjoins settled agricultural areas. Whenever boundaries do not follow natural features such as rivers, they used to be marked by cut lines, but no recent boundary maintenance has been undertaken.

Altitude: 915-1,845 m. 58 km^2 lies below 1,000 m, 385 km^2 at 1,000-1,250 m, 122 km^2 at 1,250-1,500 m, 14.5 km^2 at 1,500-1,750 m and 0.5 km^2 above 1,750 m.

Physical Features: Three-quarters of the forest occupies rather flat land on the floor of the rift valley, where the topography is broken only by a number of small, incised rivers which drain off the escarpment and flow E-W into Lake Edward. This part of the forest lies on sedimentary rocks of the Kaiso and Epi-Kaiso (Semliki) series which give rise to soils of rather low fertility, which are easily eroded. Most of the remainder of the forest (the Kalinzu portion) lies in a shallow depression on the top of the escarpment, from where it 'spills' down over the escarpment onto the valley floor. The underlying rocks here are of the Toro and Karagwe-Ankolean systems and consist of gneisses and schists, with some prominent quartzite ridges and hills. These are overlain by deep red loamy soils. The climate is tropical with two rainfall peaks from March to May and September to November. Annual temperature range, minimum: 14°-17°C, maximum: 25°-28°C. Rainfall: 1,150-1,400 mm.

Survey Work Conducted under this Project:
- a ground survey conducted over four weeks during September and October 1985;
- thirty-two censuses of forest primate populations conducted along four transect routes in different parts of the Kalinzu portion of the forest, and associated vegetation sampling, during October and November 1985;

- fourteen censuses of forest primate populations along two transect routes in different parts of the Maramagambo portion of the forest, and associated vegetation sampling, during August and September 1986;
- a flight over the Maramagambo portion of the forest in August 1986;
- vegetation sampling, ornithological and entomological survey work involving eight man-weeks of work in the Kalinzu portion of the forest at various times during July, August and September 1987.

Vegetation: The forest covers a wide variety of vegetation types which can be broadly classified as medium altitude moist evergreen forest (the Kalinzu portion), medium altitude moist semi-deciduous forest and moist thicket (the Maramagambo portion). Much of the Maramagambo portion of the forest receives so little rainfall that it can be considered to be of a marginal nature, and along its western fringes only moist thicket and bush communities develop. Fifteen percent of the area comprises grassland, bush and colonising forest, while 39% is *Cynometra*-dominated forest, 14% is *Parinari*-dominated forest and 22% is mixed forest (Fig. H1, Table H1). Two hundred and forty-two species of forest tree (57% of the country's total) have been recorded from this forest, more than from any other in Uganda. Twenty-three species were added to the list during the course of this study, and there are undoubtedly others yet to be recorded. All species are known from at least one other forest in Uganda, but many are known only from the west of the country and the following occur here as part of a very limited range in East Africa: *Elaeis guineensis, Philippia johnstoni, Elaeophorbia* sp. nov., *Cola bracteata, Dovyalis macrocarpa, Sapium leonardii-crispi, Ocotea usambarensis, Pittosporum spathicalyx, Tabernaemontana odoratissima, Dichaetanthera corymbosa, Cassipourea congoensis, Pauridiantha callicarpoides, Coffea liberica, Musanga leo-errerae, Hannoa longipes* and *Tricosycypha submontana.* Non-timber species of commercial interest include the oil palm, *Elaeis guineensis*, and Shari coffee, *Coffea liberica.* Four important timber species from this forest are considered endangered: *Chlorophora excelsa, Cordia millenii, Entandrophragma angolense* and *Lovoa swynnertonii* (FAO, 1986).

Tree species-area relationships were examined at seven sites representing a range of disturbed and undisturbed forest types (Fig. H2). Six data sets were derived from enumerations of trees exceeding 10 cm dbh in quadrats 20x20 m at 200 m intervals along primate census routes (see Fig. H1.1 for route locations), and a seventh was derived from tree enumerations in an area 5 m either side of ten 50 m cords placed at 50 m intervals alternately to the left and right, and perpendicular to, a 500 m transect line. Transect D (Fig. H1.1, Fig. H2) ran through an area of mixed forest that had been mechanically harvested over the 1950-64 period, along the road to the site of the old Kalinzu sawmill. With 63 tree species recorded in the 0.8 ha that was enumerated, this transect represents the richest of 27 sites examined in eight Ugandan forests under this research programme. The other areas examined in the Kalinzu portion (transects A, B, C, a) were somewhat poorer, but similar to sites examined in other forests at this altitude (e.g. Itwara, Kibale, Kasyoha). The forest of the Maramagambo portion appeared significantly poorer, with 27 species/ha recorded along transects E and F.

Fauna: The fauna of this reserve is reasonably well known and includes 181 species of forest bird (55% of the country's total), 6 species of diurnal forest primate (50% of the country's total) and 40 species of forest swallowtail and *Charaxes* butterfly (59% of the country's total). Species normally characteristic of both lowland and highland forest occur here in close proximity. All are known from elsewhere in Uganda, although the butterfly *Charaxes nobilis* deserves special mention as a 'very uncommon Congo forest species' (Williams, 1969) known in Uganda only from Kalinzu and Sango Bay; and the following birds occur here as part of an East African range limited to a few forests of western Uganda: white-naped pigeon *(Columba albinucha)*, Rwenzori Turaco *(Tauraco johnstoni)*, yellow-throated green cuckoo *(Chrysococcyx flavigularis)*, Willcocks' honeyguide *(Indicator willcocksi)*, black-winged oriole *(Oriolus nigripennis)*, forest flycatcher *(Fraseria ocreata)* and purple-breasted sunbird *(Nectarinia purpureiventris)*. Both the chestnut-breasted negrofinch *(Nigrita bicolor)* and the yellow-bellied wattle-eye *(Platysteira concreta)* are uncommon species known from this forest. Threatened or near-threatened species are: elephant *(Loxodonta africana)*, chimpanzee *(Pan troglodytes)*, l'hoest's monkey *(Cercopithecus l'hoesti)*, leopard *(Panthera pardus)*, white-naped pigeon *(Colombo albinucha)* and African giant swallowtail butterfly *(Papilio antimachus)*.

Twelve species of large mammal were recorded from the forest during the ground survey, either by direct sighting or auditory cues (in the case of six species of primate), by means of distinctive spoor (in the case of six other species), or by sighting chimpanzee 'nests'. The distributions of records are shown in Fig. H3. The spoor of a large duiker (probably *Cephalophus callipygus*, since an individual of this species was released from a snare during the course of the survey) were recorded in 10% of the 125 km^2 compartments surveyed, of bushbuck *(Tragelaphus scriptus)* in 2% of compartments, of a dwarf antelope *(Cephalophus monticola*, or perhaps *Neotragus batesi)* in 3%, of buffalo *(Syncerus caffer)* in 6%, of bushpig *(Potamochoerus porcus)* in 35% and of elephant *(Loxodonta africana)* in 10%. Of the primates, redtail monkeys *(Cercopithecus ascanius)* were recorded in 28% of compartments, blue monkeys *(Cercopithecus mitis)* in 30%, chimpanzees *(Pan troglodytes)* in 30%, baboons *(Papio anubis)* in 12% and black and white colobus *(Colobus guereza)* in 36% of compartments. Primate population densities, estimated from census statistics along the six line transects (Fig. H1.1), are given in Table H2. Of particular interest are the high densities of l'hoest's monkey recorded in this forest.

Economic Importance: The Kalinzu portion of this forest is an important source of timber, which has been exploited by two sawmills, one operating in the south of the reserve between 1950 and 1975, and the other operating in the centre-north of the reserve from the early 1970s to the present day. A 2% enumeration was carried out in 1953, from which an estimated stocking of 82 m^3/ha for trees exceeding 50 cm dbh was derived (Lockwood Consultants, 1973) - second only to Budongo Forest. The Maramagambo portion has not been enumerated, but there is no intention to exploit timber in most of this area in the foreseeable future.

At the time of the ground survey an estimated 40 pitsawing teams were operating in the Kalinzu portion of the reserve, engaging 200-400 people in its related activities. Some pitsawing was also reported in the extreme south of the Maramagambo portion, and a group of about ten men were engaged in charcoal manufacture in the northwestern corner of the S. Maramagambo, supplying the fishing village of Rwenshama with fuel for domestic and fish-smoking purposes. Local people use the forest as a hunting area, and as a source of building poles, medicinal compounds etc. A few small streams in the centre-north of the Kalinzu portion were being worked for gold, involving 20-40 people.

Present Status: The majority of the forest (the Maramagambo portion) is contained within the Queen Elizabeth National Park and adjoining Kigezi Game Reserve where it is relatively well protected against human disturbance. The Forest Department has undertaken not to open up any of the forest within the Park to exploitation unless there comes a time when there is a pressing demand for forest produce which cannot be supplied from elsewhere. The Kalinzu portion, on the other hand, is rather heavily exploited, and only about 9% of the original *Parinari* (climax) forest remains undisturbed, whilst 50% has been felled to supply the two sawmills, and a further 39% has been 'creamed' of the best timber trees by pitsawyers over a very wide area (Fig. H4, Fig. H1.2, Table H1). Overall, about 8% of the Maramagambo/Kalinzu forest has been mechanically harvested and a further 10% has been affected by various levels of pitsawing activity.

Hunting activity was noted in 8% of the compartments surveyed (Fig. H4), including several records of rather large parties of men (20-40 persons) with dogs, spears and nets. It is well known locally that hunting parties travel through the forest to gain access to the Queen Elizabeth National Park, where buffalo and warthog are favoured quarry; one such party was encountered on its way back from the Park, laden with meat, during the ground survey. Elephant numbers have been particularly hard hit by poaching, and most of the tracks recorded during the ground survey (Fig. H3) were more than six months old.

An area of about 8 km^2 to the west of Kasunju hill in the extreme north of the Kalinzu portion has been designated as a Nature Reserve, but it has been quite heavily exploited by pitsawyers from Rutoto.

Management: The forest is administered from the Bushenyi and Rukungiri District forest offices, with a senior forester, a forest officer and ancilliary staff posted to the Kalinzu forest station (comprising four houses, labour lines and an office); a senior forester and ancilliary staff posted to the Nkombe sawmill, Kalinzu; a forest ranger posted to Rwenshama fishing village; and a senior forester posted to Bikurungu village, south of South Maramagambo. There are additional forest guards stationed at various points around the forest. Management of N. Maramagambo is left to the National Park authorities.

Motorable tracks penetrate the Kalinzu portion as far as the site of the old Kalinzu sawmill, and from the Ministry of Works post below Lubare ridge on the main Ishaka-Katunguru road to the Nkombe sawmill and from there 1km further west and 4km south. The Kalinzu portion is very well served by footpaths, many of which follow overgrown timber extraction roads in the southern half of the area. The Maramagambo is much less accessible, the one main (foot) route following the (overgrown) 'chimp track' from Kaizi ranger post east to Bitereko.

The latest Working Plans for this area cover the period 1.7.1960-30.6.1970 (Kalinzu) and 1970-1980 (Maramagambo). They prescribe for the maximum sustained economic yield of general purpose timber, the preservation of environmental protection qualities and the preservation of a representative area as a Nature Reserve in the Kalinzu; and for the preservation of that part of Maramagambo that lies within the Park, as well as improving the potential production of usable produce from the remainder.

The National Parks authorities used to maintain a ranger post at Kaizi, near the southwestern corner of N. Maramagambo, but this was 'raided' by the National Resistance Army in September 1985 (whilst we were camped there), and has subsequently been destroyed. There is a second ranger post at Nyamasingire in the northeastern corner of the forest. At present there are no effective anti-poaching activities in this forest.

Conservation Importance:

- this is one of the richest forests in Uganda, with more tree species recorded here than anywhere else, and a great wealth of animal species.
- much of the forest lies within the Queen Elizabeth National Park, a UNESCO Man and the Biosphere reserve, and has high potential for tourism development.
- unlike most of Uganda's forest reserves which are isolated by surrounding agricultural lands, this area forms part of a major network of contiguous transnational protected areas which has the potential to safeguard viable populations of the larger and rarer species, including elephant, leopard, etc. which are extremely vulnerable elsewhere. Thus, in the long term, this forest represents one of Uganda's best opportunities to preserve a 'complete' forest ecosystem.
- the forest represents the largest undisturbed tract of forest at this altitude in Uganda.
- it harbours the largest population of l'hoest's monkey yet described, a species considered vulnerable to extinction (IUCN, 1986).
- it has particularly high primate population densities, especially in the Kalinzu.
- the forest covers an exceptional altitudinal range (915-1,845m), which combined with its topographical, climatic and geological diversity, and its location in western Uganda close to believed Upper Pleistocene forest refuges, gives rise to a great variety of forest habitats.

Threats: The greatest immediate threat to this forest is posed by the continuing operation of the Nkombe sawmill, which supplies *Parinari* timber to the Kilembe mine. *Parinari* is particularly well suited to use in the mine as it is hard and durable, yet it is not regenerating well in the logged forest where mixed communities characteristic of an earlier seral stage tend to develop in its place. The *Parinari* forest is also being heavily exploited by pitsawyers, who threaten to eliminate some of the better timber species (e.g. *Entandrophragma, Lovoa)* through their selective timber felling activities.

Agricultural encroachment is not yet a problem, but population densities are mounting rapidly along the eastern borders of the forest. According to 1980 census statistics, the population densities of the adjacent settled parts of Ryeru, Kyamugunga, Bitereko, Ruhinda and Bugangari subcounties were about 280, 140, 130, 180 and 90 people/km^2 respectively.

Uncontrolled hunting, even within the National Park, threatens all the larger ground-dwelling mammals.

Recommendations Specific to this Forest:

- more of the forest lying outside Queen Elizabeth National Park should be designated as Nature Reserve, particularly in the higher-lying (Kalinzu) portion of the reserve. A figure of 20-25% of the forest outside the Park is recommended for designation in this way (see Chapters Four and Six (Recommendation 9) for more detailed explanation and justification). A proposed Nature Reserve is marked on Fig. H1.2 covering management compartments 19, 20, 22 (western half) 32 and 33. This area covers a wide variety of communities on the forested escarpment, and up onto the plateau to include a little of the remaining undisturbed *Parinari* forest. It covers about 15 km^2 (11%) of the Kalinzu reserve. In view of the importance of this forest for species conservation, and its high potential for tourism development, serious consideration should also be given to enhanced conservation status for a much larger area of forest southwest of Lubare ridge, including management compartments 37, 38, 39, 40, 41 and 42. This would provide a 'corridor' of undisturbed forest of great conservation importance that could be exploited by developing a hiking trail and other tourist facilities between the main Ishaka-Katunguru road south of Lubare ridge and the scenic area around Lake Nyamusingire at the foot of the escarpment in the Queen Elizabeth National Park.
- anti-poaching activities should be re-activated.
- pitsawing activity should be more strictly regulated, and restricted to one or two management compartments at any one time.

Principal Reference Material:

Friedmann, H. and J.G. Williams, (1970). The birds of the Kalinzu forest, southwestern Ankole, Uganda. Los Angeles County Museum Contributions in Science Number 195.

Kisubi, A. (in prep.). Responses of wild primates to forest habitats in western Uganda. Unpublished MSc thesis. Makerere University, Kampala.

Osmaston, H.A. (1960a). Working Plan for the Kalinzu Forest. Period 1960 to 1970. Entebbe: Uganda Forest Department.

Osmaston, H.A. (1960b). Working Plan for the Maramagambo Forest. Period 1960 to 1970. Entebbe: Uganda Forest Department.

Williams J.G. (1967). A field guide to the National Parks of East Africa. London: Collins.

Williams, J.G. (1969). A field guide to the Butterflies of Africa. London: Collins.

Synnott, T.J. (1970a). Working Plan for the Maramagambo Forest Reserve. Entebbe: Uganda Forest Department.

Synnott, T.J. (1970b). Working Plan for the Kalinzu Forest Reserve. Entebbe: Uganda Forest Department.

Table H1. Areas (km2) of different vegetation types and their condition in Kalinzu/Maramagambo Forest Reserves

Condition	Vegetation types								
	Grass-land	Bush/ Thicket	Open water, swamp	Mixed forest	*Parinari* forest	*Cynometra* forest	Colon-ising forest	Hill forest	TOTAL
Undisturbed	26	30	1	112	7	225	26	48	479
Mechanically harvested	0	0	0	3	40	0	4	0	47
Lightly pitsawn	0	0	0	9	31	3	3	4	50
Heavily pitsawn	0	0	0	1	2	0	0	1	4
TOTAL	26	30	1	125	80	228	33	53	580

Table H2. The number of primate groups seen per kilometre of census route (mean ± SE) and, in parentheses, the estimated population densities (number of groups/km2) of each species along six transects. Transect locations are shown in Fig. H1.1. Data are from Kisubi (in prep.)

Census route	Length (km)	Estimated strip width (km)	No. of censuses	Primate species				
				C. ascanius	*C. mitis*	*C. l'hoesti*	*C. guereza*	*P. anubis*
A	5.0	0.06	8	0.07 ± 0.05 (1.2)	0.27 ± 0.09 (4.5)	0.04 ± 0.05 (0.7)	0.14 ± 0.05 (2.3)	0.00 ± 0.00 (0.0)
B	5.0	0.12	8	0.49 ±0,06 (4.1)	0.64 ± 0.13 (5.3)	0.11 ± 0.04 (0.9)	0.40 ± 0.09 (3.3)	0.00 ± 0.00 (0.0)
C	5.0	0.06	8	0.06 ± 0.03 (1.0)	0.28 ± 0.07 (4.7)	0.04 ± 0.03 (0.7)	0.16 ± 0.06 (2.7)	0.02 ± 0.02 (0.3)
D	4.0	0.12	8	0.82 ± 0.09 (6.8)	0.35 ± 0.10 (2.9)	0.32 ± 0.07 (2.7)	0.27 ± 0.10 (2.3)	0.10 ± 0.05 (0.8)
E	5.0	0.06	7	0.26 ± 0.09 (4.3)	0.00 ± 0.00 (0.0)	0.03 ± 0.03 (0.5)	0.23 ± 0.05 (3.8)	0.03 ± 0.03 (0.5)
F	5.0	0.06	7	0.34 ± 0.08 (5.7)	0.34 ± 0.08 (5.7)	0.09 ± 0.04 (1.5)	0.71 ± 0.07 (11.8)	0.23 ± 0.05 (3.8)

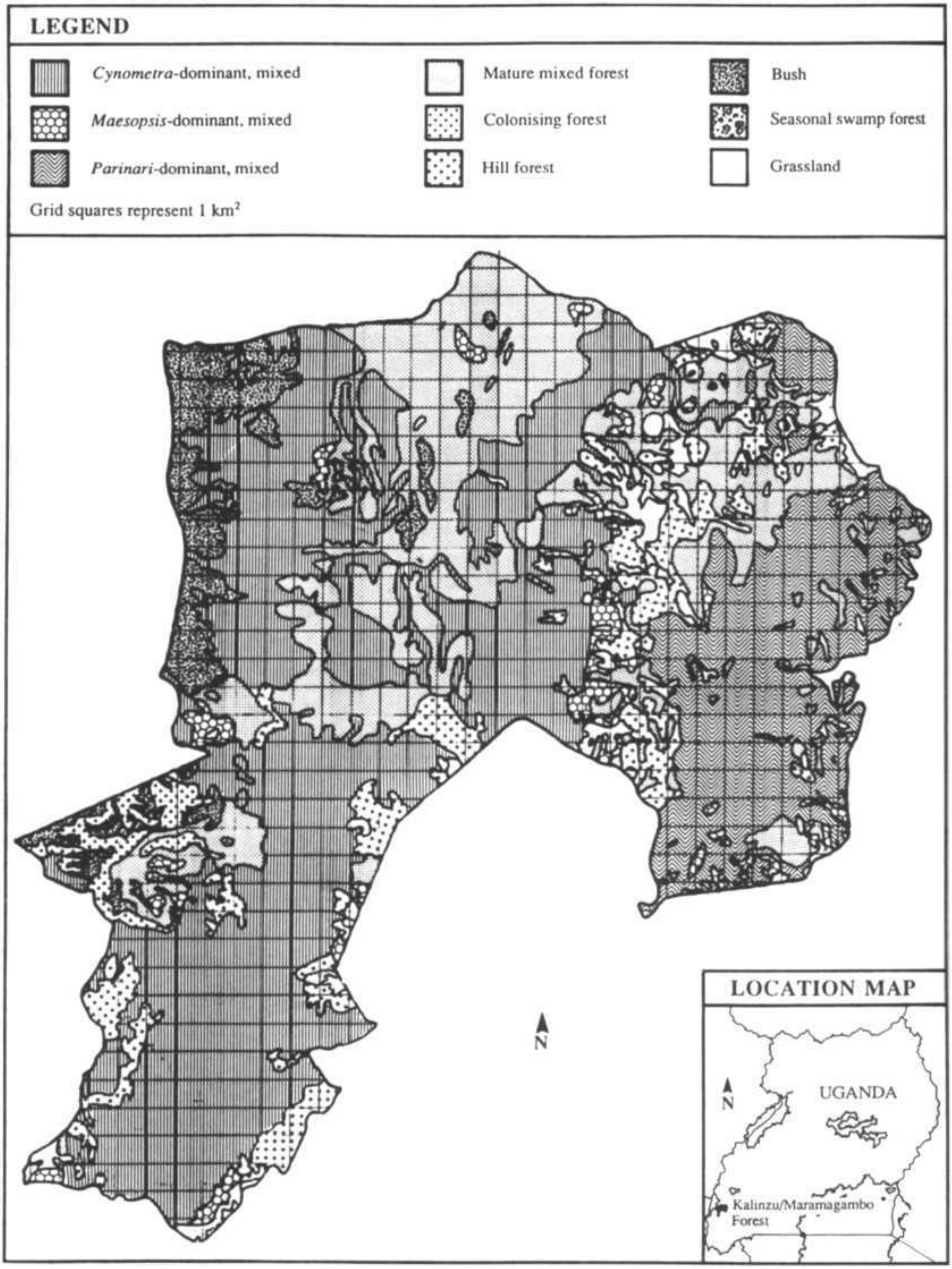


Fig. H1 Kalinzu/Maramagarnbo forest types

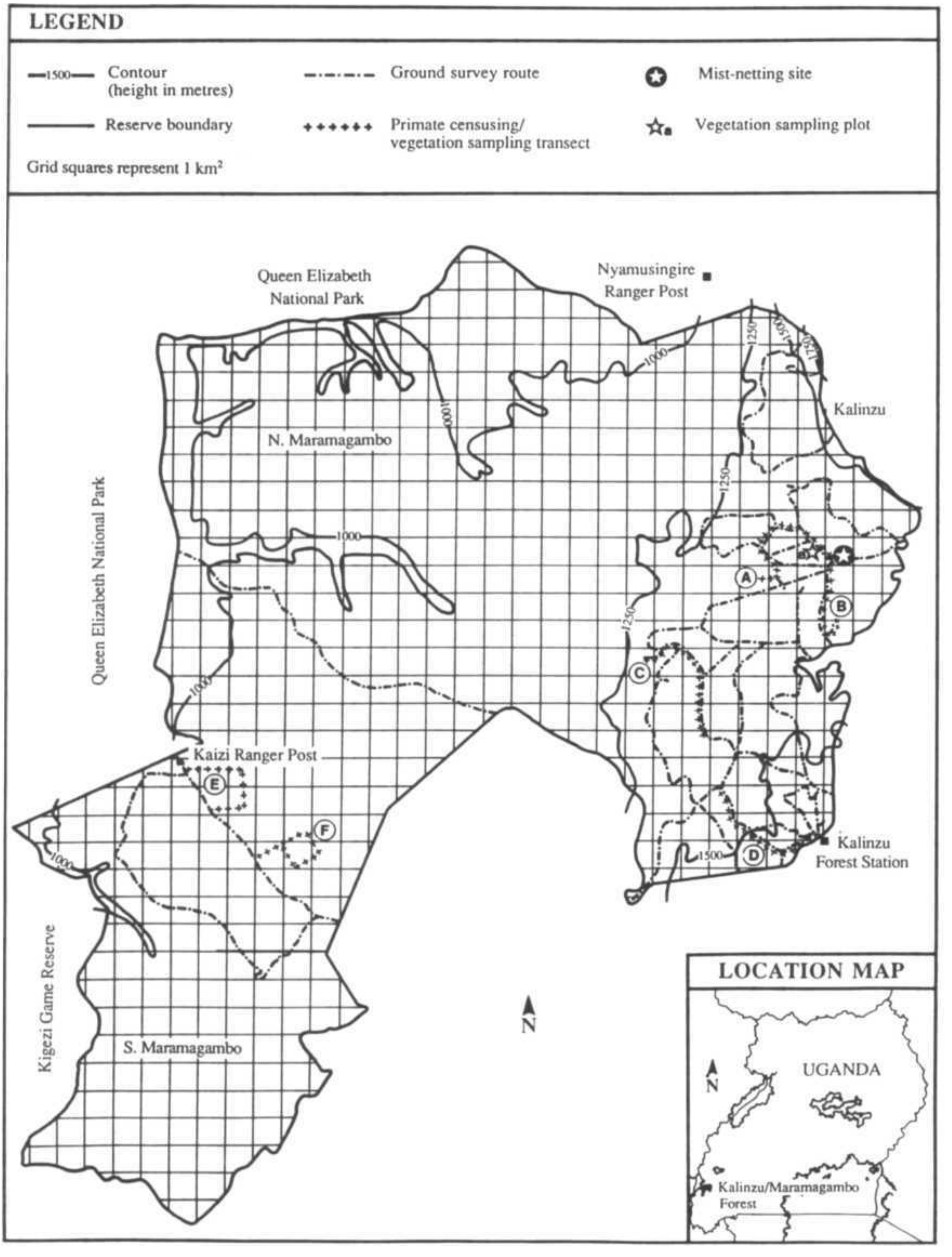


Fig. H1.1 *KalinzulMaramagambo Forest ground survey routes, transects, mist netting sites, tree enumeration sites and altitudinal zones*

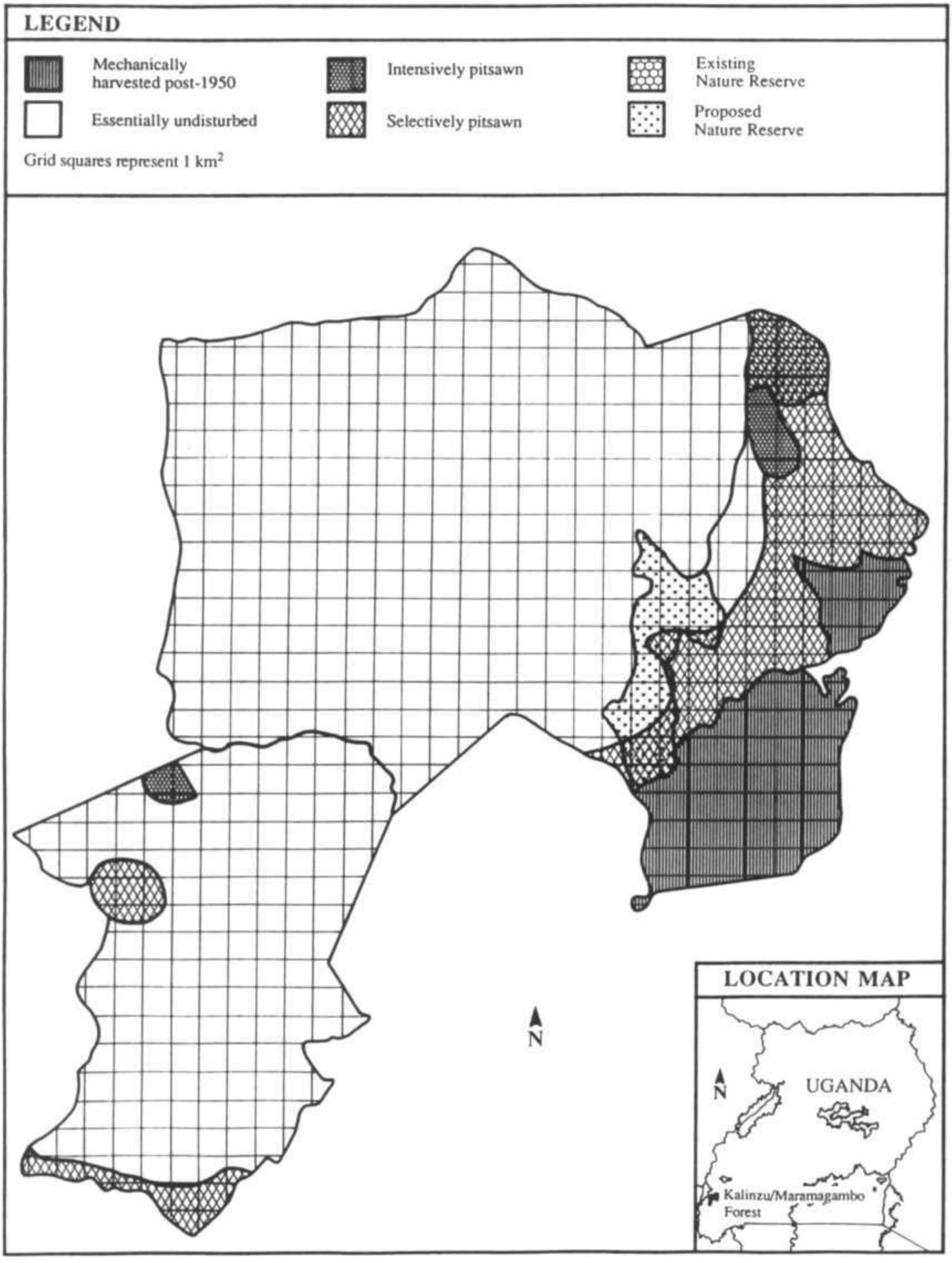


Fig. ***H1.2*** *Present status of KalinzulMaramagambo Forest, including the locations of existing and proposed Nature Reserves*

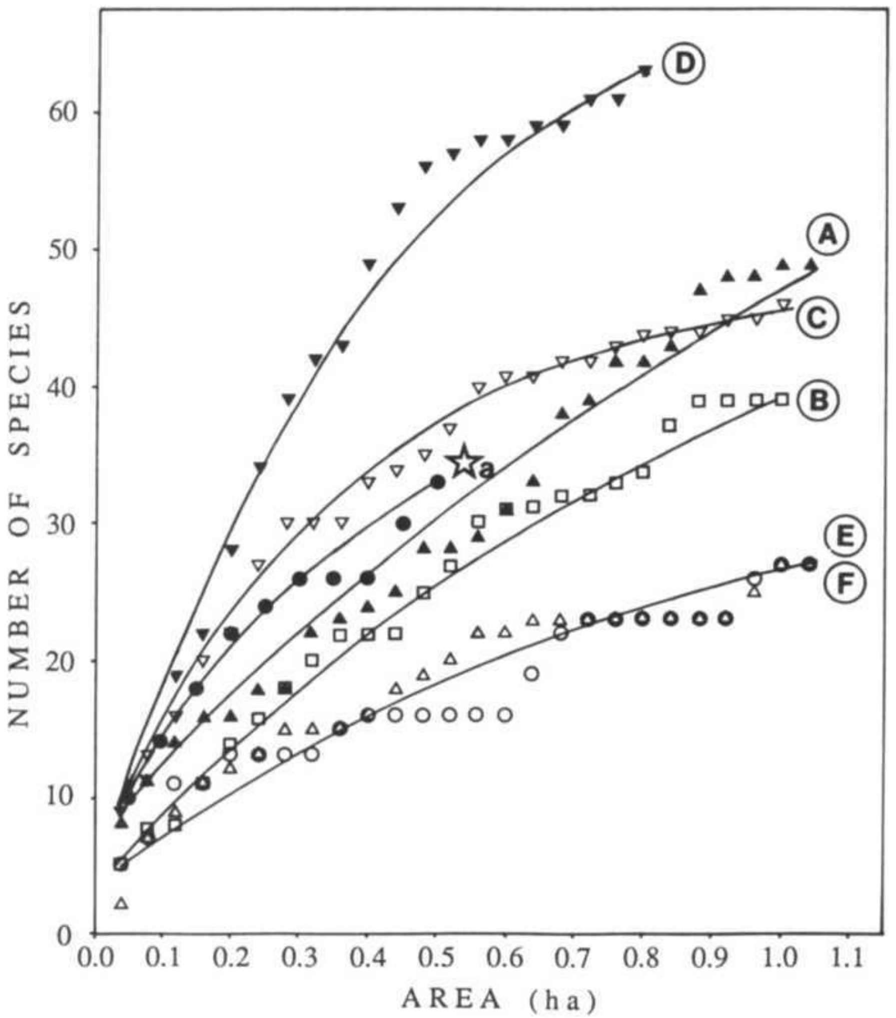


Fig. H2 *The cumulative number of tree species exceeding 10cm dbh, recorded as a function of area enumerated, at Kalinzu/Maramagambo Forest. (Data for six curves are from 20m x 20m plots positioned at 200m intervals along primate census routes. One curve is derived from 50m x 10m plots positioned at 50m intervals perpendicular to a central transect line, alternately to the left and right of the line).*

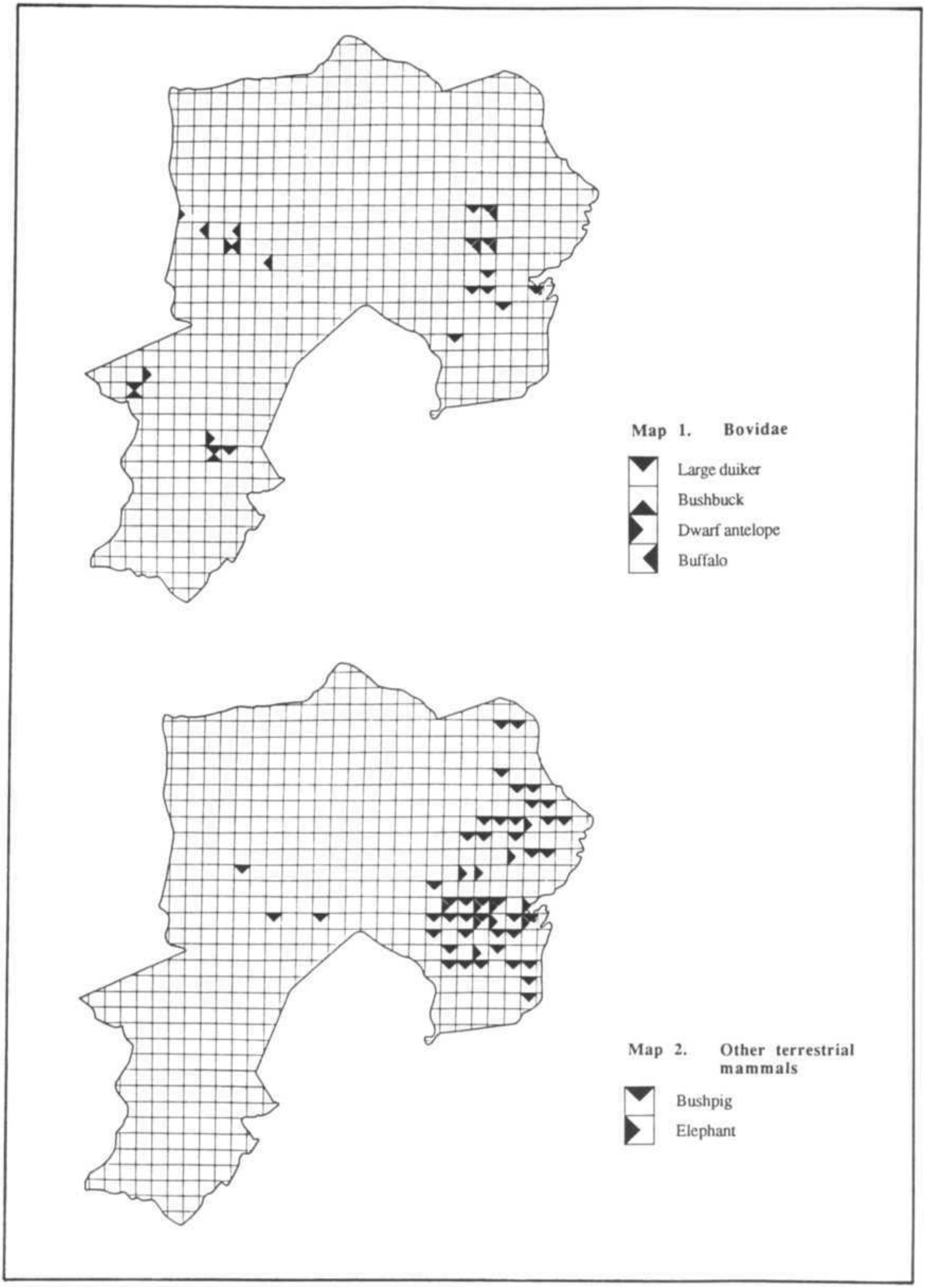


Fig. H3 *Distribution of large mammal records made during the ground survey of KalinzulMaramagambo Forest*

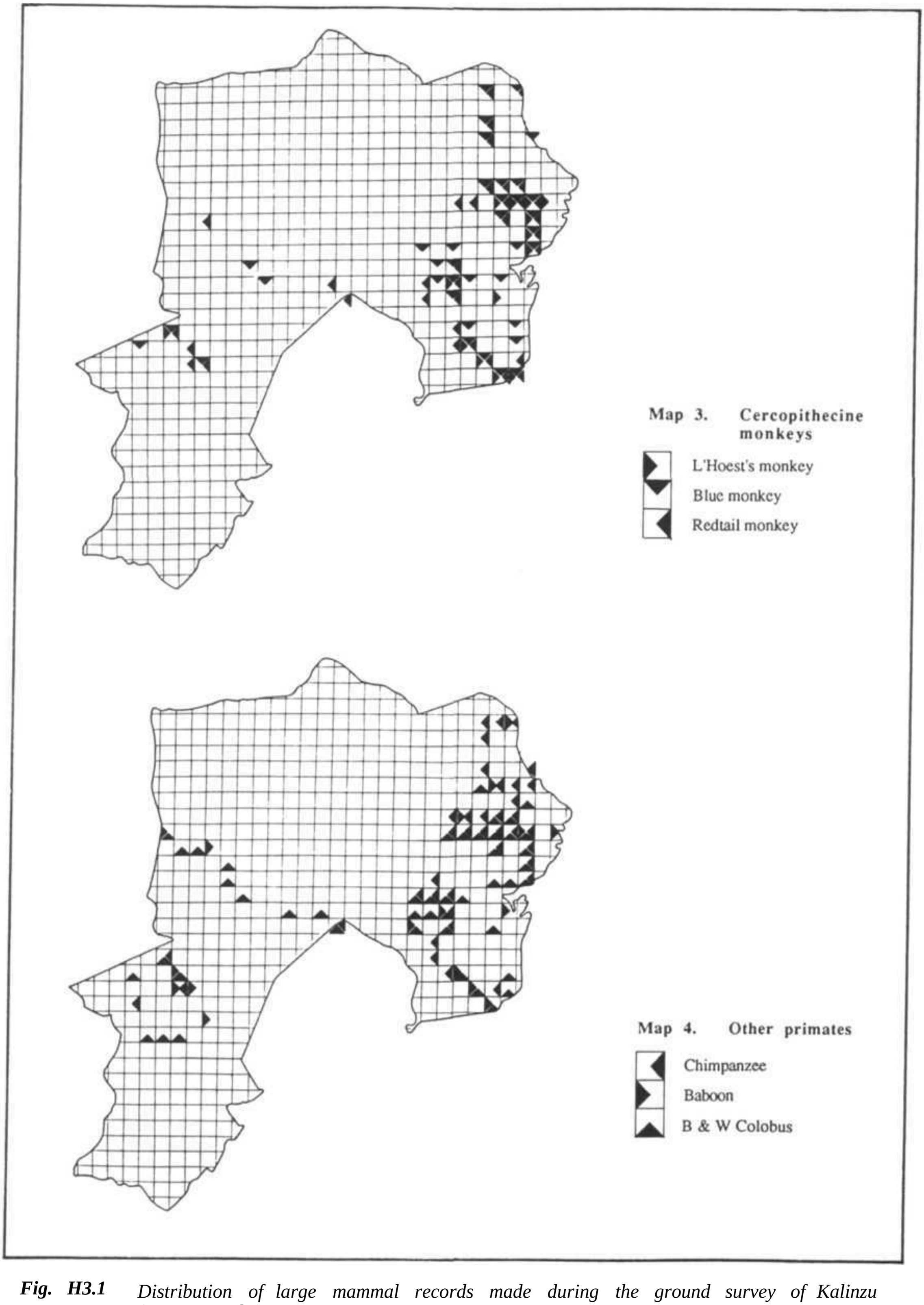


Fig. H3.1 *Distribution of large mammal records made during the ground survey of Kalinzu /Maramagambo Forest*

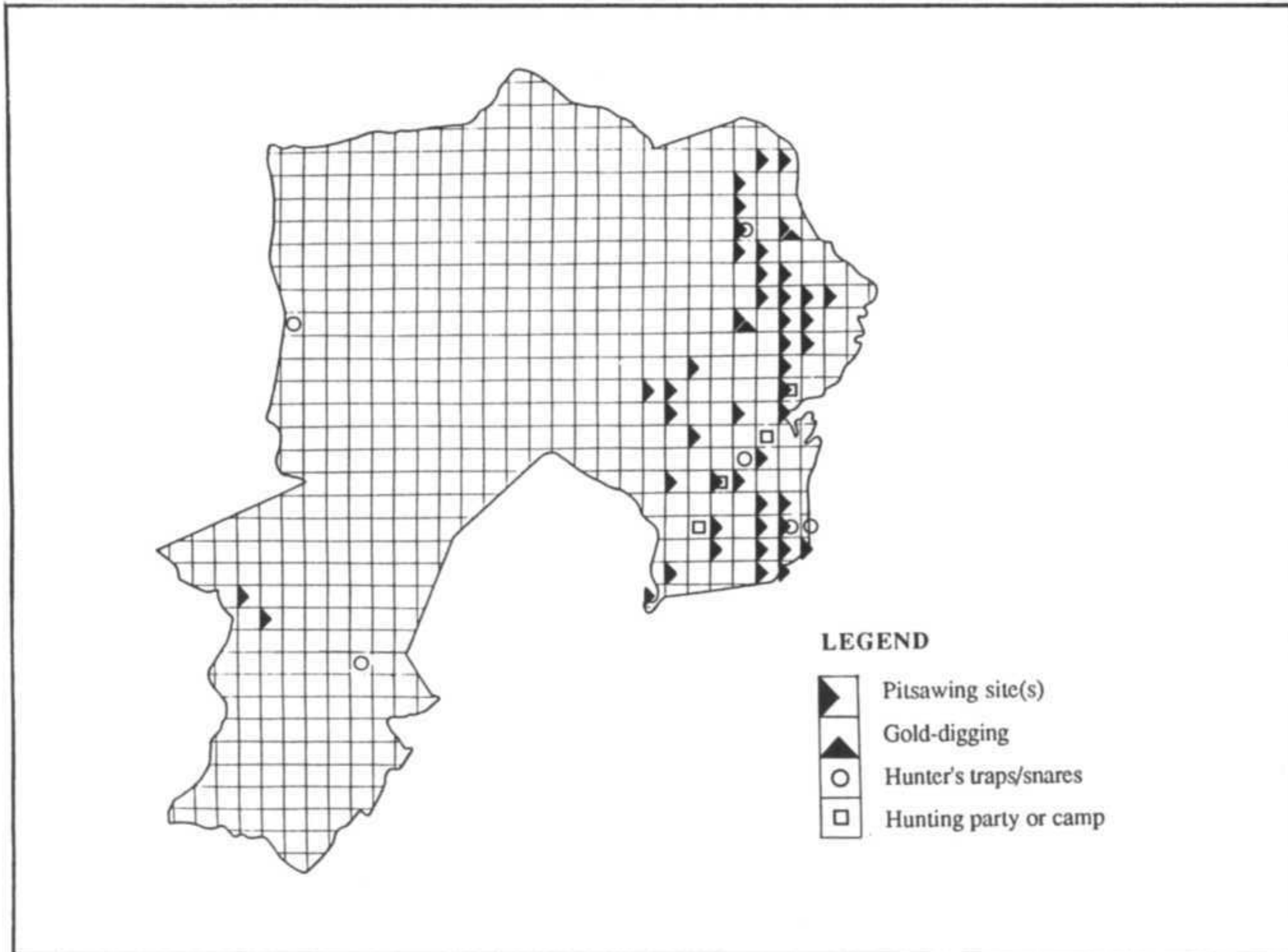


Fig. H4 *Distribution of human activities recorded during the ground survey of Kalinzu/Maramagambo Forest*

Appendix I. Profile of the Bugoma Forest Reserve

Date Established: 1932

Geographical Location: On the escarpment overlooking Lake Albert to the west of, and mid-way along the main Kyenjojo-Hoima road. The forest lies in Bugahya and Buhaguzi Counties, in the administrative district of Hoima. l°07'-l°25' N, 30°48'-31°07' E. Covered by Uganda Department of Lands and Surveys maps sheets 47/II, 47/IV, 48/I and 48/III (Series Y732) at 1:50,000.

Area: 365 km^2, partially demarcated by cut lines and direction trenches, but these have received little or no maintenance over the past decade or more. The reserve is isolated from other protected areas by land that has already been settled, or is earmarked for settlement.

Altitudinal Range: 990-1,295 m. 1.0 km^2 of the reserve lies below 1,000 m, 363.9 km^2 at 1,000-1,250 m, and 0.1 km^2 above 1,250 m.

Physical Features: The reserve occupies rolling country, which drains towards Lake Albert in the west. The only permanent river is the Nkusi, which forms the southern boundary of the reserve, with the majority of the area drained by streams that flow only seasonally. The underlying rocks consist of schists, shales, quartzites and dolerites of the Karagwe-Ankolean Series, merging with those of the Bunyoro Series in the east. The soils are mostly deep tropical red earths often lateritic with nodular concretions. The climate is tropical with two rainfall peaks from April to May and September to November. Annual mean temperature range, minimum: 16-18° C, maximum: 28-29° C. Annual rainfall: 1,100-1,350 mm.

Survey Work Conducted under this Project:

- a ground survey over eight days during March 1987 (routes followed are shown in Fig. I1.1);
- examination of tree species richness through enumeration of trees exceeding 10 cm dbh in two 0.5 ha plots. The method employed involved examining ten percent of two 500 m x 100 m plots by enumerating all trees 5 m either side of a 50 m cord positioned perpendicular to a 500 m transect at ten 50 m intervals, alternately to the left and right of the transect line;
- ornithological and entomological survey work carried out by a three man team, and including 3,200 metre-net-hours of mist-netting over fourteen days in August 1987.

Vegetation: The forest lies in irregular blocks intersected by large patches of *Hyparrhenia, Penniseturn* and *Cymbopogon* grasslands. Grassland occupies 65 km^2 or 18% of the reserve's area. The forest itself is broadly classified as medium altitude moist semi-deciduous forest (Langdale-Brown *et al.*, 1964), and is regarded from an ecological and forestry point of view as a 'poor relation' of the Budongo. About half of the forested portion is dominated by the ironwood tree, *Cynometra alexandri* which contributes more than 50% of tree basal area in forest types CYS, CY, CM, PCY, CMS (Table I1; Osmaston, 1959). A further 38% of the forested portion is of mixed forest types in which *Albizia* spp., *Celtis* spp., *Alstonia, Chrysophyllum, Entandrophragma, Schrebera, Balanites* etc. are common, and species characteristic of somewhat higher altitudes, such as *Olea*, *Parinari* and *Prunus* are well represented. The remainder of the forested area is occupied by poor, hill and colonising forest types (Table I1). Osmaston(1959) provides a useful review of available information on the processes of natural regeneration and succession in this forest and concludes that, whereas in Budongo forest *Cynometra* supersedes mixed mahogany (Eggeling, 1947), in Bugoma *Cynometra* is <u>not</u> invading the mixed forest types and the different types appear to result from differing biotic and edaphic conditions, rather than representing successive seral stages.

Tree species richness was examined in two 0.5 ha plots which yielded 36 species in a *Cynometra* forest area which had been felled about 37 years previously, and 41 species in a mixed forest area that had been disturbed. One hectare plots in these forest types would thus be expected to yield about 45 and 50-55 species respectively, making them amongst the richer Ugandan forest types.

The trees of this forest are still rather poorly known. One hundred and fifty-eight species (36% of the country's total) have been listed, including 13 added during this study. All occur elsewhere in Uganda, although *Celtis adolfi-fridericii* is known only from Bugoma and Semliki forests. Four other Bugoma species are uncommon or of very restricted distribution elsewhere in Uganda: *Pachystela msolo, Teclea grandifolia, Khaya anthotheca,* and *Cathormion altissimum.* Four tree species from this reserve are listed as endangered: *Chlorophora excelsa, Cordia millenii, Entandrophragma angolense* and *Lovoa swynnertonii* (FAO, 1986).

Fauna: The fauna of this reserve is reasonably well known, and includes 144 species of forest bird (44% of the country's total), 6 species of diurnal forest primate (50% of the country's total) and 42 species of forest swallowtail and *Charaxes* butterfly (62% of the country's total). The fauna includes species normally characteristic of lowland forest communities, including the black mangabey *(Cercocebus albigena),* birds such as the Icterine greenbul *(Phyllastrephus icterinus),* leaflove *(P. scandens),* black-capped apalis *(Apalis nigriceps),* grey longbill *(Macrosphenus concolor)* and yellow longbill *(M. flavicans)* and the butterfly, *Charaxes porthos.* All the bird, primate and butterfly species recorded are known from elsewhere in Uganda, but the following are noteworthy on account of their rather limited distributions elsewhere: Olive long-tailed cuckoo *(Cercococcyx alivinus),* black-eared ground thrush *(Turdus camaronensis),* bamboo warbler *(Bradypterus alfredi),* red-billed helmet shrike *(Prionops caniceps)* and the butterfly *Charaxes kahldeni.* Threatened or near-threatened species that are known to occur in this reserve are: elephant *(Loxodonta africana),* chimpanzee *(Pan troglodytes),* Nahan's francolin *(Francolinus nahani),* and bamboo warbler *(Bradypterus alfredi).*

Thirteen species of large mammal were recorded from the forest during the ground survey, either by direct sighting or auditory cues (in the case of five primate species, bushbuck, duiker and waterbuck) or by distinctive spoor (in the case of ungulate species). The distributions of records are shown in Fig. 13. Spoor of a large duiker *(Cephalophus callipygus?)* were found in 22% of the 51 km^2 compartments covered by the survey, of bushbuck *(Tragelaphus scriptus)* in 22% of compartments, of a dwarf antelope (blue duiker, *Cephalophus monticola?)* in 4%, of buffalo *(Syncerus* *caffer)* in 14%, of waterbuck *(Kobus defassa)* in 4%, of bushpig *(Potamochoerus porcus)* in 33%, of giant forest hog *(Hylochoerus meinertzhageni)* in 8%, and warthog *(Phacochoerus aethiopicus)* in 2%. Of the primates, no blue monkeys *(Cercopithecus mitis)* were seen, but redtail monkeys were recorded in 20% of compartments, chimpanzee *(Pan troglodytes)* in 18%, baboon *(Papio anubis)* in 12%, mangabey *(Cercocebus albigena)* in 10% and black and white colobus *(Colobus guereza)* in 14%.

Economic Importance: The forest has been exploited as a source of commercial timber since 1942, with a sawmill operating at Kidoma between 1942 and 1951, another operating at Kabwoya from 1948 to 1954 and a third operating at Mwela from 1954 to 1976. The sawmill owners were offered exceptionally lenient conditions to encourage them to operate in Bugoma, since the remoteness of the forest and the poor stocking of good timber made exploitation only marginally profitable. A 0.75% enumeration was carried out in 1956/57, from which it was estimated that the forest carried 55 m^3 of standing timber exceeding 50 cm dbh per hectare (Lockwood Consultants, 1973). A timber concession was granted to the Masindi Pitsawyers Cooperative Society in February 1987, and an unknown number of pitsawyers (perhaps 10-20 saws, 20-50 people) are now operating in the reserve.

In the past, rattan canes *(Calamus deeratus)* have been commercially exploited for furniture making, and rubber has been tapped, but neither of these products is presently being used. The forest is used by local people as a source of bushmeat, medicinal compounds and other materials.

Present Status: Fig. 14 shows the distribution of human activities recorded during the ground survey, and Fig. I 1.2 and Table I 1 show the areas of different forest types which have been affected by timber harvesting activities. Sixty-nine percent of the forested land within the reserve remains essentially intact, while 12% is in an advanced state of regeneration following harvesting in the 1940s, and the remaining 19% was felled to supply the Mwela sawmill, mostly between 1954 and 1970.

The human population density in the lands surrounding the reserve is still rather low (see below), and there has been no agricultural encroachment of the reserve.

Hunting activity was recorded in 7% of the survey compartments (Fig. 14), most of the records being of old animal traps and disused hunters' camps. Two game guards are stationed at the Mwela sawmill site, and appear to be having a significant impact in curbing hunting activity. In other Ugandan forests I have rarely seen ungulates during ground survey work, but in Bugoma several bushbuck, duiker and waterbuck were sighted. However, no signs of elephant were recorded, although a group of about six individuals was reported to be in the southeastern forest 'corridor' near Kimbugu at the time of the survey. This species was considered to be a major forestry problem until the mid-1970s at which time the population was severely reduced by ivory poachers. At the time of the ground survey, it was reported that guns were commonly used for hunting in the reserve, buffalo being a favoured quarry.

Management: The reserve is managed by a Forester stationed at Kisindi, supported by a forest ranger, a guard and three workers. The Kisindi station comprises three or four good houses, an office and ancillary buildings. A second station is located at Mwela, comprising about four houses, six round-houses and ancillary buildings, all now in a poor state of repair. Two game guards live here, with a forest ranger and two workers, but most of the buildings have been deliberately dismantled or abandoned. A motorable track runs N-S through the forest from a point 15 km along the Kabwoya-Kyangwali road via the Mwela sawmill site to Kaseeta, and a footpath runs NW-SE from Kaseeta to Kasenene through the main forest block. Otherwise access to the forest is difficult, as other tracks are completely overgrown. Management is aimed at maximising the sustainable production of hardwood timber from the natural forest, and plantation timber from the grasslands, whilst preserving the forest's ability to protect the environment (Osmaston, 1959). A small Nature Reserve (6.1 km^2 of which 2.3 km^2 is grassland) has been established in the forest's Musara block (Fig. 11.2). There are some timber trial plots at Mwela. The latest Working Plan covers the period 1.7.59 to 31.12.67.

Conservation Importance:

- this reserve represents the most extensive tract of undisturbed forest remaining at this altitude in Uganda.
- the reserve supports four species of animal considered to be globally threatened, or nearly so.

Threats: The greatest threat to this forest is posed by the sawmilling industry, and Forest Department's intention to 'utilise' the forest's timber resources. Agricultural encroachment is not considered to be immediately threatening, since the human population density in the neighbouring agricultural areas of Buseruka, Kiziranfumbi, Kabwoya and Kyangwali sub-counties is only 35, 34, 39 and 16 persons/km^2 respectively (1980 population statistics). Hunting has already reduced elephant and buffalo populations to very low levels, and unless action can be taken to reduce it, these and other large mammal species are likely to disappear from the reserve in the near future.

Recommendations Specific to this Forest:

Nature Reserves should be established in representative areas of undisturbed forest to protect viable examples of the major communities. Suitable sites need to be identified through further field surveys, accounting for approximately 8-10% of the forested part of the reserve (see Chapter Six, Recommendation 9). As a start, a second Nature Reserve should be established in the centre of the main forest block, covering the whole of management compartments 21, 26, 27 and 28. Such a reserve would cover approximately 17 km^2 (4.6% of the forest reserve's area, or 5.7% of the forested portion), and preserve a piece of forest representative of mixed and *Cynometra*-dominated forest types.

Principal Reference Material:

Eggeling, W.J. (1947). Observations on the ecology of the Budongo rain forest, Uganda. *J. Ecol.* 34(l):20-87.

Langdale-Brown, I., H.A. Osmaston, and J.G. Wilson (1964). The vegetation of Uganda and its bearing on land-use. Entebbe: Uganda Government Printer.

Osmaston, H.A. (1959). Working Plan for the Bugoma Forest. First revision. Period 1960 to 1970. Entebbe: Uganda Forest Department.

Table I1. Areas (km2) of different vegetation types and their condition in Bugoma Forest Reserve

Condition	Vegetation types							
	Grass-land	Mixed forest types SM,PM, M,YM)*	*Cynometra* forest (types CY,CM,PCY CMS)*	*Maesopsis* forest (types MA, YMA)*	Poor forest types P1, P2,P3)*	Hill type H)*	Colon-ising, swamp, undiff. (types?, C2,FS,CL)	TOTAL
Undisturbed	65	71	107	1	15	4	9	272
Harvested pre-1950	0	2	30	0	3	0	0	35
Harvested post-1950	0	40	13	2	2	0	1	58
TOTAL	65	113	150	3	20	4	10	365

* Forest Department forest-type codes, see Osmaston, 1959.

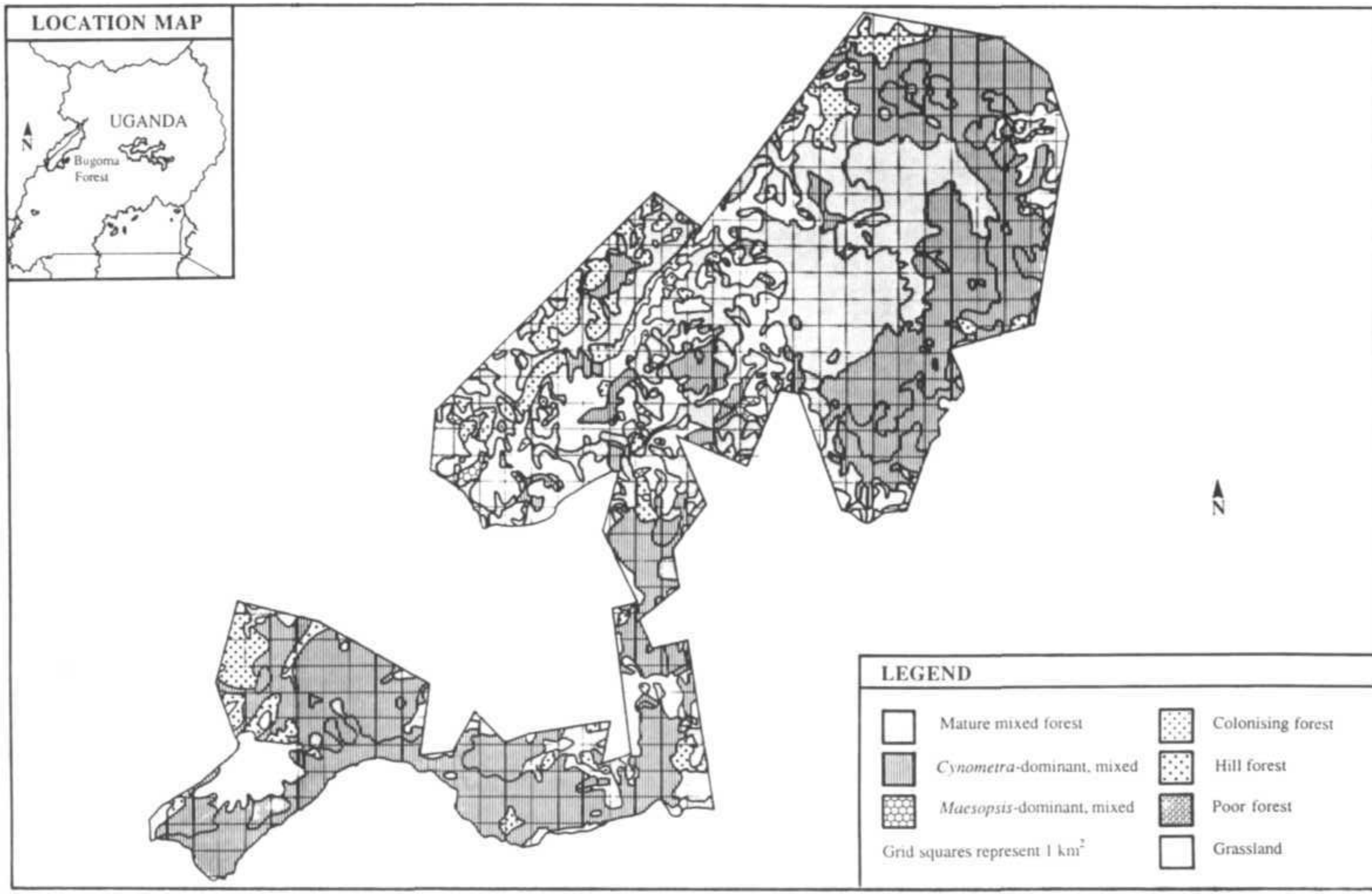


Fig. I1 *Bugoma forest types*

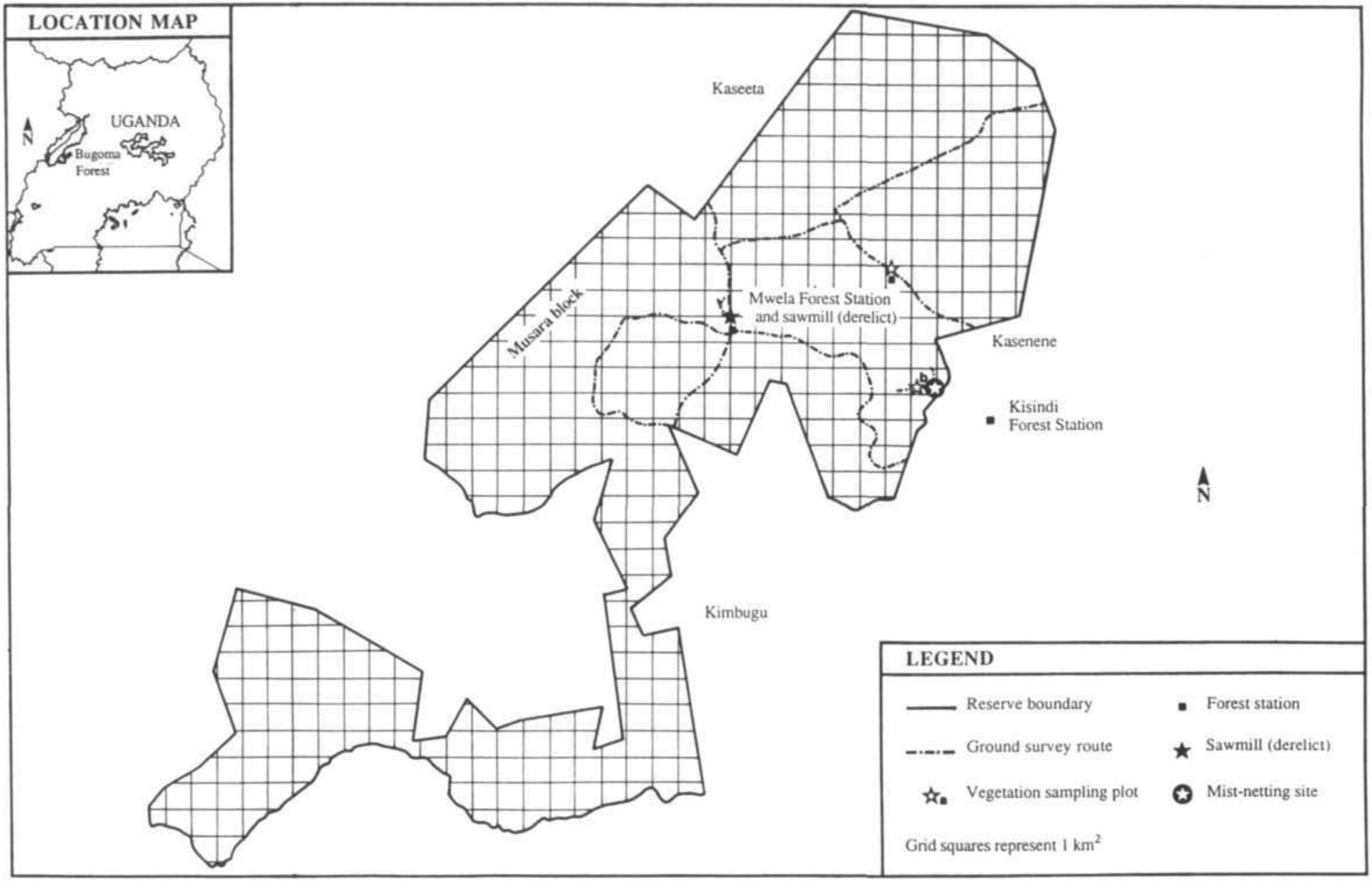


Fig. ***I1.1*** *Bugoma Forest ground survey routes, mist netting sites, tree enumeration sites and altitudinal zones*

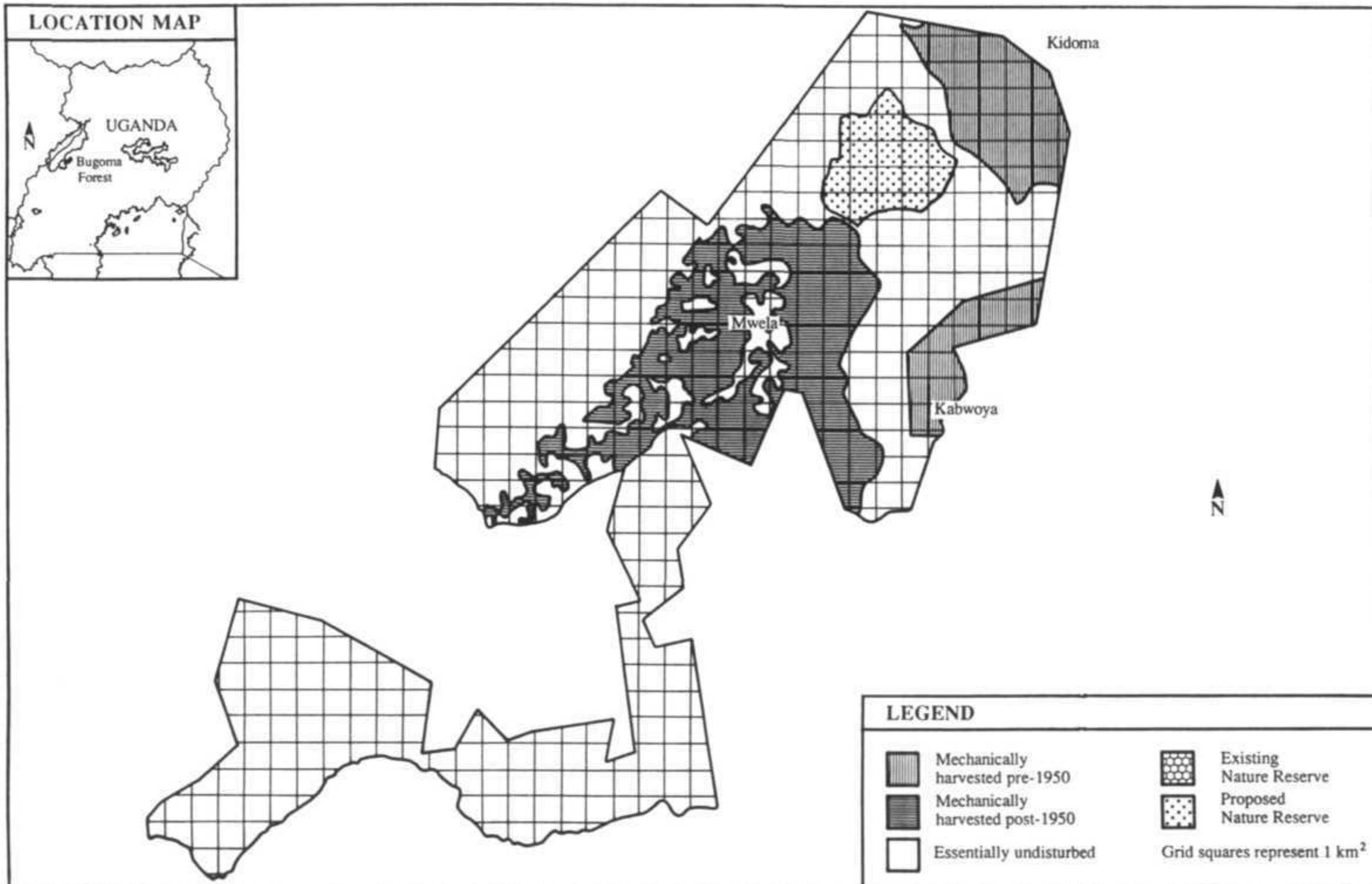


***Fig.* 11.2** *Present status of Bugoma Forest, including the location of the proposed Nature Reserve*

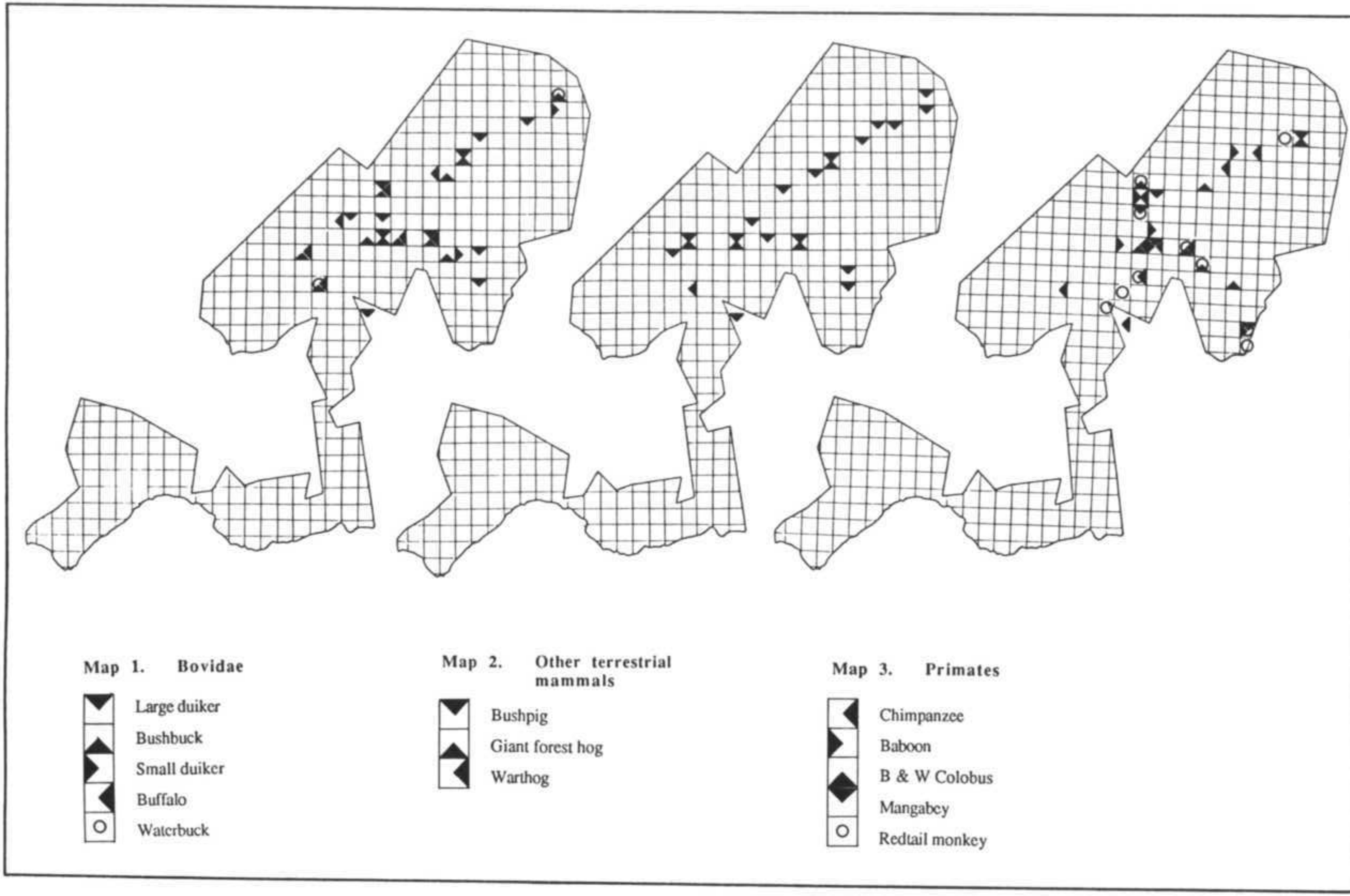


Fig. I3 *Distribution of large mammal records made during the ground survey of Bugoma Forest*

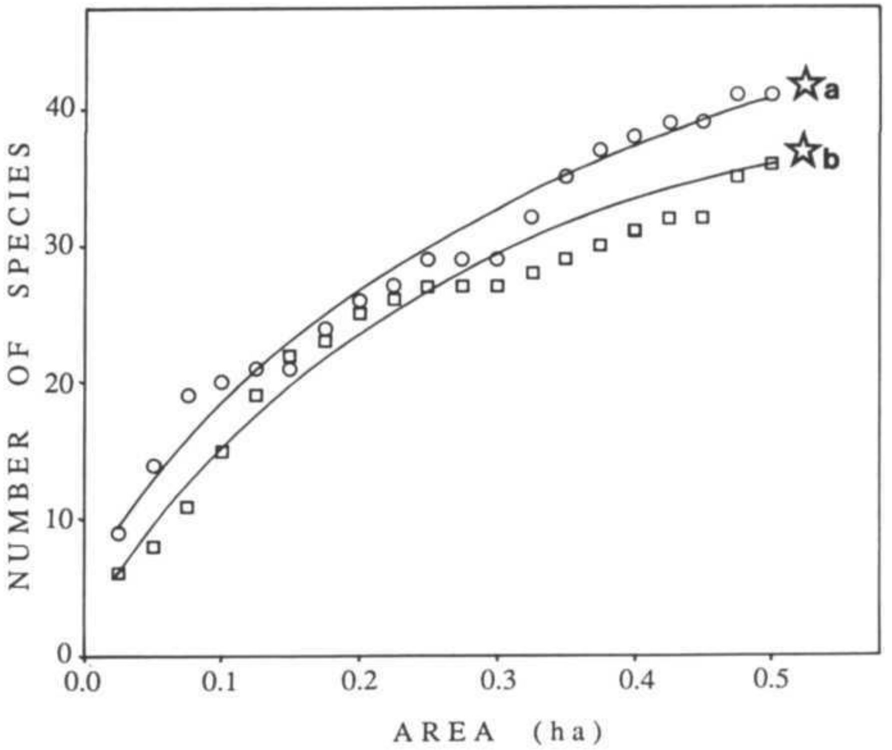


Fig. I2 *The cumulative number of tree species exceeding 10cm dbh, recorded as a function of area enumerated at Bugoma Forest. (Data are from 50m x 10m plots positioned at 50m intervals perpendicular to a central transect line, alternately to the left and right of the line).*

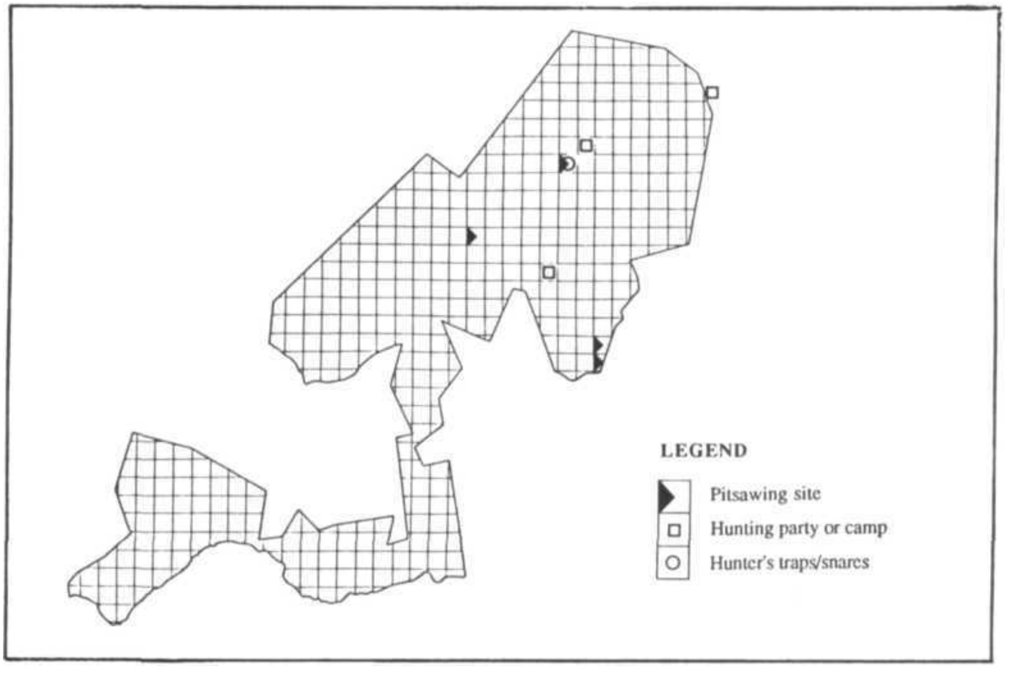


Fig. I4 *Distribution of human activities recorded during the ground survey of Bugoma Forest*

Appendix J. Profile of the Bwindi (Impenetrable) Forest Reserve

Date Established: 1932

Geographical Location: In the Kigezi Highlands overlooking the westen rift valley in southwestern Uganda. The forest lies in Kinkizi County in Rukungiri administrative district, and Rubanda and Bufumbira Counties in Kabale District, 0°53'-l°08' S, 29°35'-29°50' E. Covered by Uganda Department of Lands and Surveys maps sheets 84/III, 84/IV, 93/I and 93/III (Series Y732) at 1:50,000.

Area: 321 km^2, demarcated wherever the boundary does not follow natural features, by a line of planted exotic trees or (formerly) a cut boundary line maintained as a footpath. The reserve is isolated from other protected areas by densely populated agricultural lands.

Altitudinal Range: 1,190-2,607 m. Approximately 1 km^2 of the reserve lies below 1,250 m, 35 km^2 at 1,250-1,500 m, 68 km^2 at 1,500-1,750 m, 56 km^2 at 1,750-2,000 m, 119 km^2 at 2,000-2,250 m, 41 km^2 at 2,250-2,500 m, and 1 km^2 above 2,500 m (Fig. J1.1).

Physical Features: The reserve occupies extremely rugged country characterised by numerous steep-sided hills and narrow valleys with a steep general incline from the southeastern corner (lying above 2,250 m) to the north and western parts (lying below 1,750 m). Most of the reserve drains into the Ishasha and Ivi rivers which flow onto the dry plains of the rift valley to the northwest. Geologically the area is associated with upwarping of the western rift valley and its underlying rocks are generally phyllites and shales, with some quartz, quartzite and granitic outcrops of the Karagwe-Ankolean System. The soils are mainly humic red loams, moderately to highly acidic and deficient in bases. The climate is tropical with two rainfall peaks from March to May and September to November. Annual mean temperature range, minimum: 7-15° C, maximum: 20-27° C. Annual rainfall: 1,400-1,900 mm.

Survey Work Conducted under this Project:

- fourteen censuses of forest primate populations, and associated vegetation sampling conducted along two transect routes, during September 1986 (for transect locations see Fig. J1.1).

Vegetation: The forest includes a wide variety of vegetation types which can be broadly classified as medium altitude moist evergreen forest and high altitude forest (Langdale-Brown *et al*, 1964). Fig. J1 and Table J1 show the locations and areas of eight principal forest types, derived from Forest Department's type map for Bwindi. Approximately 40% of the reserve is occupied by rich to medium-rich mixed forest. Important constituents of this community are *Prunus africana, Newtonia buchananii, Symphonia globulifera, Chrysophyllum* spp., *Podocarpus* spp., *Strombosia scheffleria* etc. There are three (presumably climax) communities which tend towards single species dominance, the dominant apparently depending on altitude. In the lower lying areas at around 1,500 m, *Parinari excelsa* fulfils this role (this type occupies 10% of the reserve); at around 2,000 m, *Newtonia buchananii* (11% of the reserve); and at around 2,200 m, *Chrysophyllum* *gorungosanum* (8% of the reserve). Almost 30% of the reserve is occupied by various communities of low stature, which are classified as poor, hill, and colonising types, and there is a small area of swamp and grassland within the reserve. The area of bamboo forest is extremely small (less than 1 km^2; Table J1, Fig. J1).

Tree species richness was examined by enumeration of all trees exceeding 10cm dbh in 20x20 m quadrats located at 200 m intervals along two 4-5 km primate census routes. The species-area relationships established in this way are shown in Fig. J2. Transect A represents mixed forest at 2,000-2,200 m, which supports 45-50 tree species per hectare, comparable with many other sites examined in several other forests (at rather lower altitudes) during this study. Transect B represents forest at about 2,400 m which supported 20 tree species per hectare.

The trees of this forest are only moderately well known, and a complete list would undoubtedly include a great many more than the 163 species presently recorded for the area (Appendix A). The present list represents 38% of the country's forest trees, and includes the following ten species that occur nowhere else in Uganda: *Croton bukobensis, Strombosiopsis tetrandra, Brazzeia longipedicellata, Grewia mildbraedii, Maesobotrya purseglovei, Melchiora schliebenii, Xylopia staudtii, Allanblackia kimbiliensis, Memecylon* sp., and *Leplaea mayombensis.* An additional sixteen species from Bwindi show a very limited distribution elsewhere in the extreme west of Uganda: *Chrysophyllum pruniforme, Cola bracteata, Dasylepis racemosa, Oncoba routledgei, Sapium leonardii-crispi, Drypetes bipindensis, Ficalhoa laurifolia, Ocotea usambarensis, Pittosporum spathicalyx, Tabernaemontana odoratissima, Dichaetanthera corymbosa, Cassipourea congoensis, Pauridiantha callicarpoides, Musanga leo-errerae, Hannoa longipes,* and *Milletia psilopetala.* The only tree species from this reserve listed as endangered is *Lovoa swynnertonii* (FAO, 1986).

Fauna: The fauna of this reserve is outstandingly rich and includes 214 species of forest bird (65% of the country's total), 7 species of diurnal forest primate (58% of the country's total), and 57 species of forest swallowtail and *Charaxes* butterfly (84% of the country's total) (see Appendices B, C, D for species lists). The bird list is probably far from complete. Amongst the species already recorded, 12 species of bird, one primate and three butterflies are only recorded from Bwindi (and, in some cases, neighbouring highland forests of southwestern Kigezi) in the Ugandan part of their ranges. These are: Fraser's eagle owl *(Bubo poensis),* dwarf honeyguide *(Indicator pumilio),* African green broadbill *(Pseudocalyptomena graueri),* white-bellied robin chat *(Cossypha roberti),* Kivu ground thrush *(Turdus tanganjicae),* Grauer's rush warbler *(Bradypterus graueri),* Grauer's warbler *(Graueria vittata),* short-tailed warbler *(Hemitesia neumanni),* yellow-eyed black flycatcher *(Melaenornis ardesiaca),* Chapin's flycatcher *(Muscicapa lendu),* montane double-collared sunbird *(Nectarinia ludovicensis)* and dusky twinspot *(Clytospiza cinereovinacea);* the butterflies *Papilio leucotaenia, Graphium gudenusi* and *Charaxes fournierae;* and the mountain gorilla, *Gorilla gorilla beringei.* Bwindi is especially important for the conservation of Afromontane fauna, and is an important locality for many species that are endemic to the mountains of the western rift valley, including 19 (53%) of the region's 36 endemic birds (Prigogine, 1985). There are no fewer than 13 threatened or near-threatened species known from this reserve: mountain gorilla, chimpanzee *(Pan troglodytes),* l'hoest's monkey *(Cercopithecus Vhoesti),* elephant *(Loxodonta africana),* leopard *(Panthera pardus)* (possibly extinct), dwarf honeyguide, African green broadbill, Kivu ground thrush, Grauer's rush warbler, Chapin's flycatcher, Shelley's crimson-wing *(Cryptospiza shelleyi),* African giant swallowtail butterfly *(Papilio antimachus),* and cream-banded swallowtail *(Papilio leucotaenia).*

A ground survey comparable to those conducted in other forests under this project, was made in Bwindi by Butynski in 1983/4. He found evidence of elephant in 16% of the 116 km^2 compartments he surveyed, of a large duiker *(Cephalophus* sp.*)* in 13%, of bushpig *(Potamochoerus porcus)* in 16%, of giant forest hog *(Hylochoerus meinertzhageni)* in 1%, of redtail monkeys *(Cercopithecus ascanius)* in 13%, of blue monkeys *(Cercopithecus mitis)* in 40%, of l'hoest's monkey in 9%, of black and white colobus *(Colobus guereza)* in 16%, of baboon *(Papio anubis)* in 8%, of chimpanzee in 16%, and of mountain gorilla in 20% of compartments. Butynski (1985) provides estimates of primate population densities made during his surveys, and further data arising from work conducted under the present project are presented in Table J2. It should be noted that these new data represent census statistics from the higher elevation parts of the forest, which are unlikely to typify the reserve as a whole.

Economic Importance: Although access to this forest is extremely difficult, and the topography makes mechanised timber harvesting impossible, the forest is regarded by many as an important source of timber, for exploitation by pitsawyers. Based on limited 1951 enumeration data, Lockwood Consultants (1973) provided an estimate of 45 m^3 of standing timber exceeding 50 cm dbh per hectare. Recorded exploitation averaged 710 m^3 per annum over the 1961-70 period (Lockwood Consultants, 1973), and 940 m^3 per annum over the 1972-83 period (Butynski, 1984), but this is probably well below actual exploitation levels, since much pitsawing takes place illegally. Butynski (1984) estimated that 140-280 people were engaged in pitsawing and wood-carrying activities in Bwindi in 1983, 57% of them operating illegally.

Bwindi is also an important source of gold which is panned from streambeds in many parts of the reserve and occupies 100-200 people (Butynski, 1984). The forest is of local economic importance as a source of bushmeat, building poles, fuelwood, bamboos, honey, medicinal compounds and as a grazing area. At the time of Butynski's survey about 60-120 people probably entered the forest daily to exploit these resources (Butynski, 1984).

Present Status: Fig. J1.2 and Table J1 show the areas of different forest types which have been affected by light and heavy exploitation by pitsawyers, and those that remain essentially unaffected by these activities (T. Butynski, pers. comm.). Overall, about 10% of the reserve remains essentially intact, 61% has been heavily exploited by pitsawyers and 29% has been 'creamed' of its best timber trees by selective pitsawing activity.

Butynski (1984) found signs of human activity in 84% of the compartments he surveyed in 1983/84, including pitsawing in 29%, hunting in 24%, mining in 6%, livestock in 10% and footpaths in 67%. He concluded that excessive hunting activity had already caused the extinction of at least one prominent species of large mammal (buffalo, *Syncerus caffer)*, and depressed populations of many others to levels far below the area's carrying capacity. Without proper control, Butynski suggested that the extinction of leopard, elephant, giant forest hog and bushbuck would probably follow within a decade.

Management: The reserve is managed from the Kabale and Rukungiri District Forest Offices and small forest stations at Ruhizha and Rushaga. It is staffed by two forest officers, two foresters, four forest rangers, eight forest guards and about 30 workers employed by the Forest Department, and by a game assistant and about 15 game guards from the Game Department. The Impenetrable Forest Conservation Project began work in the forest in 1986, supported by WWF-US. It has a full-time expatriate project leader resident at Ruhizha, and provides support for government management staff, as well as employing five graduate counterparts to the project leader and 20 part-time conservation education assistants. The project is providing some additional management infrastructure in the form of a house, an office block, an agroforestry conservation education centre, and a new game guard camp at Ruhizha.

CARE International in Uganda and the World Wildlife Fund (WWF-US) have developed a programme to assist with the integration of rural development and the conservation of forest resources in Kabale and Rukungiri Districts in southwestern Uganda. The project, known as Development Through Conservation (DTC) in southwestern Uganda, is expected to commence late in 1988 with an initial two-year budget of US$1.2 million from USAID. It will involve in-forest activities (ecological surveys and research, management planning, multiple-use zoning, environmental education) in Bwindi, Mgahinga and Echuya forests, as well as out-of-forest rural development activities.

Vehicular access to the forest is provided by about 40 km of rough road, all of which is located within 3 km of the forest boundary, leaving the interior of the forest without easy access.

The latest Working Plan covers the period 1961 to 1971, and prescribes for the protection of the forest's environmental values, the preservation of suitable mountain gorilla habitat and (if possible without prejudicing either of the above) the production of a maximum sustainable quantity of timber. No silvicultural operations have been undertaken in this reserve. Two Nature Reserves (about 3 km^2 and 10 km^2) have been designated where no timber cutting is permitted (Fig. J1.2).

Conservation Importance:

- this reserve is undoubtedly the most important area in Uganda for wild species conservation, being both exceptionally rich in overall numbers of species and in numbers of species endemic to the Albertine Rift;
- this reserve represents the only opportunity in Uganda to preserve a reasonably extensive tract of undisturbed forest at altitudes of 1,500-2,250 m;

- the forest is internationally important as the home of about half of the world's population of mountain gorillas, as well as 12 other species of animal considered to be globally threatened with extinction, or nearly so;
- on account of its wildlife in general, and mountain gorillas in particular, the area has a very high potential for tourism development;
- the forest covers an exceptional altitudinal range (1,190-2,607 m) and contains a great wealth of distinct forest communities in close proximity to one another.

Threats: The main threats to this forest are posed by the hunting of its larger mammals, and uncontrolled timber cutting. However, given the present Uganda Government commitment to its protection, and the indispensable support of the Impenetrable Forest Conservation Project, these threats are now being moderated satisfactorily.

Agricultural encroachment has been insignificant in the past, yet it must be considered a threat since the forest lies in one of the country's most densely populated rural areas. At the time of the last population census in 1980, the populated parts of Kirima, Kayonza, Nyabwishenya, Bukimburi, Muko and Ikumba subcounties were settled at densities of about 135, 110, 80, 130, 150, and 150 persons/km^2 respectively.

Recommendations Specific to this Forest:
This reserve should be considered for Forest Park or National Park status. A decision over which of these is most appropriate will depend upon the constitution of Forest Parks, and should only be made once a thorough study of social and economic considerations has been made. The necessary information should be available as a result of opinion-sampling and research conducted under the DTC project (see Management, above).

Some detailed management recommendations have been put forward by Butynski (1984) all of which I would endorse. In particular, I would like to emphasise the need to:

- set aside at least 50% of the area for total protection against all forms of consumptive use, such as timber cutting.
- enlarge the reserve through the inclusion of adjacent forest patches that are not presently given legal protection.
- restrict human exploitation of forest resources to one or two management compartments at any particular time, so that the majority of the forest is left free of human activity and gorillas are encouraged to range over as large an area as possible.

Principal Reference Material:

Butynski, T.M. (1984). Ecological survey of the Impenetrable (Bwindi) Forest, Uganda, and recommendations for its conservation and management. New York Zoological Society.

Butynski, T.M. (1985). Primates and their conservation in the Impenetrable (Bwindi) Forest, Uganda. *Primate Conservation* 6: 68-72.

Hamilton, A.C. (1969). The vegetation of South West Kigezi. *Uganda J.* 33(2): 175-199.

Hamilton, A.C. (1974). Distribution patterns of forest trees in Uganda and their historical significance. *Vegetatio* 29: 21-35.

Harcourt, A.H. (1981). Can Uganda's gorillas survive? - a survey of the Bwindi Forest Reserve. *Biol. Conserv.* 19: 269-282.

Keith, S. (1980). The avifauna of the Impenetrable Forest, Kigezi, Uganda, with special reference to altitudinal distribution. *Proc. IVPan-Afr. Orn. Congr.* 159-167.

Keith, S., A. Twomey, H. Friedmann and J. Williams (1969). The avifauna of the Impenetrable Forest, Uganda. *Amer. Mus. Novitates.* No.2389. 41pp.

Leggat, G.J. and H.A. Osmaston (1961). Working Plan for the Impenetrable Central Forest Reserve, Kigezi District, Western Province, Uganda. Period 1961-1971. Entebbe: Uganda Forest Department.

Prigogine, A. (1985). Conservation of the avifauna of the forests of the Albertine Rift. pp 277-295. In: Conservation of tropical forest birds. ICBP Technical Publication No. 4. Cambridge: ICBP.

Table J1. Areas (km2) of different vegetation types and their condition in Bwindi (Impenetrable) Forest Reserve

	Vegetation types									
Condition	Grass-land, swamp	Mixed forest (types 4a,9,9a,13a, 13b,1,7a,10, 13,18)*	*Parinari* forest (types 17,17a)*	*Newtonia* forest (types 8, 14,15)*	*Chrysophyllum* forest (types 16, 18b)*	Poor forest (types 3,4,7,8a,ll, 16a,18a,18c, 18d,19a,20, 21,22)*	Hill forest (types 2c, 15a,17b,19, 22a,2,2a,2b, 2d,12,12b,23)*	Colonising forest (types 12, 24, 24a,25)*	Bamboo forest (type 21a)*	FOREST TOTAL
Undisturbed	(10)	22	0	14	1	0	1	0	0	38 (10)
Lightly pitsawn	-	44	0	9	17	8	9	2	0	89
Heavily pitsawn	-	60	31	12	7	27	40	6	1	184
TOTAL	10	126	31	35	25	35	50	8	1	321

* Forest Department forest-type codes, as shown on map reference KI45

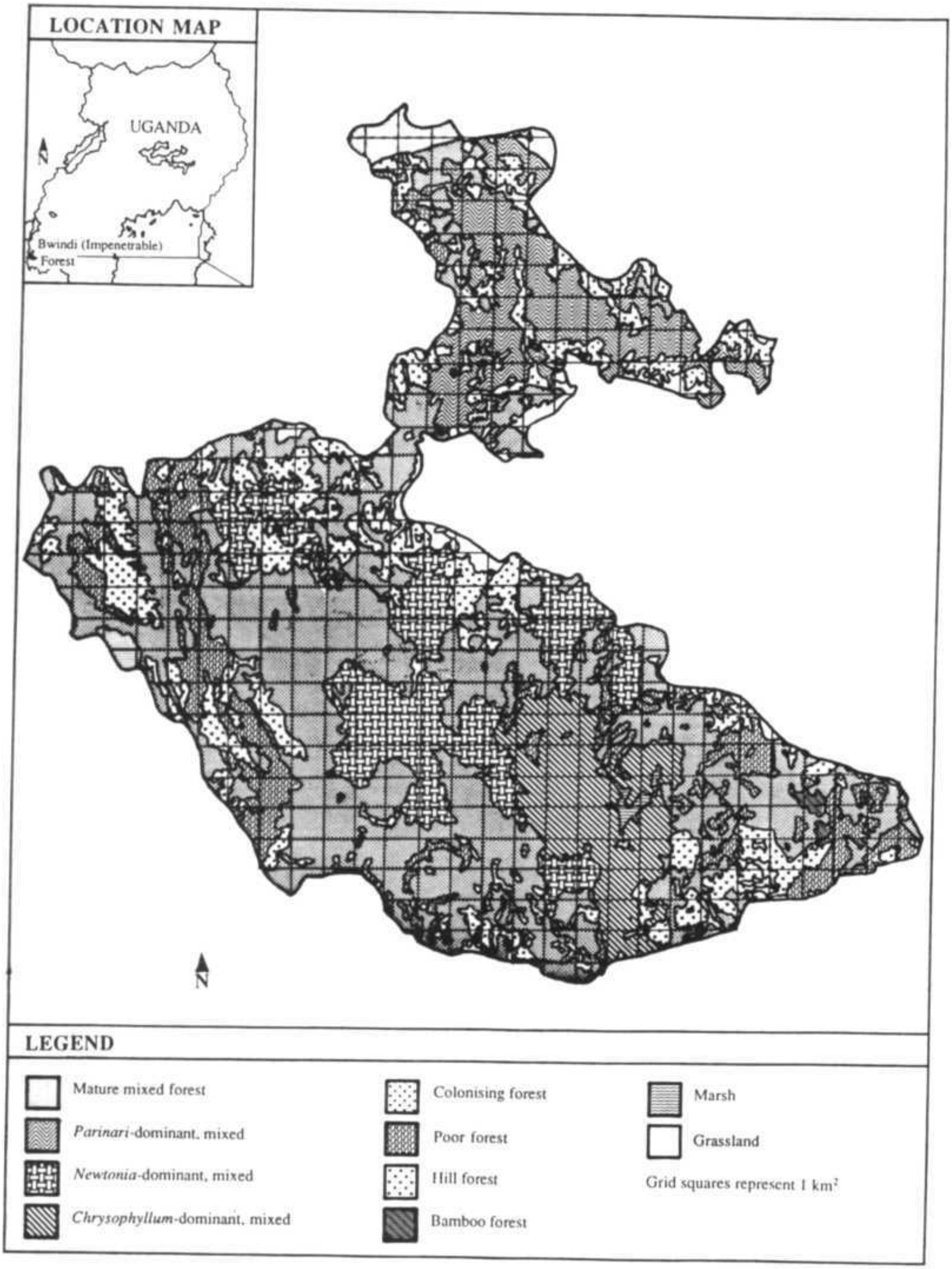


Fig. J1 *Bwindi (Impenetrable) forest types*

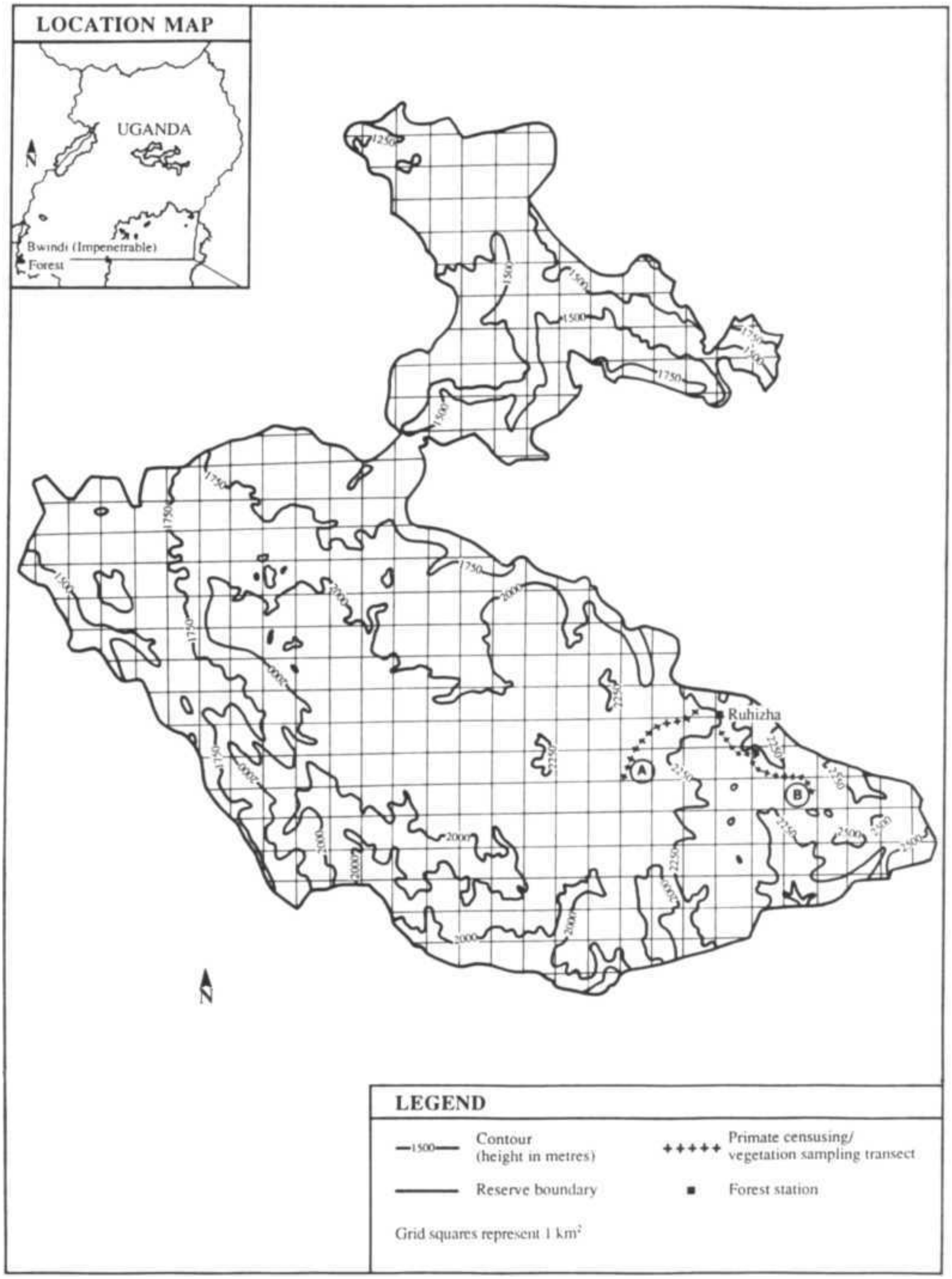


Fig. J1.1 Bwindi (Impenetrable) Forest altitudinal zones and primate censusing transects

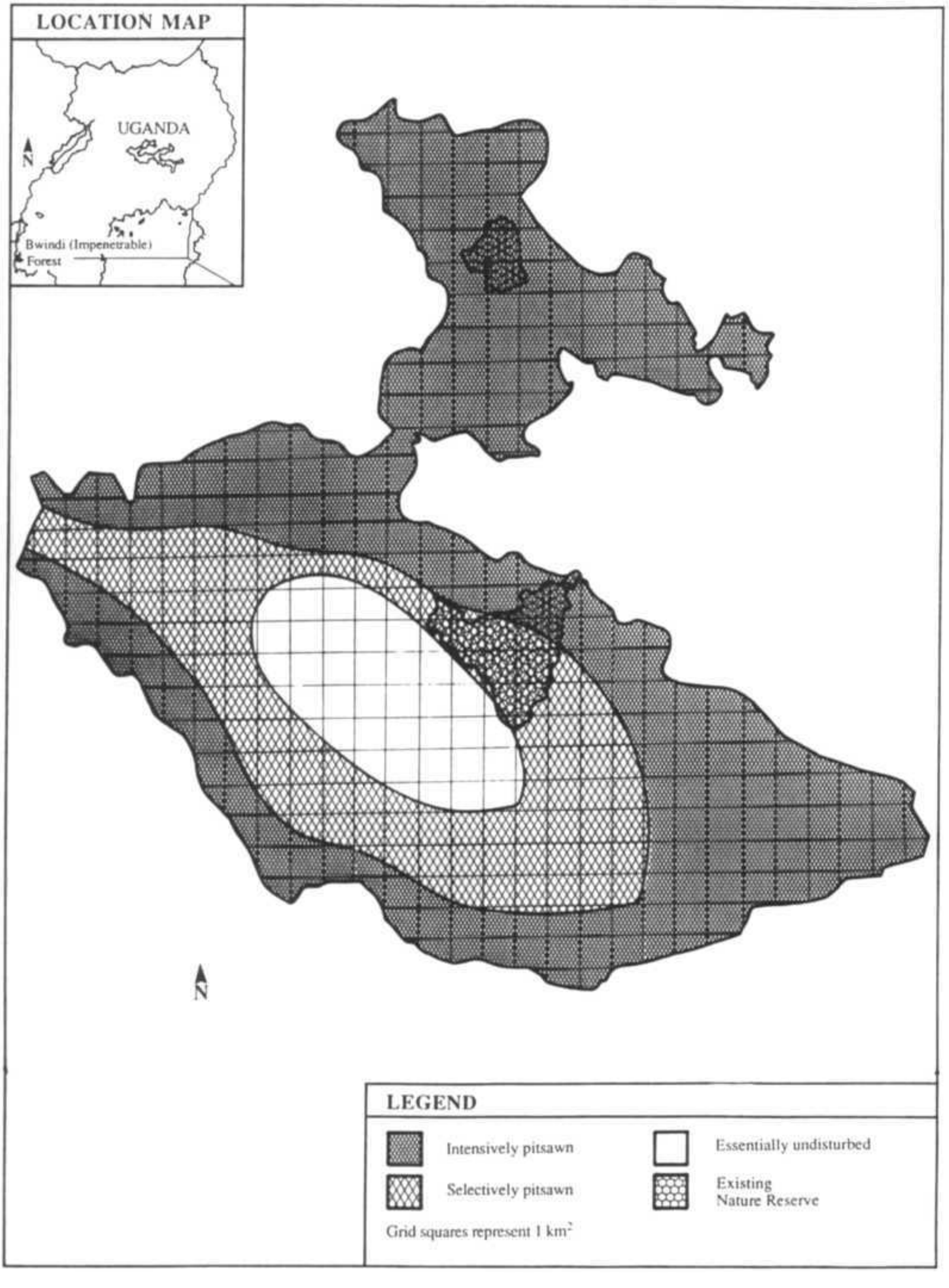


Fig. J1.2 *Present status of Bwindi (Impenetrable) Forest, including the location of the Nature Reserves*

Table J2. The number of primate groups (mean ± SE) seen per kilometre of census route and, in parentheses, the estimated population density (number of groups/km2) for each species assuming a census strip width of 100m along transect A and of 200m along transect B. See Fig. J 1.1 for transect locations. Data are from Kisubi, (in prep).

Census route	Length (km)	Estimated strip width (km)	No. of censuses	Primate species		
				C. mitis	*C. l'hoesti*	*C. guereza*
A	4.0	0.1	7	0.15 ± 0.07 (1.5)	0.04 ± 0.04 (0.4)	0.00 ± 000 (0.0)
B	5.0	0.2	7	0.34 ± 0.06 (1.7)	± ( )	± ( )

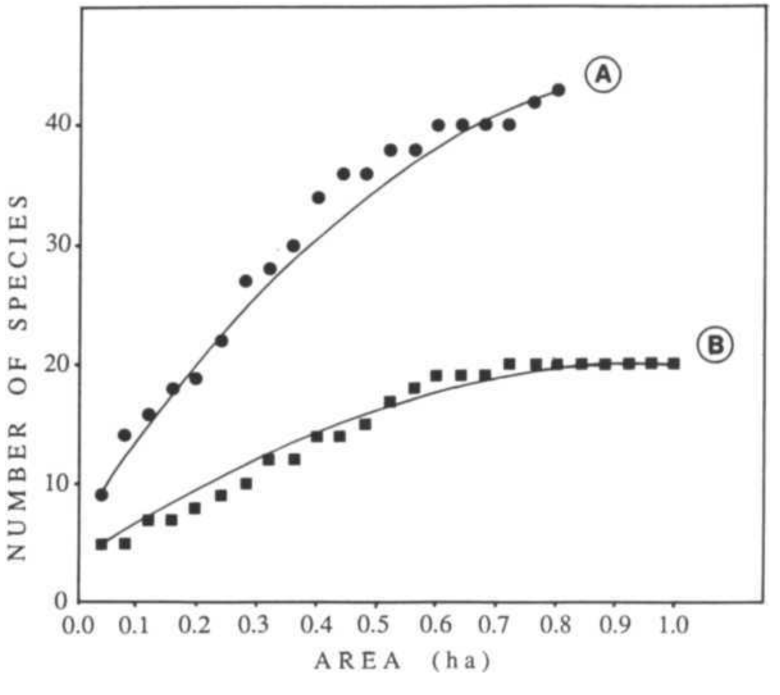


Fig. J2 *The cumulative number of tree species exceeding 10cm dbh, recorded as a function of area enumerated at Bwindi (Impenetrable) Forest. (Data are from 20m x 20m plots positioned at 200m intervals along primate census routes, see text).*

Appendix K. Profile of the Kasyoha-Kitomi Forest Reserve

Date Established: 1932

Geographical Location: On the escarpment south of Lake George and the Kazinga Channel in western Uganda. The forest straddles the counties of Bunyaruguru, Igara and Buhweju in the administrative district of Bushenyi, Ibanda (Mitoma) County in Mbarara District and Kibale County in Kabarole District, 0°05'-0°25' S, 30°05'-30°20' E. Covered by Uganda Department of Lands and Surveys map sheets 76/I, 76/II, 76/III, 76/IV (Series Y732) at 1:50,000.

Area: 399 km^2, demarcated since the boundaries were finally re-aligned in 1965, by rivers and streams and cut-lines marked at the corners by cairns and direction trenches. The boundary has received little or no maintenance during the past decade. The reserve is isolated from other protected areas by surrounding peasant agricultural lands, except for 3 km of boundary shared with the Kalinzu Forest Reserve on the south-facing slopes of Lubare ridge.

Altitudinal Range: 975-2,136 m. 0.3 km^2 of the reserve lies below 1,000 m, 36 km^2 at 1,000-1,250 m, 285 km^2 at 1,250-1,500 m, 69 km^2 at 1,500-1,750 m, 8 km^2 at 1,750 -2,000 m and 0.6 km^2 above 2,000 m.

Physical Features: The reserve occupies steeply undulating terrain, and is deeply dissected by two rivers, the Chambura and the Buhindagi, which drain the escarpment in a northerly direction, carrying water across the dry rift valley plains to the Kazinga Channel and Lake George. The area is geologically complex, the underlying rocks including quartzites, schists, gneisses, shales and phyllites of the Karagwe-Ankolean and Toro systems. The soils derived from these rocks include ferralitic sandy clay loams, podsols (on Lubare ridge) and younger, weakly developed lithosols of moderate fertility. The climate is tropical with two rainfall peaks from April to May and September to November. Annual mean temperature range, minimum: 13°-15° C, maximum: 25°-26° C. Annual rainfall: 1,250-1,400 mm.

Survey Work Conducted under this Project:
- a ground survey over two and a half weeks during September and October 1985 (routes followed are shown in Fig. K1.1);
- twenty-eight primate censuses, and associated vegetation sampling along four 4-6 km line transects located in the northeast and southwest of the reserve (see Fig. K1.1 for locations), over a five-week period during June and July 1986;
- botanical inventory work over four days during September 1987;
- ornithological and entomological survey work carried out by a three-man team, and including 21,200 metre-net-hours of mist-netting over twenty days in September 1987 (see Fig. K1.1 for mist-netting location).

Vegetation: The vegetation of this reserve is classified as medium altitude moist evergreen forest in the southwest, and medium altitude moist semi-deciduous forest in the northeast (Langdale-Brown *et al.*, 1964). The distinction is probably related to the age of the forest in the two areas, that in the northeast being an earlier seral stage in the development of a mixed forest in which *Parinari excelsa* is a characteristic constituent, as in the southwest of this reserve. Eighteen percent of the reserve supports grassland, swamp or open water communities, the remainder comprising eight forest types distinguished from aerial photographs. I have combined three types of mixed forest and two types of *Maesopsis* forest in the preparation of Table K1, showing the areas of each type. The most widespread type, covering 33% of the reserve, including most of the northeastern (Kitomi) portion, is classified as 'poor', 25% is classified as *Maesopsis* forest (the bulk of the southwestern, Kasyoha, portion), 11% as mixed forest, 10% as hill forest, and 3.5% as *Parinari* forest.

Trees exceeding 10 cm dbh were enumerated in 20x20 m quadrats located at 200 m intervals along four line transects (Fig. K1.1) representing two areas of 'poor' forest in the northeast (transects A and B), one area of *Maesopsis* forest (transect C) and one area of mixed forest (transect D). The species-area relationships determined in this way are illustrated for the four transects in Fig. K2. Transect D was found to be the richest of the four, with about 65 species per hectare, ranking it as one of the very richest sites yet examined in Uganda. Transect C, which probably represents a somewhat younger community, supported about 46 species per hectare, compared with only 30 species per hectare for both the young poor forest transects of the northeast.

The trees of Kasyoha-Kitomi are now reasonably well-known. Two hundred and four forest tree species (47% of the country's total) have been recorded in the area, including 68 species added to the list during this study. The following species occur in Kasyoha-Kitomi, as part of a very limited range in western Uganda: *Dovyalis macrocarpa, Dichaetanthera corymbosa, Cassipourea congoensis, Tricoscypha submontana, Lecaniodiscus cupanioides.* A number of specimens collected in the forest during this study are yet to be identified and almost certainly include trees of phytogeographical interest. *Uvariodendron magnificum* is known only from Kasyoha-Kitomi in the Ugandan part of its range. Three tree species from this reserve are listed as endangered: *Cordia millenii, Entandrophragma angolense* and *Lovoa swynnertoni* (FAO, 1986).

Fauna: The fauna of this reserve is still largely unknown, but includes 104 species of forest bird (32% of the country's total), 6 species of diurnal forest primate (50% of the country's total), and 21 species of forest swallowtail and *Charaxes* butterfly (31% of the country's total). All of the species recorded are known from at least one other Ugandan forest. The occurrence of white-naped pigeon *(Columba albinucha),* black roughwing *(Psalidoprocne pristoptera),* Petit's cuckoo shrike *(Campephaga petiti)* and yellow-bellied wattle-eye *(Platysteria conreta),* all birds of restricted distribution, is of interest; as is the occurrence of the swallowtail butterfly, *Graphium latreillanus* on the eastern limits of its range (previously known only from the Semliki Forest in the East African part of its range). A 'royal antelope' (presumably *Neotragus batesi)* was once seen near the point at which the river Ngoro leaves the reserve, and there is a rather dubious report of a Congo forest crocodile which fell down a goldminer's pitlatrine in the 1930's (Synnott, *in litt.).* Threatened or near-threatened species that are known to occur in this reserve are:

elephant *(Loxodonta africana)*, chimpanzee *(Pan troglodytes)*, l'hoest's monkey *(Cercopithecus l'hoesti)* and white-naped pigeon *(Columba albinucha)*.

Ten species of large mammal were recorded from the forest during the ground survey, either by direct sighting or auditory cues (in the case of six species of primate) or by distinctive spoor (in the case of four other species). The distributions of records are shown in Fig. K3. Spoor of a large duiker *(Cephalophus callipygus?)* were found in 9% of the 85 km^2 compartments covered by the survey, of bushbuck *(Tragelaphus scriptus)* in 1% of compartments, of bushpig *(Potamochoems porcus)* in 24%, and of elephant *(Loxodonta africana)* in 7%. Of the primates, redtail monkeys *(Cercopithecus ascanius)* were recorded in 28% of compartments, blue monkeys *(Cercopithecus mitis)* in 32%, l'hoest's monkey *(Cercopithecus l'hoesti)* in 4%, chimpanzee *(Pan troglodytes)* in 18%, baboon *(Papio anubis)* in 6%, and black and white colobus *(Colobus guereza)* in 26%. The population densities of primates calculated from census statistics at four sites are given in Table K2.

Economic Importance: The forest is regarded by the Forest Department as an important source of unexploited timber. A 0.28% enumeration was carried out by Lockwood Consultants in the early 1970s which involved the establishment of plots in all eight forest types. It is estimated that the forest carries an average of 51.3 m^3 of standing timber exceeding 50 cm dbh per hectare, with considerable variation between forest types, the best being the mixed, *Maesopsis* and *Parinari* types (types 2,3,4,5) characteristic of the southern (Kasyoha) portion of the reserve (Lockwood Consultants, 1973). A timber concession, covering the entire reserve, has recently been granted to a sawmilling company, which is reportedly intending to establish a sawmill at Kyabakara just outside the northwestern boundary of the reserve.

An estimated 150-250 people were engaged in pitsawing and its related activities in the Kasyoha portion of the reserve at the time of the ground survey, with a similar number operating in the northeastern Kitomi portion. An important local trading route passes along the Munyoni ridge in the centre of the reserve. The forest is extensively used by local people as a source of bushmeat, firewood, building poles, and medicinal compounds.

Present Status: Fig. K4 shows the distribution of human activities recorded during the ground survey. Derived from these results and additional information gathered through local interviews, Fig. K1.2 and Table K1 show the areas of different forest types affected by varying degrees of disturbance. This is one of the least disturbed of Uganda's major forests, with a little over 80% of the forested land remaining essentially intact. Only about 7% of the forest has been heavily disturbed by pitsawing, with a further 12% 'creamed' of the larger better-quality timber trees. Apart from two small cultivation plots in the southern grasslands, there has been no agricultural encroachment of this reserve.

Alluvial gold is worked from many of the streams and rivers in this part of Uganda, and gold-diggers were found to be operating, often in groups of 60-80 people, at several points within the reserve. Overall, 10% of the survey compartments contained gold-diggings, concentrated in the northeastern (Kitomi) portion of the reserve (Fig. K4).

Hunting activity was recorded in 10% of the survey compartments (Fig. K4). Only one group of snares was found, the remainder of the records being of parties of men accompanied by dogs and equipped with nets and spears. The southwestern portion of the reserve, west of the Chambura river, appeared to be under particularly intensive hunting pressure.

Management: The reserve is managed from the Bushenyi District Forest Office, and a local office at the Ndeke sub-county headquarters. A forester is stationed at Ndeke, and another at Nsika; forest rangers (2) at Katerera and Ndeke; forest guards (3) and patrolmen (3) at Katerera, Bitoma and Nsika. There is no departmental infrastructure. The Working Plan prescribes for the maximum sustained yield of hardwood timber, the production of timber from softwood plantations in the grasslands, and the protection of the area's important water catchment role. There is no Nature Reserve. Some timber trial plots were established at the top of Lubare ridge near the main Katunguru-Ishaka road in the 1960s. The latest Working Plan covers the period 1.7.68 to 30.6.78.

Conservation Importance:
- this reserve represents the most extensive tract of undisturbed forest remaining at this altitude in Uganda.
- by virtue of its location close to postulated Pleistocene forest refugia, its great geological and topographical diversity, and the wide range of altitude represented, we should expect to find an exceptionally diverse flora and fauna here.
- the more mature forest communities of southwestern Kasyoha are amongst the richest in the country.
- the reserve supports at least four species of animal considered to be globally threatened with extinction, or nearly so.

Threats: The greatest threat to this forest is posed by the sawmilling industry, and the Forest Department's intention to 'utilise' the forest's timber resources. There is an urgent need to review the timber concession that has been granted. Agricultural encroachment is not yet a problem, but there has been considerable recent settlement of the land bordering the reserve by immigrants from Kigezi, and to a lesser extent Bundibugyo. This is well illustrated by the situation outside the northeastern boundary in Rukiri subcounty where R. Malpas (pers. comm.) reported some tree felling and light cultivation at the time of his 1982 aerial survey, whereas by late 1985 the area was practically cleared of forest and intensively settled and cultivated. Population pressure is greatest in Ryeru and Kichwamba subcounties along the western boundary of the reserve, where 1980 population statistics indicated densities of 280 and 210 persons/km^2 respectively. The northern boundary lands support about 100 to 115 persons/km^2 in Rukiri and Kicheche subcounties respectively, with land to the east of the reserve rather sparsely populated at about 40-70 persons/km^2 in Burere and Bichanga subcounties.

Hunting activity is particularly severe in the forest of densely populated Ryeru subcounty, but it threatens the larger mammals throughout the reserve. The occurrence of buffalo *(Syncerus caffer)* is reported in the 1968 Working Plan, but no signs of this species were found during the ground survey, and it is very likely that it has been hunted out. Elephant *(Loxodonta africana)* is no longer 'found in all parts of the forest' (Ball, 1968), and one died in the forest of bullet wounds shortly before the ground survey.

Recommendations Specific to this Forest:

- the sawmilling concession should be reviewed;
- Nature Reserves should be established in representative areas of undisturbed forest to protect viable examples of the major communities. Suitable sites need to be identified through further field surveys, accounting for approximately 15-20% of the forested part of the reserve (see Chapter Six, Recommendation 9). As an immediate measure, a Nature Reserve should be established in the Kasyoha portion of the reserve, between the Chambura river, its Bulingo tributary, and its major (unnamed) tributary to the east which forms the Buhweju/Igara County boundary (Fig. K1.2). Such a reserve would cover 47 km^2 (11.8% of the forest reserve's area) and preserve representative portions of the more mature mixed *Parinari, Maesopsis* and hill forest types. A second Nature Reserve should be established in the low-lying northwestern (Kitomi) portion;
- the majority of the reserve should be designated as buffer zone, in which timber extraction if permitted at all, would be strictly limited to non-mechanised methods;
- a vigorous social forestry (village tree planting) programme should be pursued in the densely populated agricultural lands of Ryeru and Kichwamba subcounties, as a matter of urgency.

Principal Reference Material:

Ball, J.B. (1968). Working Plan for Kasyoha-Kitomi Forest Reserve. Period 1.7.68 to 30.6.78. Entebbe: Uganda Forest Department.

Table K1. Areas (km2) of different vegetation types and their condition in Kasyoha-Kitomi Forest Reserve

	Vegetation type						
Condition	Grass land Swamp, lake	Mixed forest (types 3,4,6)	*Maesopsis* forest (types 1,2)	*Parinari* forest (type 5)	Poor forest (type 8)	Hill forest (type 7)	TOTAL
Undisturbed	71	31.5	77.5	13	112.5	29.5	335
Heavily pitsawn	0	3.5	5.5	0	10.5	4.5	24
Lightly pitsawn	0	10	16	1	7	6	40
TOTAL	71	45	99	14	130	40	399

* Forest Department forest-type codes, as shown on map reference AN/C2

Table K2. The number of primate groups seen per kilometre of census route (mean ± SE) and, in parentheses, the estimated population densities (number of groups/km2) of each species along four transects. Transect locations are shown in Fig. K1.1. Data are from Kisubi, (in prep).

Census route	Length (km)	Estimated strip width (km)	No. of censuses	Primate Species				
				C.ascanius	*C. mitis*	*C.l'hoesti*	*C.guereza*	*P.anubis*
A	5.0	0.06	7	0.71 ± 0.15 (11.8)	0.03 ± 0.03 (0.5)	0.00 ± 0.00 (0.0)	0.66 ± 0.18 (11.0)	0.06 ± 0.04 (1.0)
B	5.8	0.06	7	0.81 ± 0.10 (13.5)	0.03 ± 0.03 (0.5)	0.00 ± 0.00 (0.0)	1.11 ± 0.07 (18.5)	0.07 ± 0.05 (1.2)
C	4.0	0.06	7	0.39 ± 0.08 (6.5)	0.11 ± 0.05 (1.8)	0.04 ± 0.04 (0.7)	0.42 ± 0.07 (7.0)	0.00 ± 0.00 (0.0)
D	4.4	0.06	7	0.78 ± 0.11 (13.0)	0.29 ±0.11 (4.8)	0.00 ± 0.00 (0.0)	0.33 ± 0.05 (5.5)	0.00 ± 0.00 (0.0)

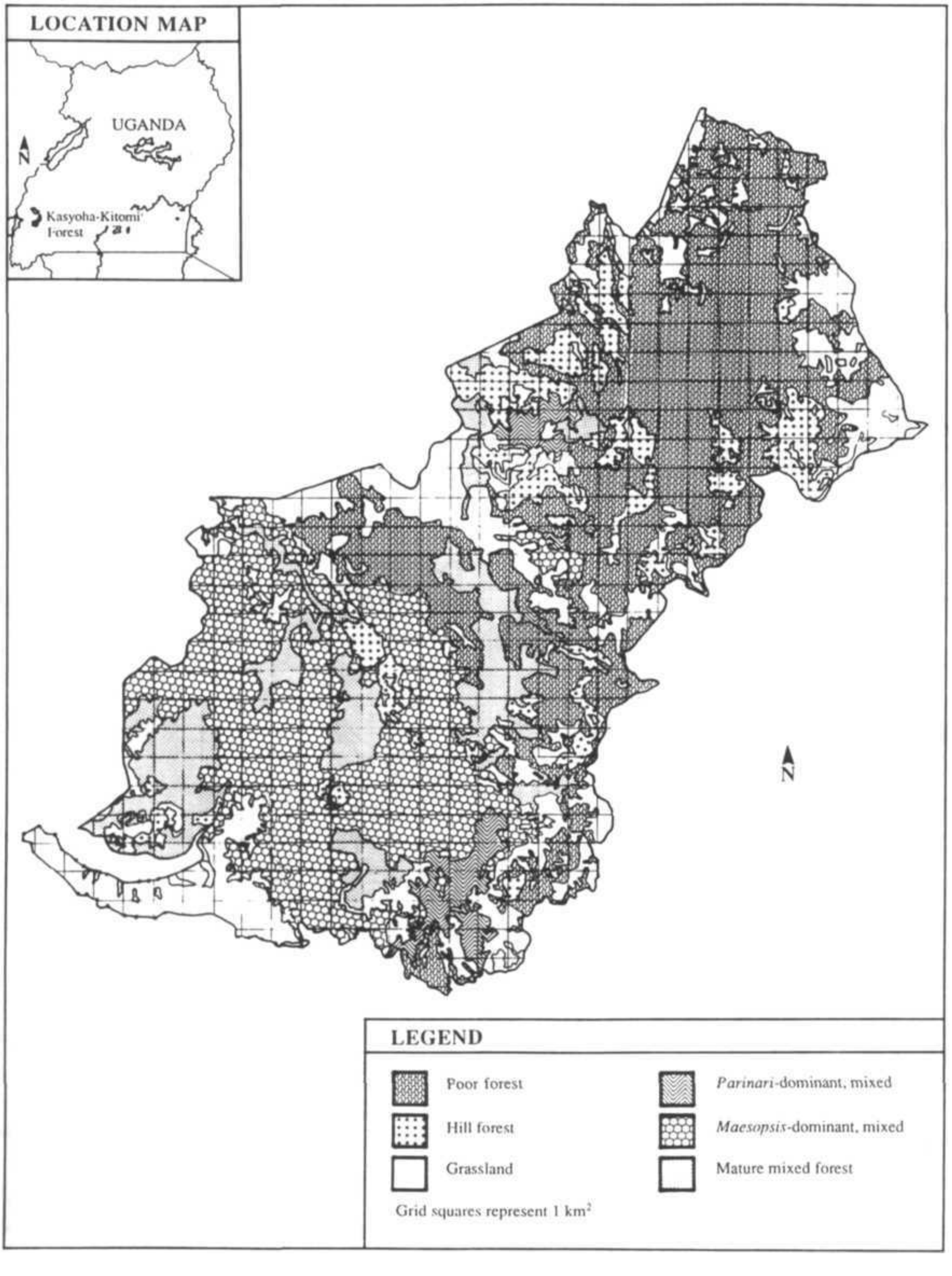


Fig. K1 *Kasyoha-Kiiomi forest types*

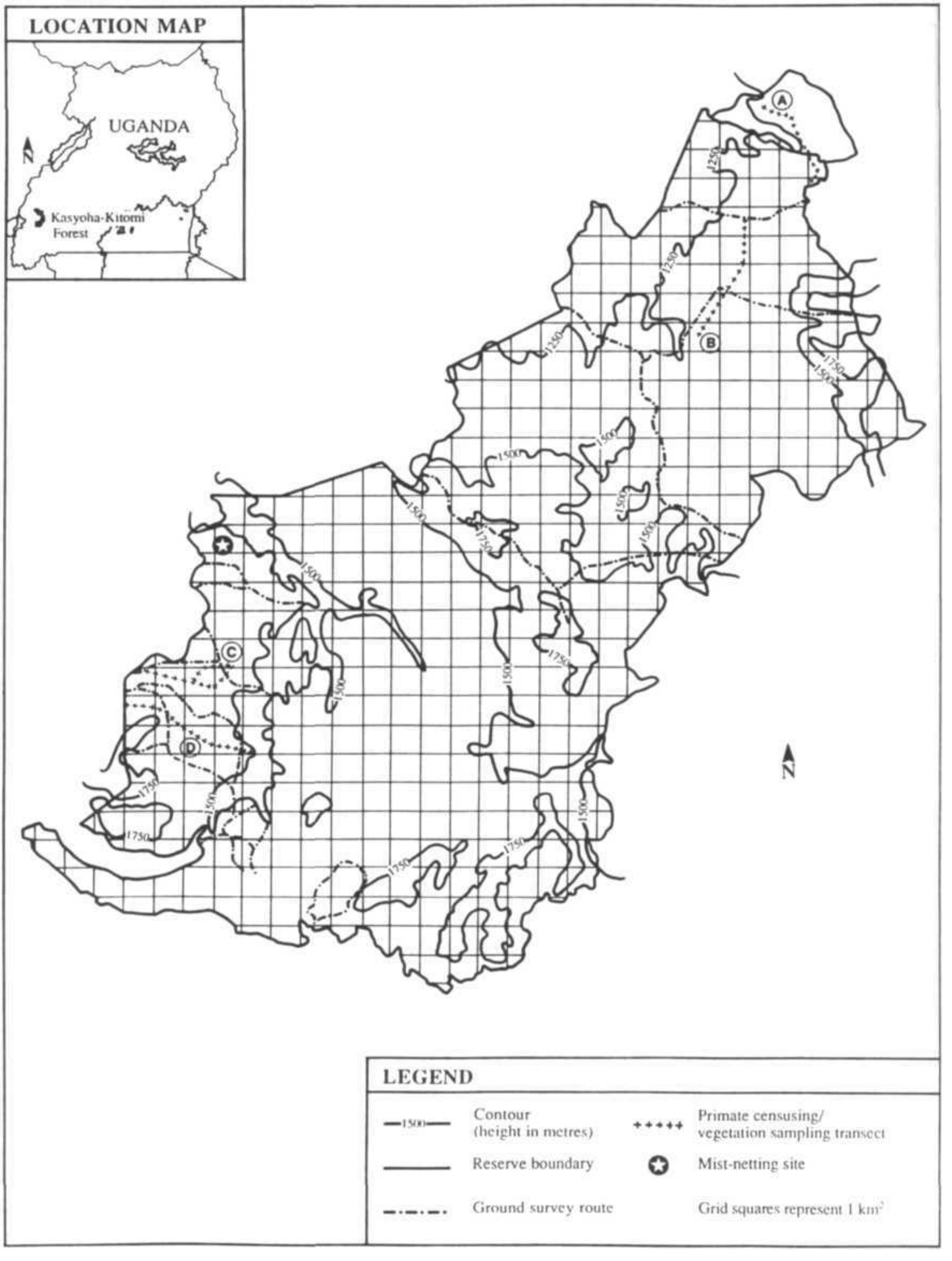


Fig. K1.1 *Kasyoha-Kitomi Forest ground survey routes, mist netting sites, tree enumeration sites and altitudinal zones*

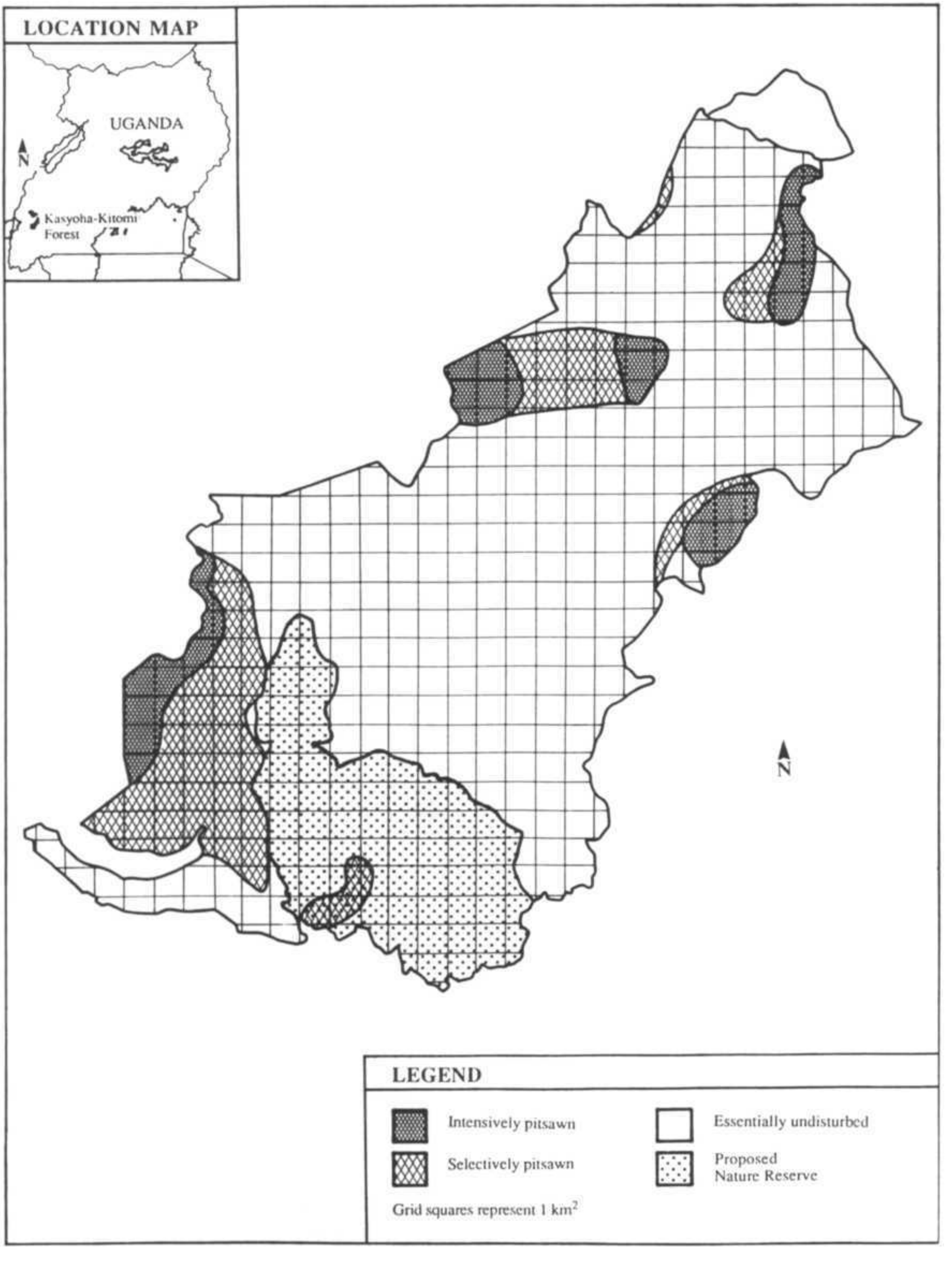


Fig. K1.2 *Present status of Kasyoha-Kitomi Forest, including the location of the proposed Nature Reserve*

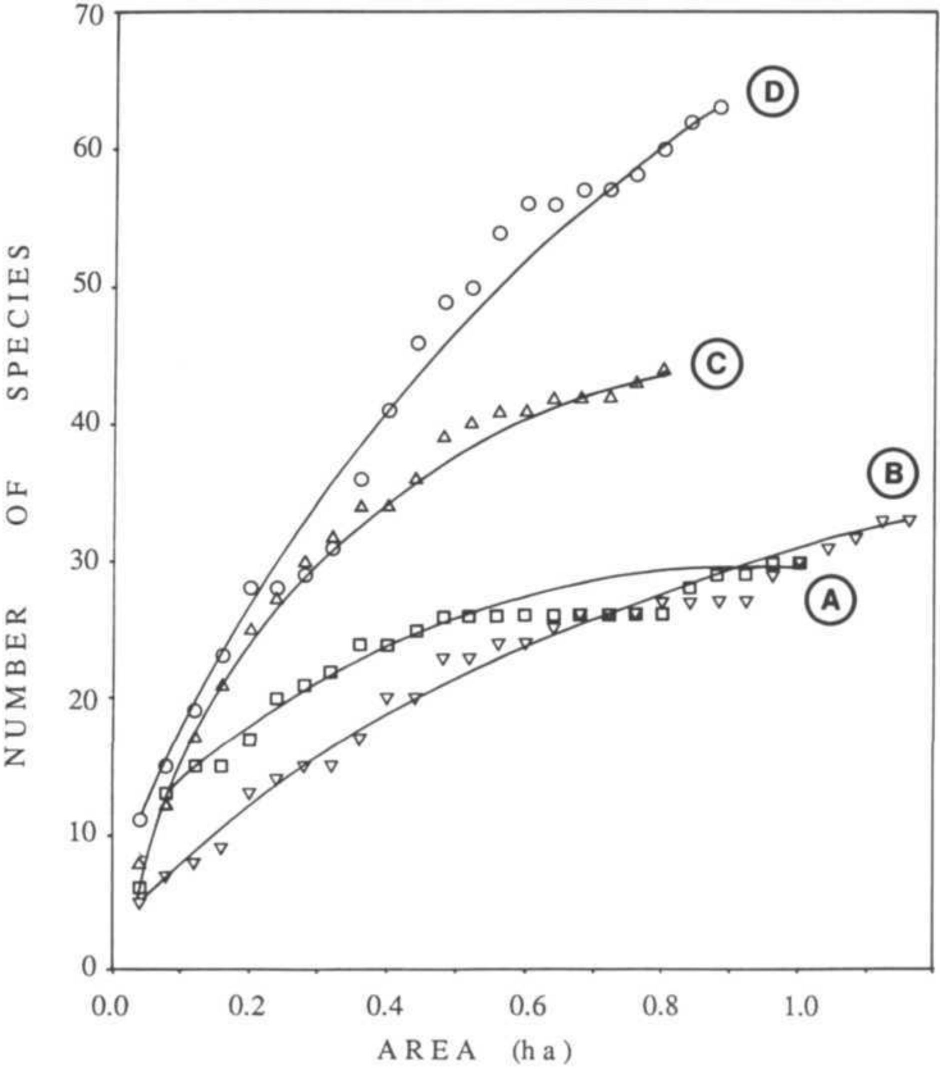


Fig. K2 *The cumulative number of tree species exceeding 10cm dbh, recorded as a function of area enumerated at Kasyoha-Kitomi Forest. (Data are from 20m x 20m plots positioned at 200m intervals along primate census routes, see text).*

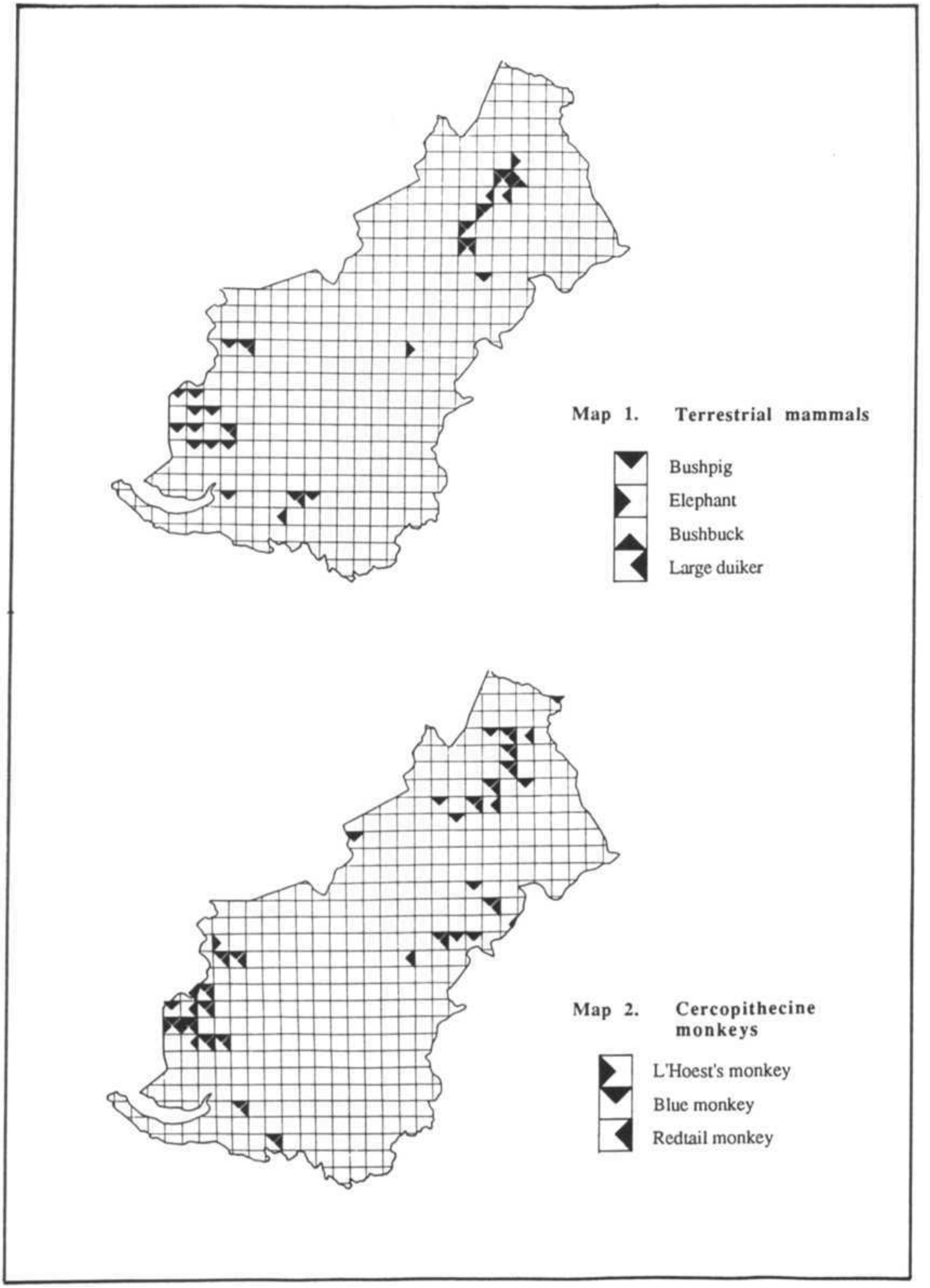
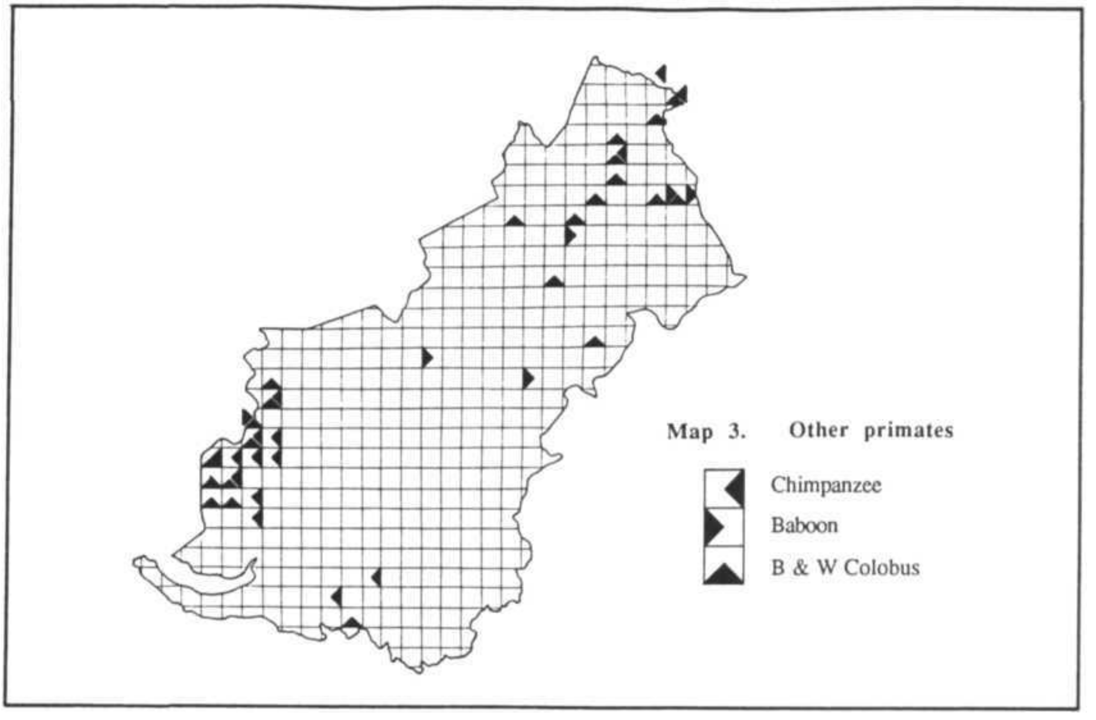


Fig. K3 *Distribution of large mammal records made during the ground survey of Kasyoha-Kitomi Forest*



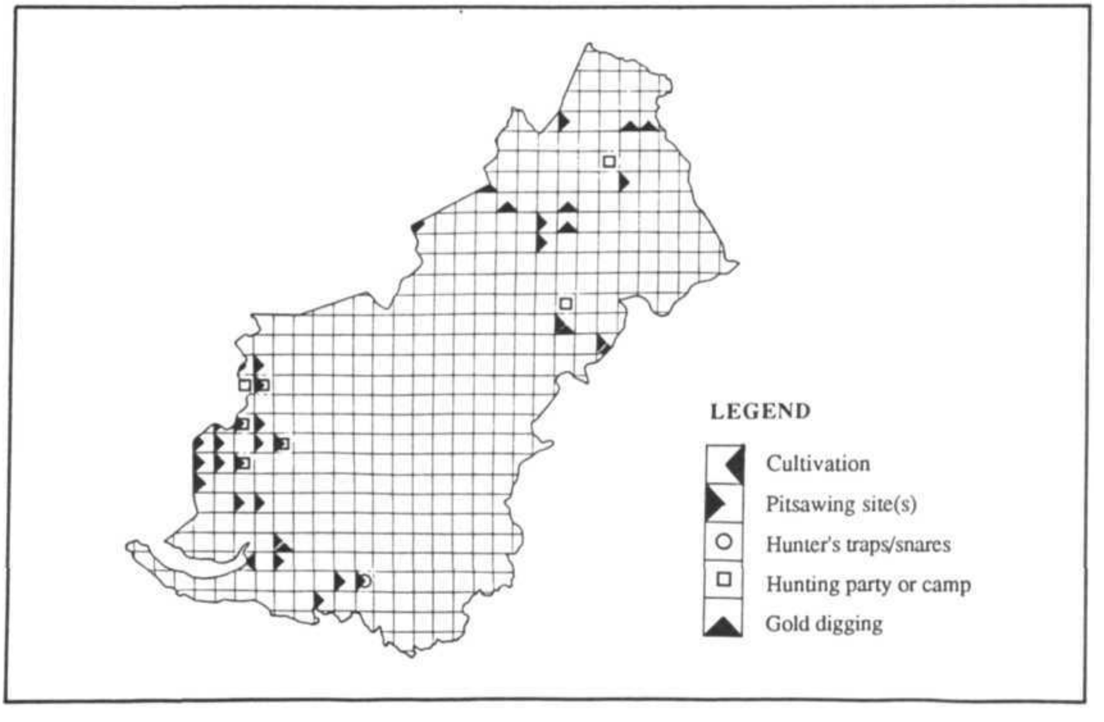


Fig. K4 *Distribution of human activities, as recorded during the ground survey of Kasyoha-Kitomi Forest*

Appendix L. Profile of the Itwara Forest Reserve

Date Established: 1932

Geographical Location: On the escarpment overlooking the western rift valley, 25 km south of Lake Albert, and 25 km northeast of Fort Portal. The forest is divided between Burahya and Mwenge Counties in the administrative district of Kabarole, 0°45'-0°52' N, 30°25'-30°32' E. Covered by Uganda Department of Lands and Surveys map sheets 56/II and 57/I (series Y732) at 1:50,000.

Area: 87 km^2, originally demarcated with cut and cairned boundary lines, and by lines of planted trees wherever the boundary passes through grassland. The boundary has received little maintenance. The reserve is isolated from other protected areas by surrounding peasant agricultural lands and tea estates.

Altitudinal Range: 1,220-1,510 m. 0.5 km^2 of the reserve lies below 1,250 m, 85.5 km^2 at 1,250-1,500 m, and 1.0 km^2 above 1,500 m.

Physical Features: The reserve occupies steeply undulating terrain, and is dissected by the Wamisu and Sogahi rivers which drain northwards. The underlying rocks are sedimentary, strongly folded and metamorphosed, overlain by red ferralitic sandy clay loams of moderate fertility. The climate is tropical with two rainfall peaks from April to May and September to November. Annual mean temperature range, minimum: 15° C, maximum: 27° C. Annual rainfall: 1,250-1,400 mm.

Survey Work Conducted under this Project:

- a ground survey over three weeks during June, July and August 1985 (routes followed are shown in Fig. L1.1);
- sixteen primate censuses, and associated vegetation sampling along two 5 km line transects located in mechanically harvested and undisturbed forest types (see Fig. L1.1 for locations);
- compilation of a preliminary tree species list for the reserve based on four days of survey and collecting work in September 1987;
- ornithological and entomological survey work carried out by a three man team, and including 13,500 metre-net-hours of mist-netting over sixteen days in August and September 1987 (mist netting locations are shown in Fig. L1.1).

Vegetation: The forest is similar to others that occur at this altitude along the eastern rim of the rift valley escarpment, including Kibale, Kalinzu, Kasyoha-Kitomi and Bwindi. In common with these forests, the vegetation is classified as medium altitude moist evergreen forest, and is dominated by species such as *Olea welwitschii, Parinari excelsa, Carapa grandiflora, Aningeria altissima, Strombosia scheffleri* and *Newtonia buchanani.* Twenty-two percent of the reserve supports grassland communities, 13% supports mixed forest and 60% supports *Olea*-dominated forest (Fig. L1, Table L1). It is thought that the latter forest-type constitutes a seral stage in the development of climax *Parinari* forest from grassland, with the mixed forest communities of the southwestern corner of the reserve representing the most mature types to be found here (Osmaston, 1959).

Trees exceeding 10 cm dbh were enumerated in 20x20 m quadrats located at 200 m intervals along two line transects (Fig. L1.1) representing disturbed and undisturbed *Olea* forest communities. The richest of these ran through forest that was mechanically harvested in 1972/3, and now supports 48 species per hectare (Fig. L2). Perhaps significantly, it is located in the southwestern corner of the reserve where the original forest is thought to have reached a more advanced successional stage than elsewhere. The second transect, which penetrated the undisturbed central portion of the reserve, supported 30 tree species per hectare (Fig. L2).

Little is known about the trees of this reserve. One hundred and forty-three forest species (33% of the country's total) have been recorded, including 127 species added to the list during this study. The list is thought to be far from complete. The following species occur in Itwara as part of a very limited range in western Uganda: *Chrysophyllum pruniforme, Dasylepis racemosa, Oncoba routledgei, Isolona congolana, Tabernaemontana odoratissima, Pauridiantha callicarpoides, Hannoa longipes and Turraeanthus africanus.* In addition, *Chrysophyllum pentagonocarpum* is only known from Itwara in the Ugandan part of its range. Two tree species from this reserve are listed as endangered: *Cordia millenii and Lovoa swynnertoni* (FAO, 1986). Non-timber trees of economic importance include wild robusta coffee, *Coffea canephora,* and Shari coffee, *Coffea liberica.*

Fauna: The fauna of this reserve is poorly known, but includes at least 87 species of forest bird (26% of the country's total), 6 species of diurnal forest primate (50% of the country's total) and 25 species of forest swallowtail and *Charaxes* butterfly (37% of the country's total). The fauna shows Afromontane affinities, and includes species such as the white-eyed slaty flycatcher *(Melaenornis chocolatina),* Waller's chestnut-winged starling *(Onychognathus walleri),* thick-billed seedeater *(Serinus burtoni),* l'hoest's monkey *(Cercopithecus l'hoesti)* and Mackinnon's swallowtail butterfly *(Papilio mackinnoni).* All of the species recorded are known from at least one other Ugandan forest. The occurrence of the west African butterfly, *Charaxes kahldeni* (also known from Semliki, Bwindi and Bugoma forests) is of interest. Threatened species that are known to occur in this reserve are: elephant *(Loxodonta africana),* chimpanzee *(Pan troglodytes)* and l'hoest's monkey *(Cercopithecus l'hoesti).*

Twelve species of large mammal were recorded from the forest during the ground survey, either by direct sighting or auditory cues (in the case of six species of primate) or by distinctive spoor (in the case of six other species). The distributions of records are shown in Fig. L3. Spoor of a large duiker *(Cephalophus callipygus?)* were found in 18% of the 55 km^2 compartments covered by the survey, of bushbuck *(Tragelaphus scriptus)* in 9% of compartments, of (probable) buffalo *(Syncerus caffer)* in 2%, of bushpig *(Potamochoerus porcus)* in 49%, of giant forest hog *(Hylochoerus meinertzhageni)* in 2% and of elephant *(Loxodonta africana)* in 2%. Of the primates, redtail monkeys *(Cercopithecus ascanius)* were recorded in 20% of compartments, blue monkeys *(Cercopithecus mitis)* in 27%, l'hoest's monkey *(Cercopithecus l'hoesti)* in 2%, chimpanzee *(Pan troglodytes)* in 25%, baboon *(Papio anubis)* in 11% and black and white colobus *(Colobus guereza)* in 7%. The population densities of primates calculated from census statistics are given in Table L2.

Economic Importance: The forest is important as a source of timber. Based on a 0.83% enumeration carried out in 1956, it is estimated that the forest carried 47 m^3 of usable timber per hectare giving a total annual allowable cut of 3,100 m^3. A sawmill has been operating in the southwestern corner of the reserve since 1970, but there are no reliable records of the quantity of timber harvested. However, since approximately 1,320 hectares of forest have been mechanically harvested to supply this sawmill in the past 17 years, it would appear that something very close to the annual allowable cut has been taken over this period. An estimated 60-100 pitsawyers and wood-carriers were operating in the reserve at the time of the ground survey. Wild coffee has been harvested for many years, the first licence being issued in 1932. There are no records of the size of the Itwara crop, but in neighbouring Kibale Forest, almost 100 tons were harvested in a single year in the 1930s. The forest is extensively used by local people as a source of bushmeat, firewood, building poles, wild yams and medicinal compounds.

Present Status: Fig. L4 shows the distribution of human activities recorded during the ground survey. Derived from these results and information supplied by Forest Department staff, Fig. L1.2 and Table L1 show the area of different forest types affected by varying degrees of disturbance.

The mixed forest of the southwestern corner of the reserve has been seriously degraded by timber harvesting operations, with 64% of the area cut by sawmill operators, and a further 18% degraded by pitsawing activity. The younger forest types have suffered less disturbance, with 81% of the area remaining essentially intact (Table L1). Overall, 25% of the reserve's forest has been significantly disturbed by timber harvesting.

Hunting activity is particularly widespread and intensive in this forest, being recorded from 35% of the survey compartments. Numerous hunting parties, usually comprising 5-15 men with dogs, nets and spears, were seen on the roads around the forest, especially on Sundays. Simple snares, sprung snares and pitfall traps are common throughout the forest (Fig. L4). Despite the heavy hunting pressure, large mammal populations appear to be somewhat higher than in other forests (see 'Fauna' above). Elephants were not recorded during the initial ground survey, but a path was found in the centre of the reserve in January 1986 indicating that they do still use the area. Local reports suggest that they have traditionally visited the forest seasonally from the Toro Game Reserve to the west and the Kibale Forest to the south, but their migration corridors are presently being settled by cultivators, and it is doubtful whether any elephant will be able to continue making use of the area in this way in the future.

Management: The reserve is managed from the Kabarole District Forest Office, Fort Portal. One principal forester, one forester, two forest guards and about four workers are assigned to protect the reserve. There is a guard post at Kijura with one uniport and a two-roomed prefabricated wooden house, and another uniport at the Itwara sawmill. A road penetrates the forest for about 3 km in the southwestern corner of the reserve, providing access to the sawmill; and a number of poorly maintained log-extraction roads span out from this point into the adjacent management compartments.

The latest Working Plan covers the period 1959 to 1965 and prescribes for the conversion of the forest to a uniform system by clear felling (or nearly so), on a 60-year rotation. Two small grassland areas in the west of the reserve have been leased to a neighbouring tea estate for use as a fuelwood *(Eucalyptus)* plantation, and all other grassland areas are designated for the establishment of timber plantations, but no planting has yet taken place.

Conservation Importance:
- by virtue of its location close to a postulated Pleistocene forest refugium in the Semliki Valley (Hamilton, 1981), Itwara supports a diverse community of forest species, including many Congo basin plants and animals on the eastern limits of their ranges.
- the reserve supports at least three species of animal considered to be globally threatened with extinction, or nearly so.

Threats: The greatest threat to this forest is presented by the continuing operation of the Itwara sawmill without a satisfactory alternative source of roundwood supply to the natural forest. Agricultural encroachment is not considered to be an immediate threat since the settled areas of Bukaaki, Kyarusozi and Hakibaale subcounties, which surround the forest, were populated at a density of only about 70 persons/km^2 at the time of the last population census in 1980. Excessive hunting poses a threat to forest ungulate populations, since all parts of this small forest are readily accessible to hunters, leaving no 'refuge' serving to re-populate depleted areas.

Recommendations Specific to this Forest:
- timber exploitation from the natural forest should be carried out by pitsawyers, or by use of small portable machines, rather than by use of heavy logging machinery.
- the sawmill should be encouraged to transfer its operations elsewhere, or find alternative sources of roundwood supply that do not involve hardwood extraction from the natural forest.
- a Nature Reserve should be established in the centre of the forest between the Wamisu and Sogahi rivers, covering the whole of management compartments I21, I26, I28, I32 and I33 (1,350 ha, representing 15.5% of the reserve, or 20.0% of the forested area) (Fig. L1.2).

Principal Reference Material:

Osmaston, H.A. (1959). Working Plan for the Kibale and Itwara Forests. First Revision: Period 1959 to 1965. Entebbe: Uganda Forest Department.

Table L1. Areas (km2) of different vegetation types and their condition in Itwara Forest Reserve

Condition	Vegetation types: Grass land	Mixed forest	*Olea*-mixed forest	Poor forest	Albizia *Celtvs* forest	Colon-ising forest	Hill forest	TOTAL
Undisturbed	19.3	2.0	41.6	0.8	2.4	0.6	0.5	67.2
Mechanically harvested	0.0	7.2	6.0	0.0	0.0	0.0	0.0	13.2
Heavily pitsawn	0.0	1.0	2.5	0.0	0.0	0.0	0.0	3.5
Lightly pitsawn	0.0	1.0	2.0	0.0	0.0	0.0	0.0	3.0
TOTAL	19.3	11.2	52.1	0.8	2.4	0.6	0.5	86.9

Table L2. The number of primate groups seen per kilometre of census route (mean ± SE), and in parantheses, the estimated population densities (number of groups/km2) of each species along two transects. Transect locations are shown in Fig. L1.1. Data are from Kisubi (in prep.).

Census route	Length (km)	Estimated strip width (km)	No. of censuses	Primate species: *C.ascanius*	*C. mitis*	*C.guereza*	*P.anubis*	*P.troglodytes**
A	5.0	0.10	8	0.13 ± 0.04 (1.3)	0.08 ± 0.02 (0.8)	0.03 ± 0.02 (0.3)	0.05 ± 0.03 (0.5)	0.05 ± 0.05 (0.5)
B	5.0	0.06	8	0.07 ± 0.05 (1.2)	0.10 ± 0.04 (1.7)	0.00 ± 0.00 (0.0)	0.03 ± 0.02 (0.5)	0.00 ± 0.00 (0.0)

* Data for chimpanzees refer to the number of individuals, not groups.

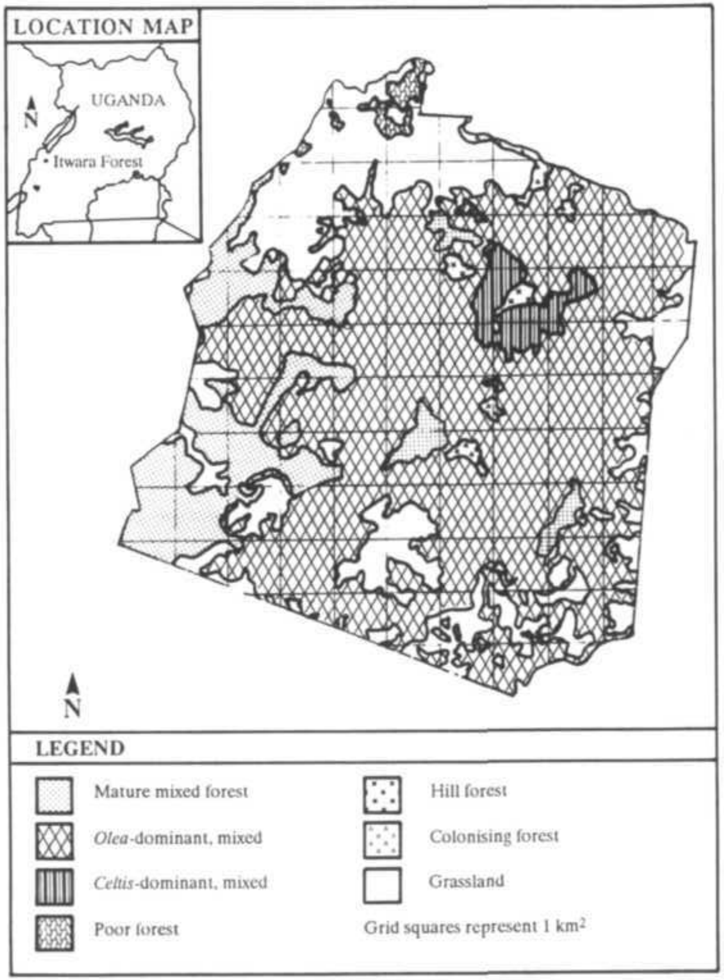


Fig. L1 *Itwara forest types*

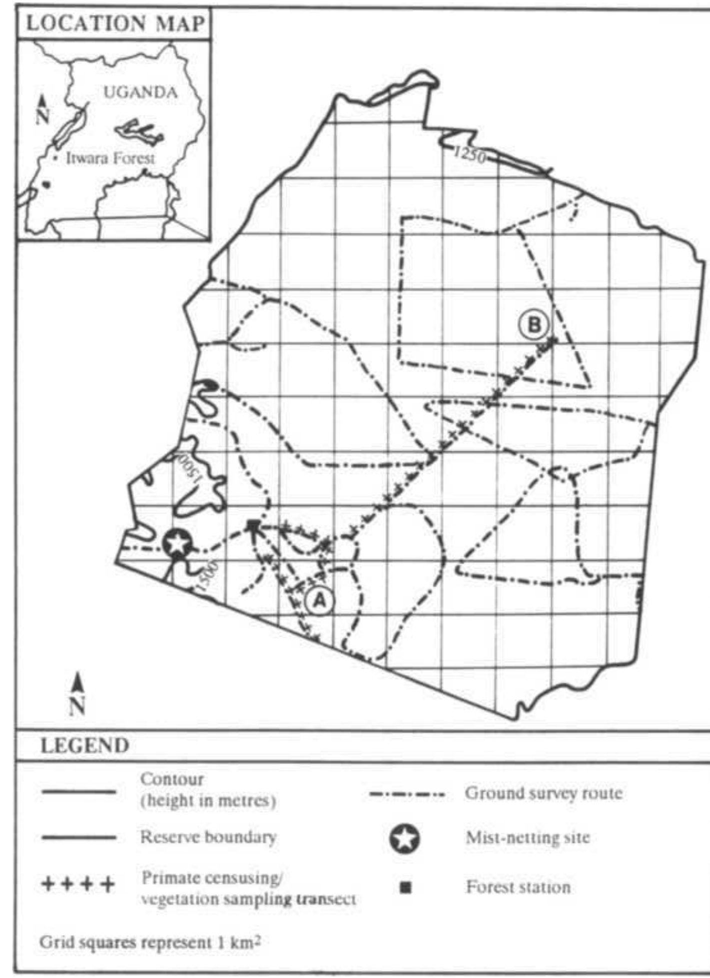


Fig. L1.1 *Itwara Forest ground survey routes, transects and mist netting sties*

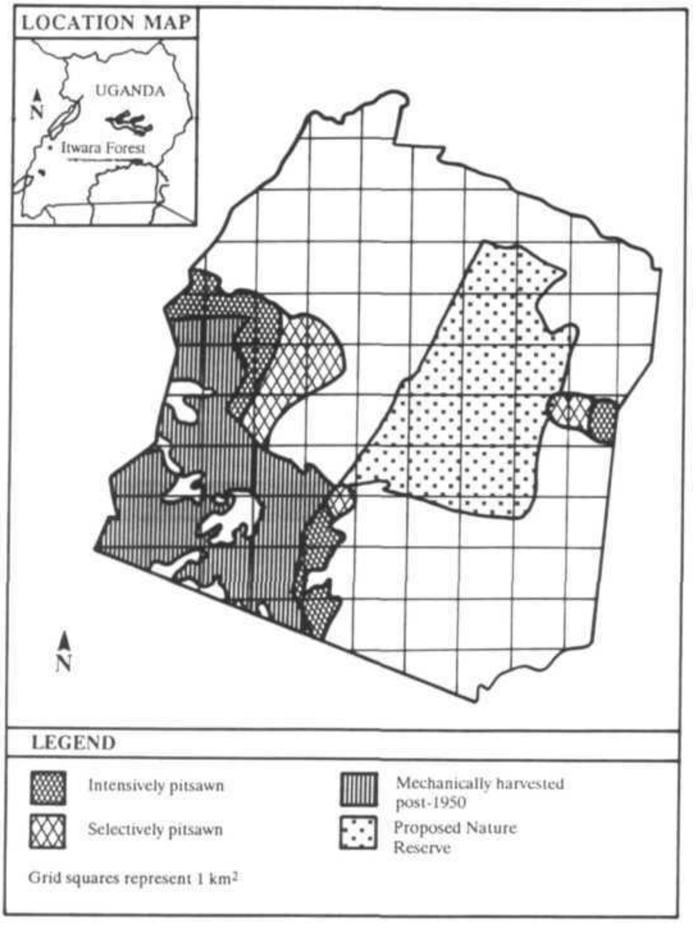


Fig. L1.2 Present status of Itwara Forest, including the location of the proposed Nature Reserve

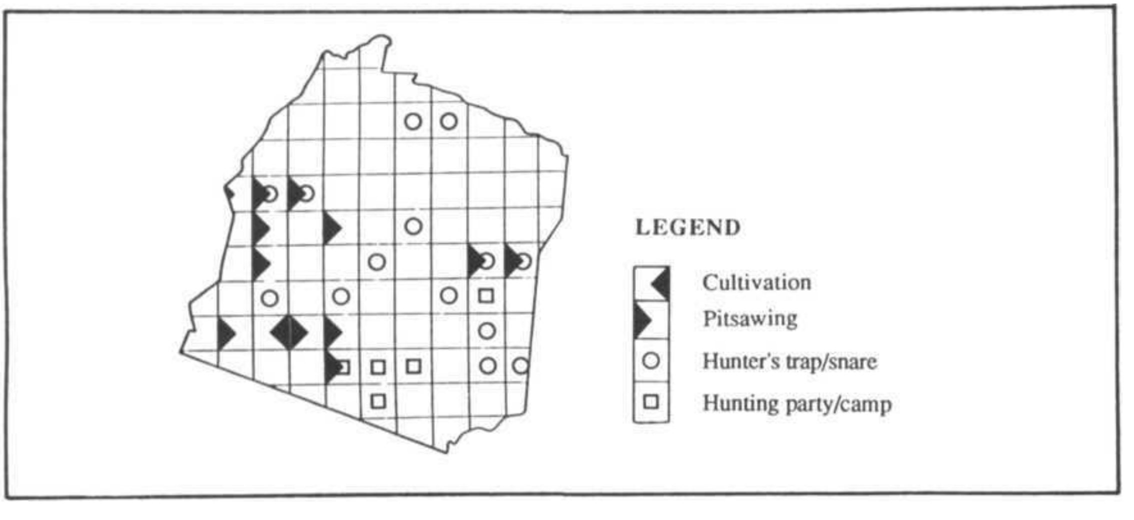


Fig. L4 Distribution of human activities, as recorded during the ground survey of Itwara Forest

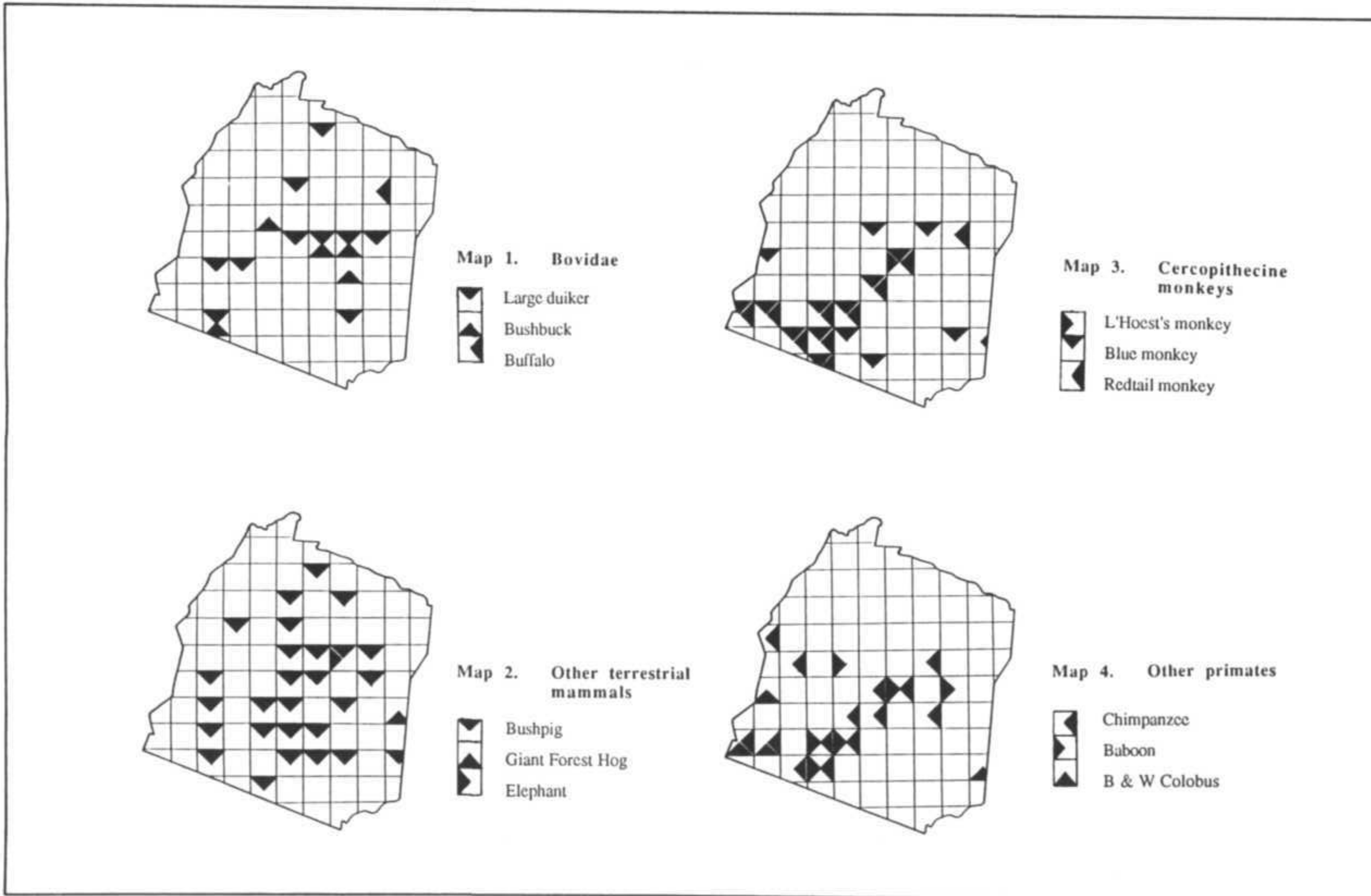


Fig. L3 *Distribution of large mammal records made during the ground survey of Itwara Forest*

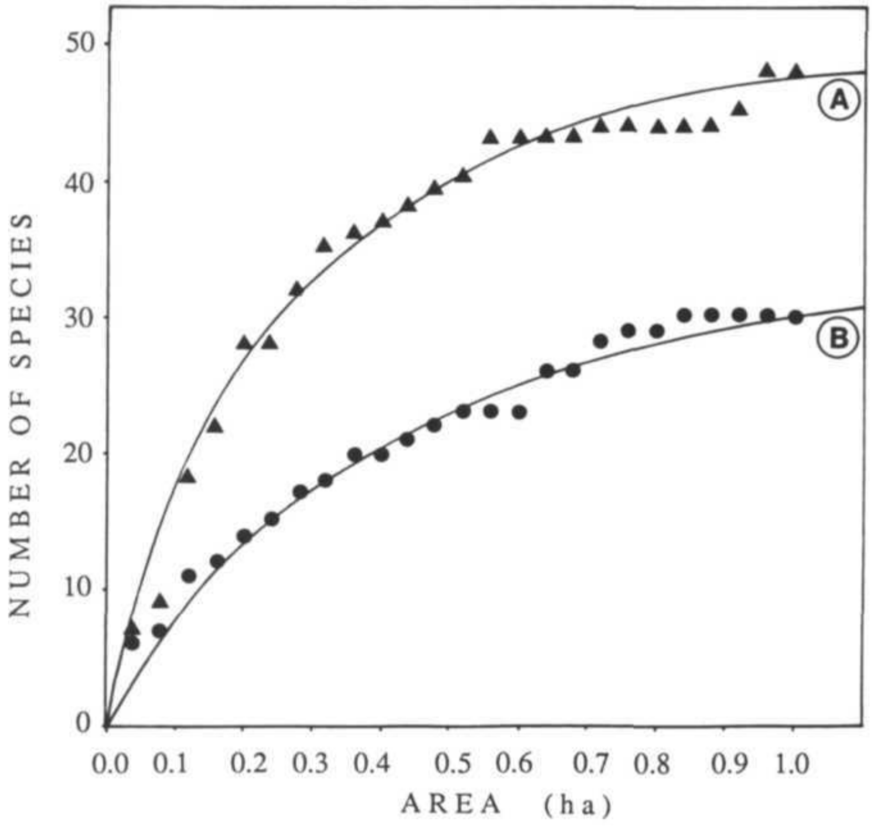


Fig. L2 *The cumulative number of tree species exceeding 10cm dbh, recorded as a function of area enumerated at Itwara Forest. (Data are from 20m x 20m plots positioned at 200m intervals along primate census routes, see text).*

Appendix M. Profile of the Sango Bay Forest Reserves (Kaiso, Malabigambo, Namalala and Tero)

Date Established: not known; the forests were re-gazetted (or perhaps gazetted for the first time) in 1950.

Geographical Location: On the Lake Victoria shore near the Tanzanian border. The forests lie in Kyotera County in the administrative district of Rakai, 0°47'-l°00' S, 31°28'-31°43' E. Covered by Uganda Department of Lands and Surveys map sheet 88/III (Series Y732) at 1: 50,000.

Area: 151 km^2, undemarcated. The Kaiso and Malabigambo reserves are contiguous with the Minziro Forest in Tanzania. The boundary is natural, and follows the limits of areas of seasonally inundated grassland and swamp which surround the forest.

Altitudinal Range: All forest blocks occupy flat land at about 1,130 m.

Physical Features: The forests occupy part of the Kagera river floodplain, and are surrounded by swamp and seasonally flooded grassland communities. The floodplain is broken by a number of Bukoba sandstone outcrops, which lie to the south and east of the forests. Kaiso, Malabigambo and Namalala lie on heavy clay loams that are frequently waterlogged, whereas much of the Tero block lies on a sandy soil, that appears to be better drained. The climate is tropical with two rainfall peaks from March to May and October to November. Annual mean temperature range, minimum: 16° C, maximum: 26° C. Annual rainfall: 1,150-1,400 mm.

Survey Work Conducted under this Project:
- ground survey work conducted over four days in January 1987, and seven days in September 1987;
- entomological and ornithological survey work involving seven man-weeks of work, including 12,300 metre-net-hours of bird mist-netting during July and September 1987;
- examination of tree species richness through enumeration of trees exceeding 10cm dbh in two (0.25 and 0.45 ha) plots. The trees were enumerated in plots 5 m either side of a 50 m cord positioned alternately to the left and right, and perpendicular to a central transect line. The enumeration cords were positioned at 50m intervals along the transect line, such that 10% of any given area was sampled, with each cord representing a 0.05 ha sub-plot (see Fig. M1.1 for plot locations);
- botanical inventory work over six days in September 1987.

Vegetation: The Sango Bay forests are of a rather homogeneous nature, and can be broadly classified as swamp forest (Langdale-Brown *et al,* 1964). The canopy is generally lower than that of medium altitude mixed evergreen forest, although many of the component species are the same.

The Forest Department has produced (in 1955) a preliminary type map for the area, in which 13 forest types are distinguished from aerial photography. Fig. M1 is derived from this type map supported by ground checks made during this study.

The distinctions between forest types are not at all clear, but in general terms the forest to the north and east appears more waterlogged than that to the south and west. Parts of the forest closest to the lakeshore at Sango Bay (i.e. the northern part of Namalala, and the eastern edge of Tero East) have been flooded and killed, presumably at the time of the rise of Lake Victoria in the early 1960s when the Owen Falls Dam was built.

The Sango Bay forests were the first to be exploited in Uganda, and there are few areas unaffected by exploitation. Thus the entire forest is of a secondary nature. The wetter areas are characterised by a good mixture of species including *Syzygium guineense, Prunus africana, Spondianthus preusii, Pseudospondias microcarpa, Macaranga monandra, Baphia wollastonii,* and *Klainedoxa gabonensis.* The canopy is generally low (15-20 m) and the understorey tends to be a dense tangle of woody plants that is difficult to penetrate. The better drained areas of Malabigambo and Kaizo support a taller mixed forest with a more open understorey. Here *Beilschmiedia ugandensis, Spondianthus preusii, Olea welwitschii,* and *Maesopsis eminii* are common canopy elements. *Carapa grandiflora* is dominant in the better drained parts of Tero West, though not encountered elsewhere.

Two areas of swamp forest, one in the Namalala and one in the Malabigambo blocks were examined for tree species richness, and proved to be amongst the richest of all the forest types examined during the course of this study. Although the plots were small, the species-area relationships indicate about 60-70 tree species per hectare in these two areas.

The trees of the Sango Bay forests are now reasonably well known. One hundred and seventy forest species (40% of the country's total) have been recorded, including 73 species added to the list during this study. *Pseudagrostistachys ugandensis* is not known from elsewhere in Uganda, and *Podocarpus usambarensis* var. *dawei* is an endemic variety. In addition, *Heywoodia* sp., *Manilkara obovata,* and *Heisteria parvifolia* are known from only one or two other localities, and are probably indicative of an ancient relict forest community. A number of montane species occur here at an unusually low altitude, including *Podocarpus milanjianus, Podocarpus gracilior, Ilex mitis, Psychotria megistosticta* and *Olea africana,* and their occurrence here would seem to support the view that this is a relict forest.

Even before the recent rise in the level of Lake Victoria, there was evidence to support the view that the Sango Bay forests were 'out of sympathy' with their site conditions and that recent changes in the climate and drainage of the area were affecting adversely the regeneration of important timber species such as *Podocarpus usambarensis* (Forest Department, 1955), probably through waterlogging of the soil. The harvesting of the forest during the first half of this century has undoubtedly accelerated the rate at which the composition of the forest is changing, and it is difficult to predict the type of climax community which is likely to replace the original 'fossil' forest that was felled.

Non-timber tree species of commercial importance include wild robusta coffee, *Coffea canephora.* Two trees which occur in these forests are listed as endangered: *Cordia millenii* and *Irvingia gabonensis* (FAO, 1986).

Fauna: The fauna of these reserves is reasonably well known and includes 119 species of forest bird (36% of the country's total), 6 species of diurnal forest primate (50% of the country's total) and 45 species of forest swallowtail and *Charaxes* butterfly (66% of the country's total). All of the species recorded are known from at least one other Ugandan forest, although the *adolfi-friederici* subspecies of black and white colobus monkey *(Colobus angolensis)* is restricted to Sango Bay in the Ugandan part of its range. In addition, the *doggetti* subspecies of blue monkey *(Cercopithecus mitis)* occurs at Sango Bay as part of a limited range in southwestern Uganda, and two species of butterfly *(Charaxes hadrianus* and *C. nobilis)* are each known from only one other Ugandan locality. The avifauna is typical of a lowland community and includes species such as the white-bellied kingfisher *(Alcedo leucogaster),* Icterine greenbul *(Phyllastrephus icterinus)* and crested malimbe *(Malimbicus malimbicus)* which do not occur in the transition and montane forests of higher altitudes. Elephant *(Loxodonta africana)* and blue swallow *(Hirundo atrocaerulea)* are the only threatened species.

Nine species of large mammal were recorded from the forests during the ground survey, either by direct sighting or auditory cues (in the case of six species of primate) or by distinctive spoor (in the case of three other species). The distributions of records are shown in Fig. M3. Spoor of a dwarf antelope (blue duiker, *Cephalophus monticola?)* were found in 4% of the km^2 compartments covered by the survey, of bushpig *(Potamochoerus porcus)* in 4%, and of elephant in 32%. Of the primates, redtail monkeys *(Cercopithecus ascanius)* were recorded in 18% of compartments, blue monkeys *(Cercopithecus mitis)* in 36%, de Brazza's monkey *(Cercopithecus neglectus)* in 4%, baboon *(Papio anubis)* in 4%, black and white colobus in 7% and mangabey *(Cercocebus albigena)* in 18%.

Economic Importance: The forests are of very little commercial importance, but local people use them as a source of bushmeat, building poles, natural fibres and medicinal compounds. Cattle are grazed in the forest at times of need, and fish are trapped during periods of inundation. No evidence of past or present pitsawing activity, agricultural encroachment or hunting activity was found, although the latter undoubtedly occurs.

Present Status: As discussed under Vegetation above, the entire group of forests has been felled, and the different blocks are at various stages of regeneration. The Tero block was felled over the period 1908-15, whilst the Kaiso, Namalala and Malabigambo blocks were felled over a period of about 40 years from 1920. There are very few signs of human activity throughout the majority of the forest, which is hardly surprising in view of the difficult access and the impenetrable nature of the understorey in many parts. Elephants are still widespread and obviously travel freely between the forests and adjacent swamps and grasslands. Sitatunga *(Tragelaphus spekei)* are reportedly common in the swamps, though no evidence of this species was seen during the survey. A pair of reedbuck *(Redunca redunca),* normally one of the first species to disappear under hunting pressure, was seen in the grassland adjacent to Tero West.

Management: The reserves are managed from the Rakai District Forest Office. One forester is assigned to the management of the Sango Bay forests, and one forest guard is stationed at Katera. There is no departmental infrastructure. The 'main' road between Kyotera and Kyebe passes through the northern edge of the Malabigambo block for about 2 km, and a (bearly) motorable track is being maintained along the old railway line between Katera and Minziro.

Otherwise, there is no vehicular access, all log extraction roads being completely overgrown. A few footpaths provide local people with access to the edges of the forest at several points for the collection of useful products, but none of these penetrate very far. The only silvicultural operations were carried out over the period 1908-1930, and involved planting of *Podocarpus* and *Maesopsis* seedlings over an area of about 50 hectares of exploited forest. The locations of these trials is not known, and seedling survival rates appear to have been low (Forest Department, 1955). The latest Working Plan for the area was based on very scant information, and covered the 1955-65 period. At the time of its preparation the forests were leased to Sango Bay Estates Ltd, who apparently had a very free hand over their exploitation. The only departmental field work proposed in the plan was for timber enumeration and regeneration assessment and research, but it is thought unlikely that any such work was actually carried out.

Conservation Importance:
- the forests represent a unique 'relict' forest community of considerable biogeographical interest, with many species of plants and animals occurring here on the edges of their ranges;
- this is the only extensive area of swamp forest in Uganda;
- the forests represent an important component of the Kagera river floodplain ecosystem, in which many animal species, such as elephants and many birds range freely between grassland, swamp and forest communities;
- the Malabigambo and Kaiso blocks form part of an extensive trans-national forest which is sufficiently large to support viable populations of some of the rarer species;
- the reserves support two species of animal considered to be globally threatened with extinction, or nearly so.

Threats: The forests are not considered to be under any immediate threat because of their inaccessible nature, poor post-harvest stocking of usable timber, lack of potential for conversion to agricultural land, and low human population densities in surrounding areas (averaging 40-50 persons/km^2).

Recommendations Specific to these Forests:
- more detailed investigations into differences in community composition should be carried out, prior to the selection and establishment of appropriate Nature Reserves;
- Nature Reserves should be established, accounting for approximately 8-10% of the forest (see Chapter Six, Recommendation 9).

Principal Reference Material:

Forest Department (1955). Working Plan for the Sango Bay Forests, Buddu County, Masaka District, Uganda, for the period 1955-65. Entebbe: Uganda Forest Department.

Fricdmann, H. and J.G. Williams (1969). The birds of the Sango Bay Forests, Buddu County, Masaka District, Uganda. Los Angeles County Museum Contributions in Science No. 162. 48pp.

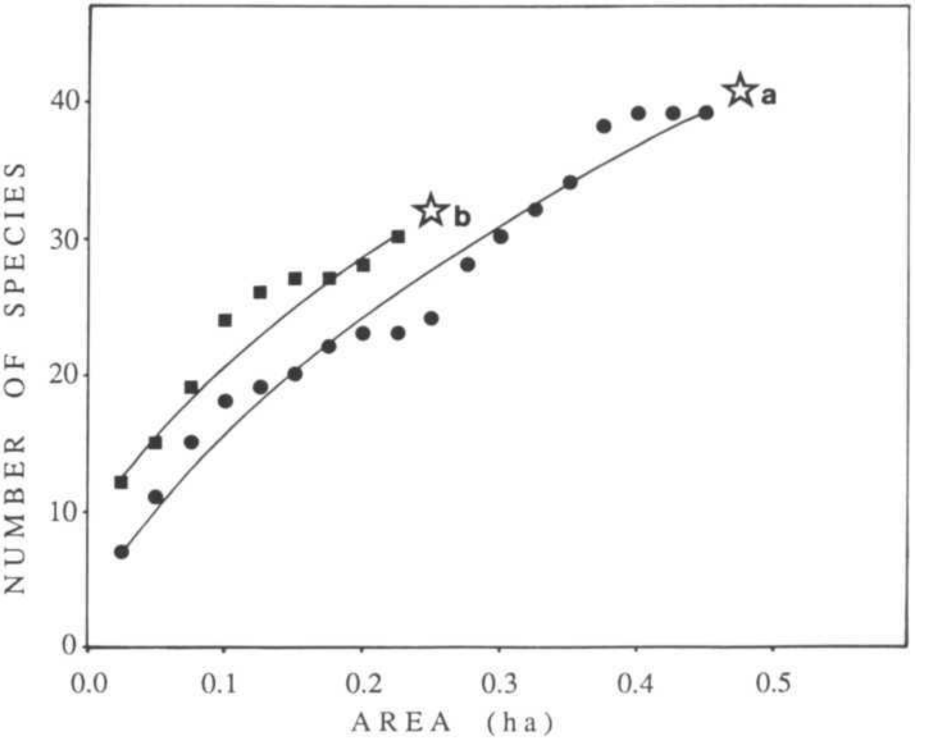


Fig. M2 *The cumulative number of tree species exceeding 10cm dbh, recorded as a function of area enumerated al Sango Bay. (Data are from 50m x 10m plots positioned at 50m intervals perpendicular to a central transect line, alternately to the left and right of the line).*

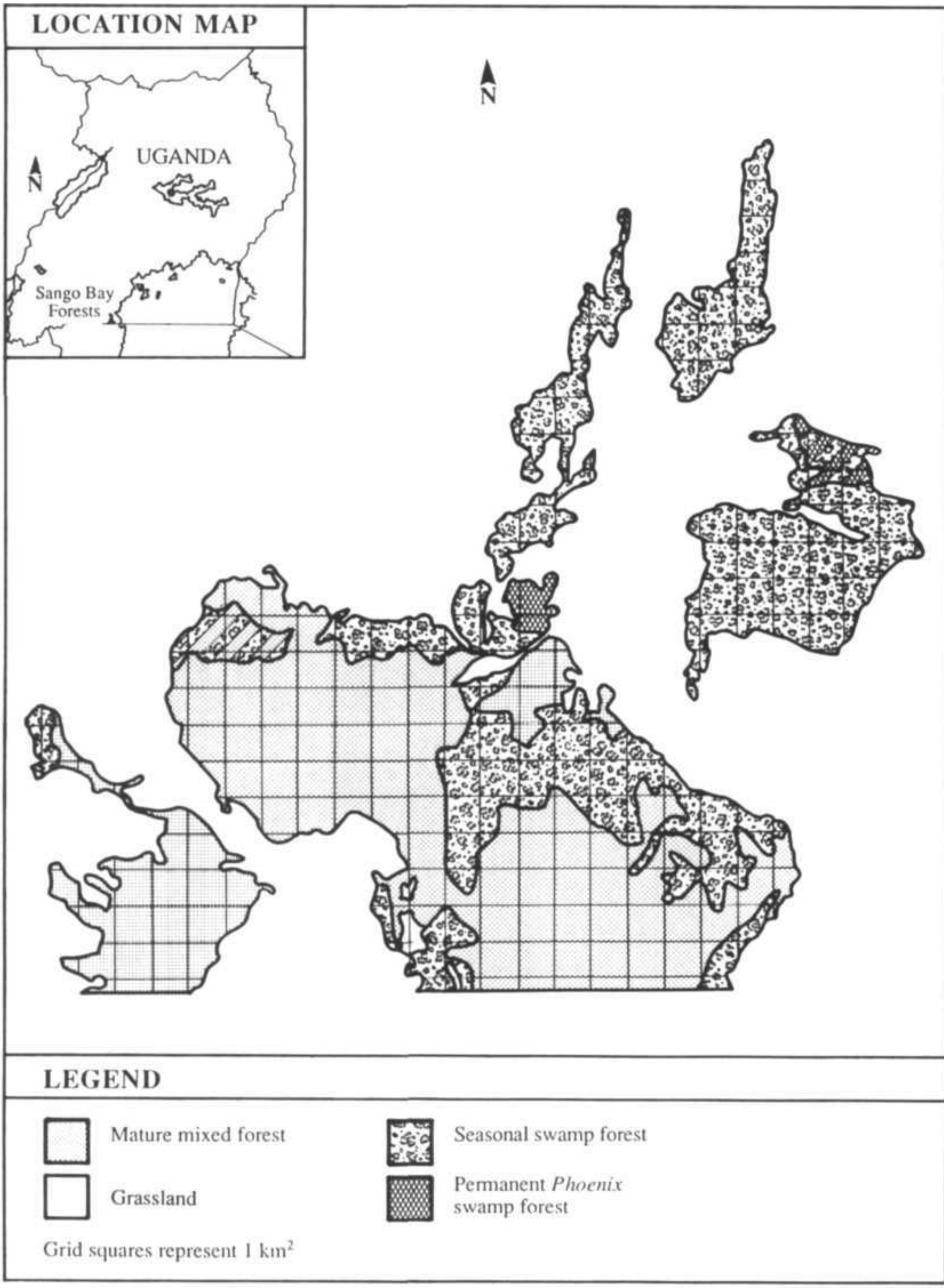


Fig. M1 Sango Bayforest types

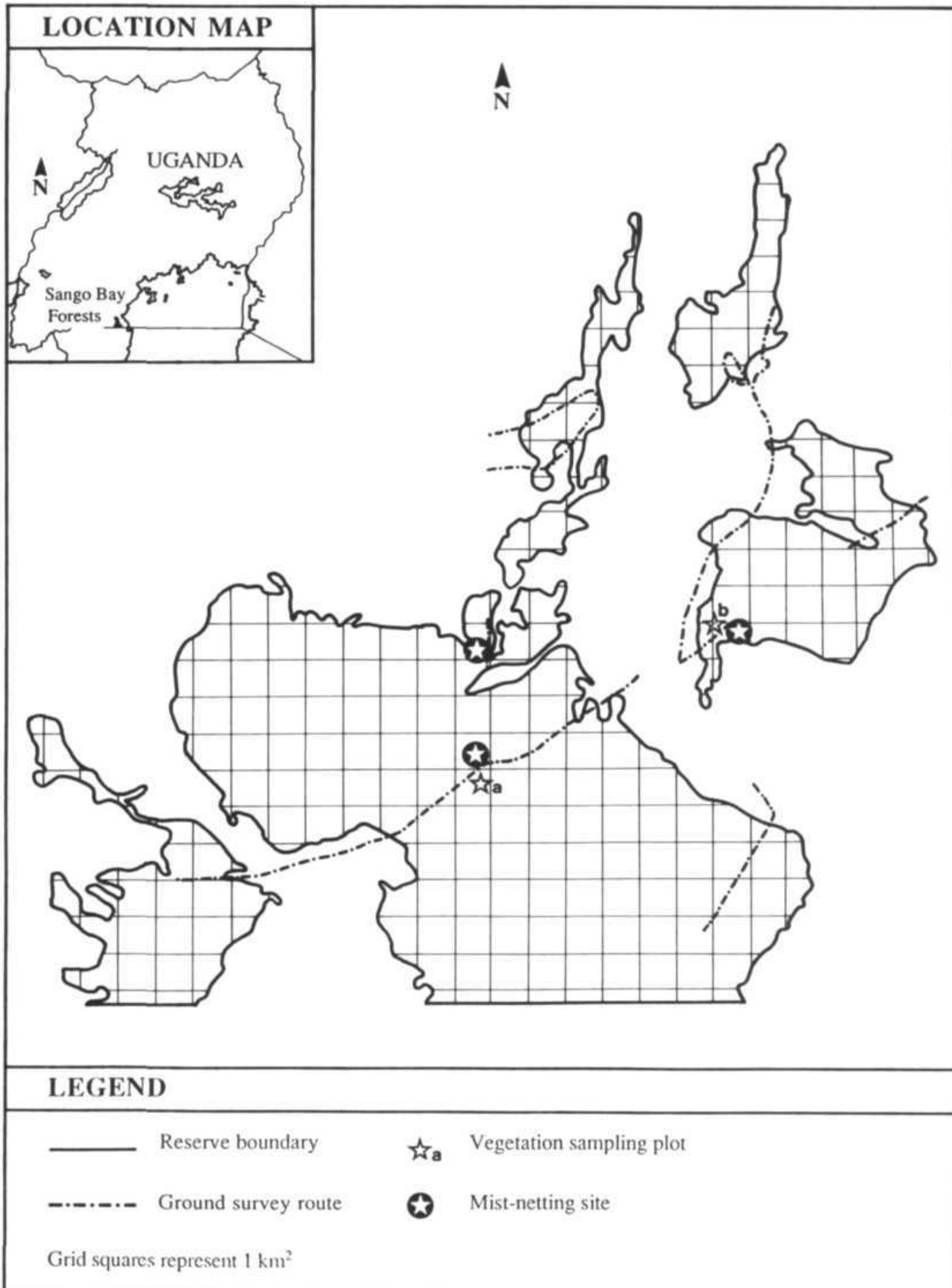


Fig. M1.1 Sango Bay ground survey routes, vegetation sampling sites and mist netting sites

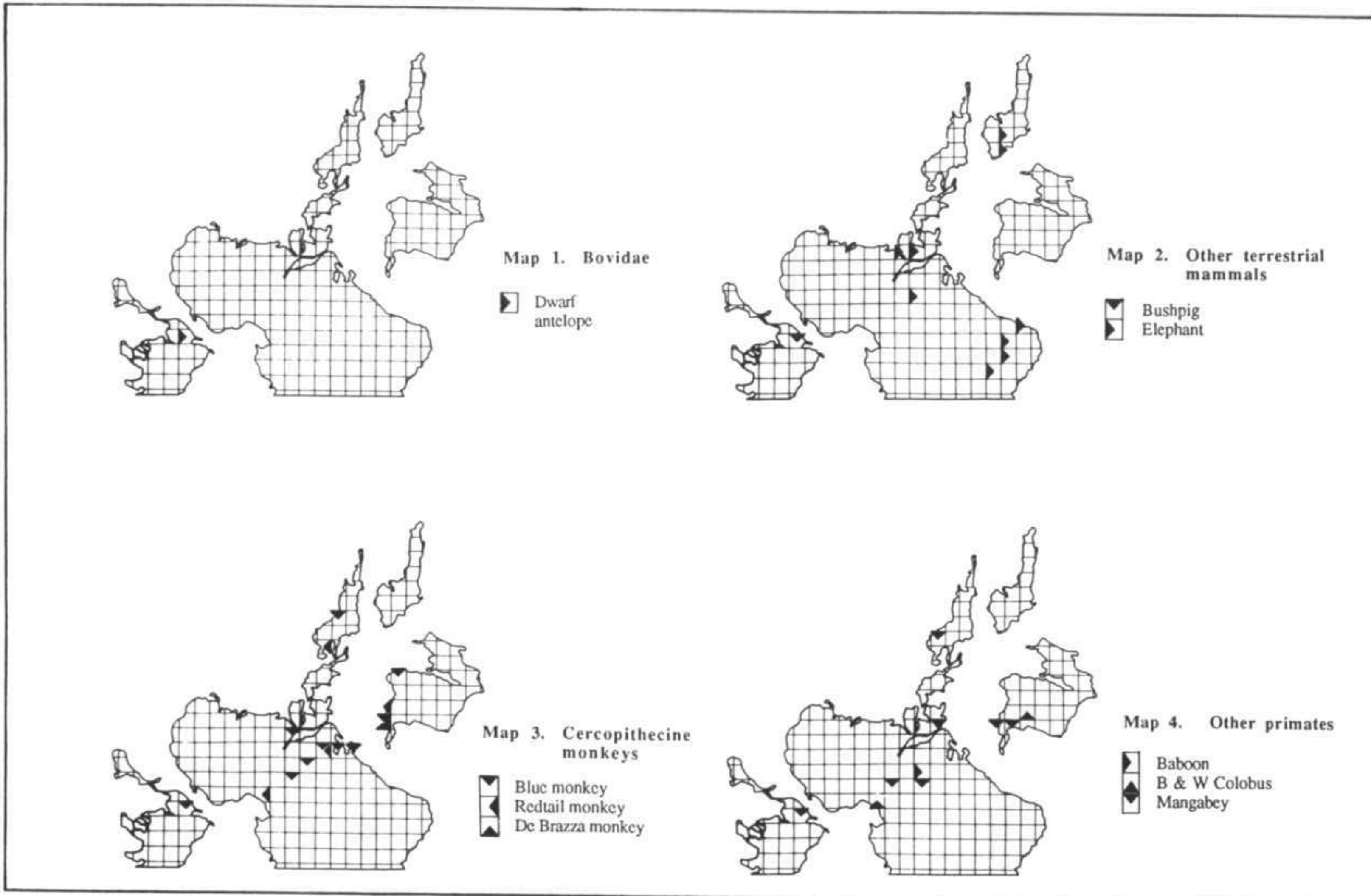


Fig. M3 *Distribution of large mammal records made during the ground survey of the Sango Bay forests*

Appendix N. Profile of the Mabira Forest Reserve

Date Established: 1900 (under the Buganda Agreement)

Geographical Location: 20 km north of the Lake Victoria shoreline, immediately to the west of the Victoria Nile. The reserve occupies parts of Buikwe and Nakifuma Counties in Mukono administrative district, 32°52'-33°07' E, 0°24'-0°35' N. Covered by Uganda Department of Lands and Surveys map sheets 61/IV, 62/III, 71/II and 72/I (Series Y732) at 1: 50,000.

Area: 306 km^2, demarcated with numbered concrete posts at the corners, as well as direction trenches and cairns. The boundary lines were sown with the seed of *Cassia spectabilis* but in some areas these failed to grow and/or have subsequently been cut down. The reserve is isolated from other protected areas by settled agricultural land.

Altitudinal Range: 1,070-1,340 m. Approximately 3.5 km^2 comprises isolated hills lying above 1,250 m, with 303 km^2 occupying land at altitudes of 1,000-1,250 m.

Physical Features: The reserve occupies gently undulating country characterised by numerous flat-topped hills (relics of the ancient African peneplain), and wide shallow valleys. The topography is such that the land drains to the north, even though the reserve's southern boundary lies only 13 km from the lakeshore. The underlying rocks are composed of micaceous schists and shales of the Buganda-Toro system with ridges of quartzite and amphibolite. The soils are generally ferralitic sandy clay loams, with black waterlogged clays in the valley bottoms. The climate is tropical with two rainfall peaks from April to May and October to November. Annual mean temperature range, minimum: 16-17° C, maximum: 28-29° C. Annual rainfall: 1,250-1,400 mm.

Survey Work Conducted under this Project:

- an aerial survey was conducted in March 1987 in collaboration with the Stanford University's Center for Conservation Biology Tropical Forest Diversity Project;
- a preliminary reconnaissance survey was conducted over four days in April 1987 (routes followed are shown in Fig. N1.1);
- this report also draws on recent survey and fieldwork conducted by Steven Kramer and Jennifer Holmes of the Stanford University Forest Diversity Project.

Vegetation: Mabira is considered to be a secondary forest, in which the distinctive vegetation types represent sub-climax communities, heavily influenced by man over prolonged periods of time (Sangster, 1950). There are four forest types which make up the bulk of the forest (Fig. N1, Table N1). The youngest of these is dominated by the colonising tree *Maesopsis eminii* which associates with *Albizia* spp., *Markhamia platycalyx*, *Sapium ellipticum*, *Celtis* spp. etc. over about 25% of the reserve's area. A later successional stage is represented by communities classified as young mixed forest and *Celtis-Holoptelea* forest, which together cover 59% of the reserve's area (prior to recent destruction, see below). The only other important community is the poor mixed forest of wet valley bottom sites (dominated by *Baikiaea insignis minor)* which, until recently, covered about 15% of the reserve

(Fig. N1, Table N1). No area of the forest is considered representative of a climax community, and, given time, the succession might be expected to proceed towards some kind of single-species dominance (Sangster, 1950).

The trees of this forest are reasonably well known on account of recent work conducted under Stanford University's Forest Diversity Project. Two hundred and two species (47% of the country's total) have been recorded so far, including one *(Diphasia angolensis)* not known from elsewhere in Uganda. *Lecaniodiscus fraxinifolius* reaches the western limits of its range in Mabira, and the following are rare species which occur here as part of a limited range in Uganda: *Oreobambos buchwaldii, Chrysophyllum delevoyi, Lindackeria bequaertii, Claoxylon hexandrum, Paropsia guineensis, Staudtia kamerunensis,* and *Antrocaryon micraster.* Five tree species from this reserve are listed as endangered (FAO, 1986): *Chlorophora excelsa, Cordia millenii, Irvingia gabonensis, Entandrophragma angolense* and *Lovoa swynnertonii.* Wild robusta coffee, *Coffea canephora* grows in this forest.

Fauna: The fauna of this reserve is reasonably well known and includes 151 species of forest bird (46% of the country's total), 2 species of diurnal forest primate (17% of the country's total), and 39 species of forest swallowtail and *Charaxes* butterfly (57% of the country's total) (see Appendices B, C and D for species lists). The Tit Hylia *(Pholidornis rushiae)* is known only from Mabira in the East African part of its range, but all other species are known from at least one other forest in Uganda. The fauna is characteristic of a lowland forest community, and includes the following uncommon species: Cassin's hawk-eagle *(Hieraaetus africanus),* forest francolin *(Francolinus lathami),* pied hornbill *(Tockus fasciatus),* purple-throated cuckoo shrike *(Camephaga quiscalina),* leaflove *(Phyllastrephus scandens),* black-capped apalis *(Apalis nigriceps),* grey longbill *(Macrosphenus concolor),* blue-headed crested flycatcher *(Trochocercus nitens)* and chestnut-winged starling *(Orychognathus fulgidus).* The depauperate primate fauna appears to be a rather recent phenomenon, since there are old records of black and white colobus *(Colobus guereza)* (Kingdon, 1971), and legends suggest the occurrence of chimpanzee *(Pan troglodytes)* here (Kingdon, 1971). The present status of the larger mammals is not known, but buffalo *(Syncerus caffer)* were reported along the Musamya river in 1983 (S. Mpangire, pers. comm.), and elephant *(Loxodonta africana)* were last recorded in the mid-1950s (S. Kramer, pers. comm.). Threatened or near-threatened species known from this reserve are elephant (probably now extinct) leopard *(Panthera pardus),* Nahan's francolin *(Francolinus nahani),* and blue swallow *(Hirundo atrocaerulea).*

Economic Importance: The forest has been an important source of various products for longer than its recorded history. Large scale commercial exploitation began in 1906 when the first sawmill operations were initiated, but they were rather haphazard and it was not until 1944 that any form of systematic management was embarked upon. 'Organised' commercial felling of the forest began in earnest in 1953, and 3,430 ha of forest was felled in the first eight years to mid-1960. Exploitation has been more-or-less continuous since that time. Based on a 1.4% enumeration sample in the southwest of the reserve, Lockwood Consultants (1973) estimated 37 m^3 of standing timber exceeding 50 cm dbh per hectare: a rather low figure.

Over the last ten to fifteen years uncontrolled exploitation of this forest has become a serious problem, and the forest has assumed major economic importance not only as a source of illegal timber, but more importantly as a source of agricultural produce grown by illegal settlers. Mabira has also become a major source of charcoal for the nearby cities of Jinja and Kampala and produced 1,500 tons (60,000 bags) in the year to June 1969 (Earl, 1971).

The forest is locally important as a source of building poles, firewood, bushmeat, fibres, wild fruits and medicinal compounds. Rubber was produced commercially from the latex of *Funtumia elastica* tapped from wild stock in the Mabira during the first half of this century.

Present Status: Fig. N1.2 and Table N1 provide the best available information on the present status of this forest, based on the limited fieldwork undertaken on this project, together with all available Forest Department records and information supplied by local departmental staff. A much more accurate and thorough account is expected shortly as a result of work being undertaken by personnel of Stanford University's (Center for Conservation Biology) Tropical Forest Diversity Project.

The portion of the reserve lying to the west of the Musamya river (representing 36% of the total area) was subjected to early commercial exploitation, but has now reached a fairly advanced stage of regeneration. Management compartments in the northeast of this block appear (from the air and nearby roads) to have been so little affected by past exploitation as to warrant the description undisturbed, and one of these compartments (compartment 216) is designated a Nature Reserve. Management compartments in the south of West Mabira have recently been exploited, to varying degrees, by pitsawyers, and pitsawyers are now operating in compartments 222 and 223 (S. Kramer, pers. comm.). Compartment 224, adjacent to the Nature Reserve, is currently being felled mechanically.

To the east of the Musamya river, 28% of the reserve is described as 'lightly pitsawn', meaning that it has not yet been subjected to any large scale mechanised harvesting; most of this area has in fact been 'creamed' of its most valuable timber (most *Chlorophora* and *Entandrophragma* of any size have been selectively cut out). The remainder of the reserve (36% of the total area) has been severely degraded by recent mechanised timber harvesting operations, which have preceded the conversion of some 26% of the reserve to agricultural plots. The process of degradation operating here typically follows a sequence of (i) poorly managed mechanised timber harvesting, (ii) 'refinement' of the 'logged over' forest through the conversion of tree remains and additional 'weed' trees into charcoal (iii) cultivation of matoke banana for 3-4 years (until yields decline) using hired labour, and finally (iv) settlement of the degraded land by subsistence farmers practicing simple crop rotations.

A census of encroachers was carried out by Forest Department personnel in 1988. A total of 3,506 families were enumerated, of whom 1,408 (40%) were living outside the forest, and simply using the forest land for cultivation. An estimated total of 4,500 ha of land (15% of the reserve) was found to be under cultivation, a figure somewhat lower than the estimate made under this project (see above). Cultivation permits had been issued by the Forest Department to 917 (26%) of the encroachers, the majority of which had expired between 1982 and 1986: none were still valid. Most (68.6%) of the encroachers originated from the neighbouring districts of Mukono (42.3%), Iganga (20.4%) and Kamuli (5.9%).

There is no information available on the present status of large mammal populations in this forest, but with the exception of monkeys, none were detected during the course of a few short foot surveys conducted on this project. Since no control is exercised over hunting activity, there is a heavy human presence in many parts of the forest, and no part of the forest is far from human habitation, it is to be expected that large mammal populations are well below the area's carrying capacity.

Management: The reserve is managed from the Mukono District Forest Office, and three local forest stations at Nagojje, Najembe and Liga. Vehicular access to the forest is provided by a network of roads and tracks which link the main highways with a number of tea, coffee and sugar estates and other legal enclaves within the forest. This network of 'legitimate' roads has been extended considerably by timber cutters and encroachers, so that few areas of the reserve are now more than 2 km from a vehicular access point.

The latest Working Plan covers the period 1.7.61 to 30.6.71, and prescribes for the maximum sustainable production of high grade timber to satisfy Uganda's domestic requirement, and (if possible) export demands. A 40-year 'conversion cycle' was prescribed which, if implemented, would have seen the entire reserve felled by 1982. During the 60s and early 70s a few small encroachments were reclaimed by Forest Department and successfully planted to *Maesopsis eminii;* and 'charoal refinement' techniques for the logged forest were developed. Later, however, Forest Department's management capability was so severely eroded that it began to lose control of many areas of the forest, and the present-day situation has resulted. There are two Nature Reserves designated (Compartments 209, 216; Fig. N1.2) which together cover approximately 12 km^2 (3.9%) of the reserve; at least one of them (Compartment 209) is presently being degraded by pitsawyers.

Conservation Importance:

- this reserve is the largest block of forest remaining in the central region of Uganda, and represents the best opportunity to maintain a complete forest community characteristic of this important biogeographical region;
- by virtue of its location between Uganda's two main urban centres, Mabira is likely to assume great importance as a recreational area;
- the reserve supports at least three species of animal considered to be globally threatened with extinction, or nearly so.

Threats: As discussed above, a great many exploitative activities have already degraded large parts of Mabira and continue to pose threats to the integrity of the forest. The greatest of these is undoubtedly agricultural settlement, which often results from a sequence of degradative processes which begins with poorly managed mechanical timber felling. The forest is surrounded by densely populated agricultural lands. If the populations of Najembe, Wakisi, Nagojje and Ntunda subcounties recorded in the 1980 population census were living on the land designated for agricultural use in those areas, they would be at densities of about 160, 330, 180 and 240 persons/km^2 respectively. In fact, many of the people, especially those of Najembe and Wakisi, are living in the forest reserve, and so actual populations densities are lower than this.

Recommendations Specific to this Forest:

- all encroachment of this forest should be stopped, and those responsible evicted;
- once this has been done, priority should be given to the restoration of forest cover in areas that have come under cultivation. The methods to be adopted in achieving this will vary from place to place, but could include natural regeneration, aerial seeding and enrichment planting. Research should be carried out to determine the most appropriate methods;
- future management of the forest needs to be carefully planned, with zones designated for strict protection, low-intensity use and sustainable timber production (see Chapter Six, Recommendation 1). The selection of sites for strict protection as Nature Reserves will necessitate further survey work, and should aim to identify suitable areas representing 15-20% of the total area (see Chapter Six, Recommendation 9). As an immediate measure, the two existing Nature Reserves should be joined to form a single much larger Nature Reserve, by including compartments 215 (part only), 214, 213, 212 and 210 which lie between them;
- further recommendations are expected shortly as a result of detailed work carried out by the Tropical Forest Diversity Project of the Center for Conservation Biology (Stanford University), which has just completed a full year of field work in this reserve.

Principal Reference Material:

Carswell, M. (1986). Birds of the Kampala area. *Scopus* special supplement No. 2. Nairobi: Ornithological sub-committee, EANHS.

Earl, D.E. (1968). Latest techniques in the treatment of natural high forest in South Mengo District. Entebbe: Uganda Forest Department.

Earl, D.E. (1971). The Mabira Forest. *Uganda J.* 35:90-91.

Hamel, P.J. (1980). Avifauna of the Kifu and Mabira Forests, Uganda. *Proc. IV Pan-Afr. orn. Congr.* 135-145.

Holmes, J. and Kramer, S. (in prep.). Maintenance of wild genetic resources in the Mabira Forest, Uganda. Report of the Center for Conservation Biology, Forest Diversity Project. Stanford University.

Pitman, C.R.S. (1954). The Mabira Forest. *Uganda J.* 1: 7-16.

Sangster, R.G. (1950). Working Plan for the South Mengo Forests, Uganda, for the period 1948-1957. Entebbe: Uganda Forest Department.

Webster, G. (1961). Working Plan for the South Mengo Forests, Mengo District, Uganda. 1st revision from 1st July 1961 to 30th June 1971. Entebbe: Uganda Forest Department.

Table N1. Areas (km2) of different forest types and their condition in Mabira Forest Reserve

Condition	Forest types					
	Maesopsis (types MA, MAP,MAY, MAY-H)*	*Celtis* (types CH,PCH)*	Young mixed types F,NF,SF)*	Hill (type E)*	Poor (wet) (types PGW,PWP)*	TOTAL
Undisturbed	5	0	16	0	5	26
Lightly pitsawn	24	24	24	4	12	88
Mechanically harvested pre-1950	13	45	13	0	13	84
Mechanically harvested post 1950	12	11	1	0	5	29
Lightly encroached	2	3	1	0	2.	8
Heavily encroached	19	12	30	1	9	71
TOTAL	75	95	85	5	46	306

* Forest types as depicted on Forest Department type map Reference EB66(a).

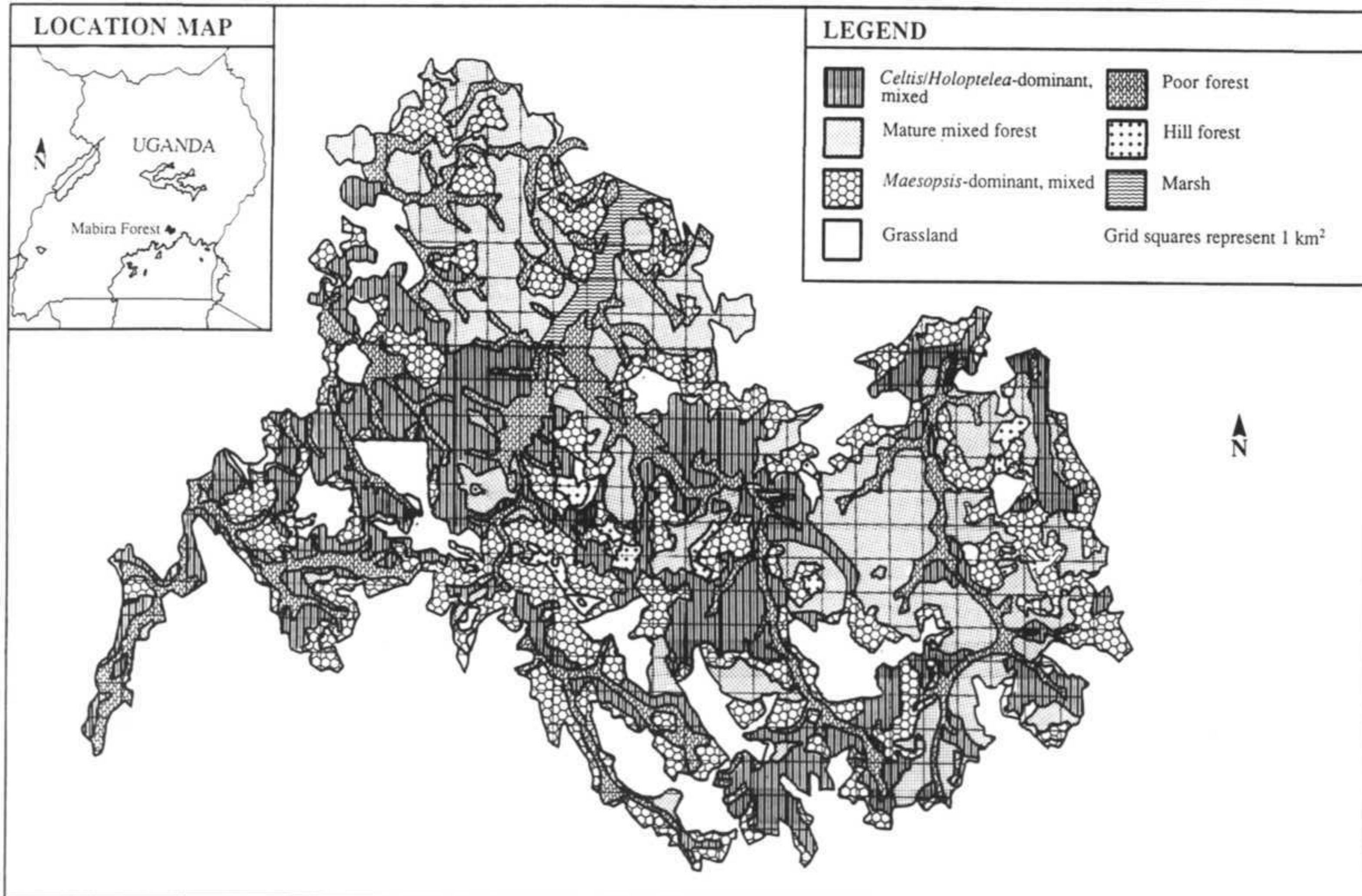


Fig. N1 *Mabira forest types*

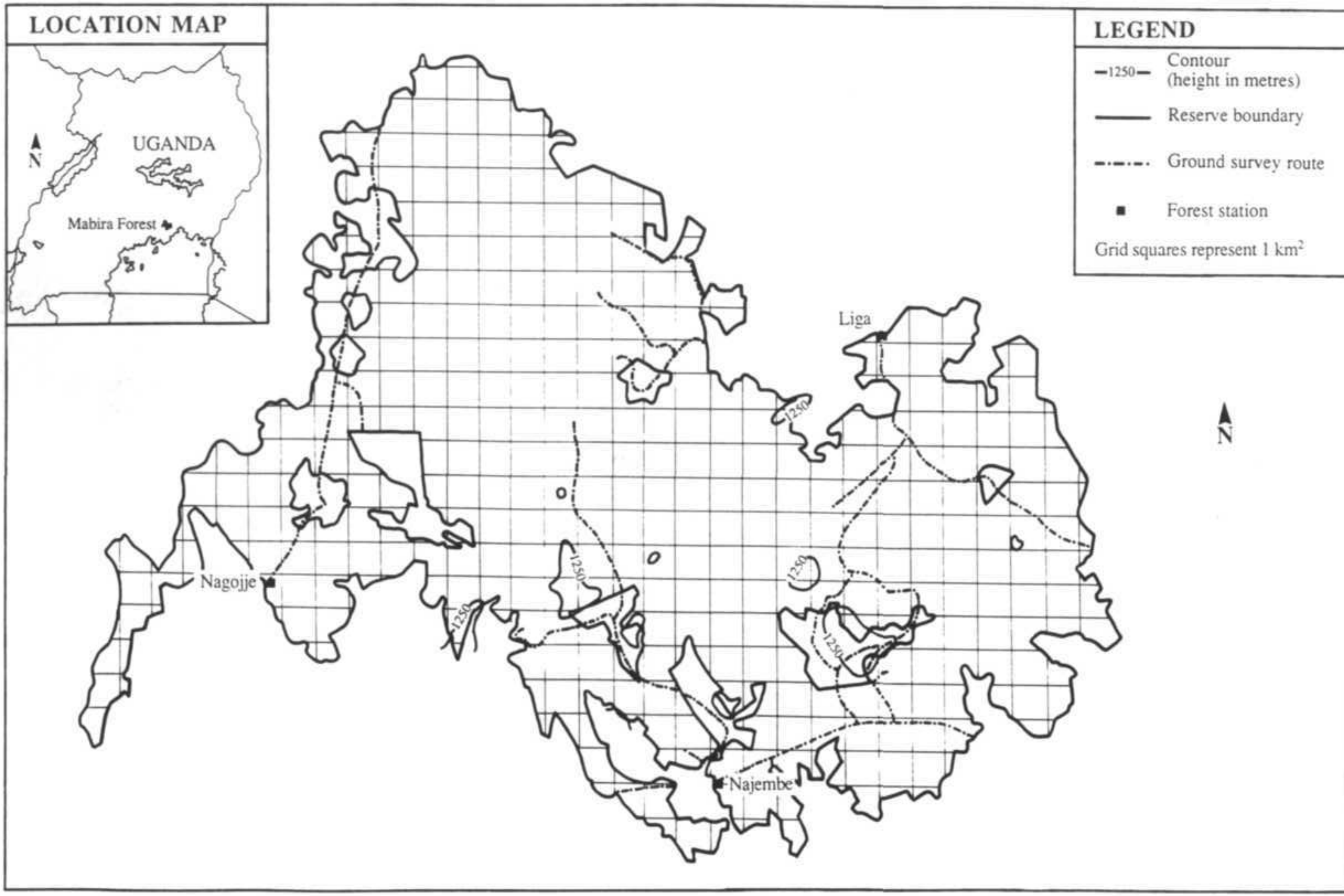


Fig. ***N1.1*** *Mabira Forest ground survey routes and altitudinal zones*

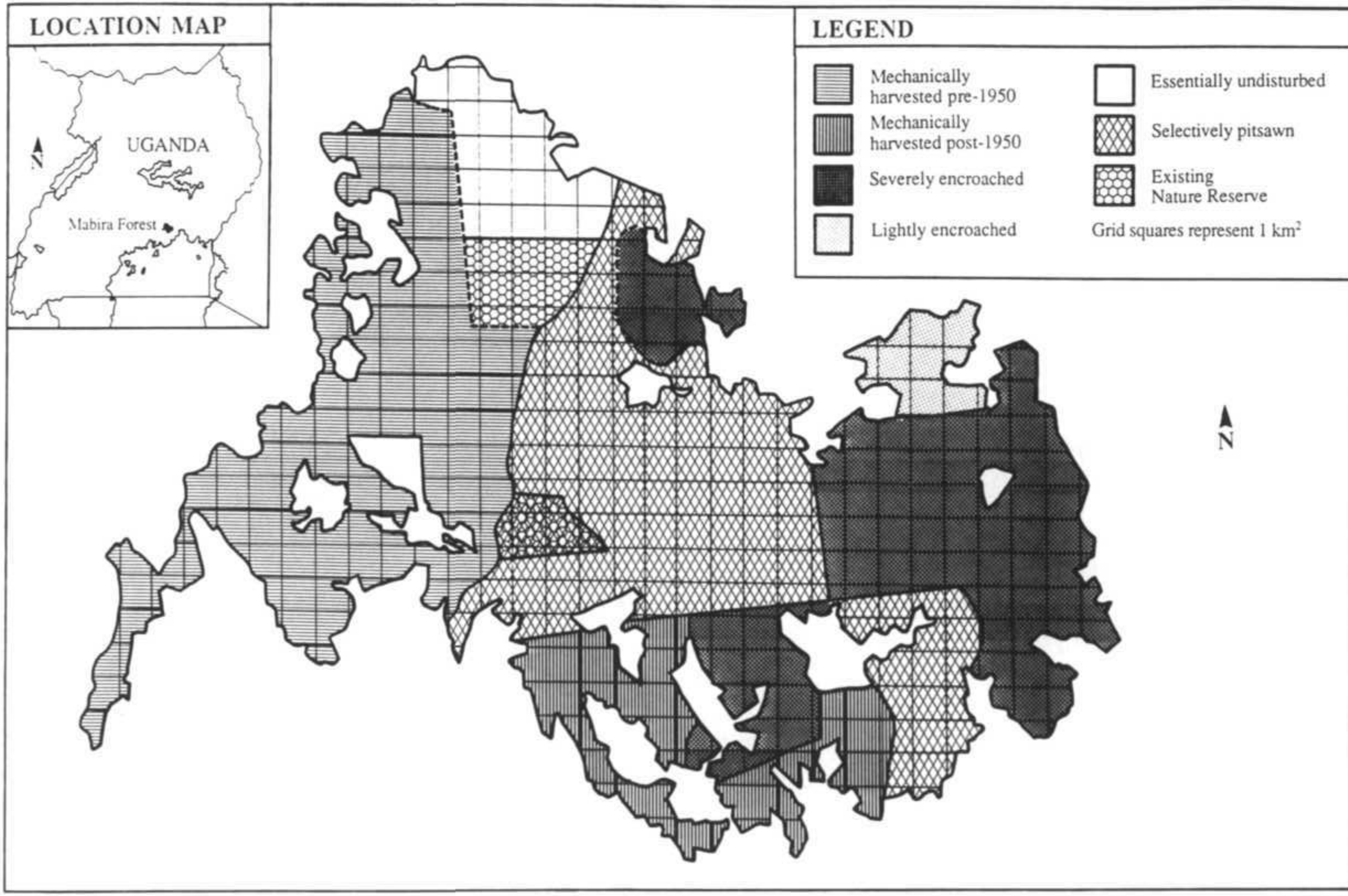


Fig. N1.2 *Present status of Mabira Forest*

Appendix O. Profile of the Mount Elgon Forest Reserve

Date Established: 1938

Geographical Location: On the border between Uganda and Kenya, 100 km north east of the Lake Victoria shoreline. The reserve straddles Kongasis and Tingey Counties in Sebei District and North Bugisu, Manjiya and South Bugisu Counties in Bugisu District, 0°52-l°25' N,. 34°14'-34°44' E. Covered by Uganda Department of Lands and Surveys maps sheets 54/II, 54/III, 54/IV, 55/I, and 55/III (Series Y732) at 1:50,000, and a special series tourist map 'Mount Elgon' at 1:125,000.

Area: 1,145 km^2 following the excision of 60 km^2 in Kwen and Kongasis Counties in 1983. Until about ten years ago the boundaries were cut and maintained as footpaths with all corners marked with earth cairns and direction trenches. The reserve is contiguous with the Mount Elgon Forest Reserve and Mount Elgon National Park which protect approximately 900 km^2 of upper Elgon on the Kenyan side of the international border. Most of the reserve's boundary borders onto densely populated agricultural lands.

Altitude: 1,460-4,320 m. 15 km^2 lies below 1,750 m, 34 km^2 at 1,750-2,000 m, 122 km^2 at 2,000-2,250 m, 177 km^2 at 2,250-2,500 m and 797 km^2 above 2,500 m.

Physical Features: Mount Elgon is a solitary extinct volcano, with one of the largest craters in the world, 8 km across. The rim of the crater reaches 4,320m, but because of the large basal area of the mountain, the overall slope is only about 4%, which gives the mountain a very gently sloping profile when seen from a distance. A 20 km long ridge, rising above 2,000 m (the Nkokonjeru peninsula), juts out westwards from the main mountain towards Mbale. On the Ugandan side, the mountain descends to the plain in a series of precipitous cliffs separated by gently sloping 'shelves' and is deeply dissected by numerous streams. The mountain rests on a dissected peneplain of the pre-Cambrian Basement Complex and the bulk of it is made up of tuffs and coarse agglomerates of undersaturated rocks, with fragments and extrusions of basaltic lava. The soils are young, rich in weatherable minerals, and remarkably resistant to erosion (Synnott, 1968). The climate is dominated by seasonally alternating moist south-westerly and dry north-easterly air streams and shows a weakly bimodal rainfall pattern, the wettest months being April to October with June somewhat drier. The west of the mountain receives about 2,000 mm of rainfall, and the north and east somewhat less.

Survey Work Conducted under this Project:

- a ground survey was conducted over three weeks in September 1986 (see Fig. O1.1 for survey route locations).

Vegetation: Four broad classes of vegetation occupy different altitudinal zones on Mount Elgon. These are (i) a community of mixed montane forest below about 2,500 m, (ii) a broad belt of bamboo and low canopy montane *(Hagenea-Rapanea)* forest between about 2,400-3,000 m, (iii) a zone of high montane heath between 3,000-3,500 m and (iv) a high moorland community above 3,500 m. The vegetation has been described by, amongst others, Dale (1940), Hedberg (1948), Langdale-Brown, Osmaston and Wilson (1964), Synnott (1968) and Hamilton and Perrott (1981). On the ground the altitudinal zonation is not as clearcut as might be suggeted by the above, and there is a great deal of variation in the composition of the forest communities in response to local variations in topography, slope, aspect and soil depth; and, at a macro-level to difference in climate and the severity of the dry season. Thus the wetter southern and western slopes of the mountain support a montane forest community dominated by species such as *Prunus africana, Aningeria adolfi-friedericii* and *Olea welwitschii,* whilst the drier northeast supports a coniferous forest dominated by *Podocarpus gracilior, Juniperus procera* and *Ekerbergia capensis* with an understorey *of Ilex mitis, Olea* sp., *Teclea nobills,* etc.

The vegetation is mapped in Fig. O1. Twenty percent of the reserve supports mixed montane forest with some potential for timber production, whilst 28% is classified as poor forest including *Hagenea-Rapanea* communities, 21% is bamboo *(Arundinaria alpina)* forest, 7% is heathland and bush, and 24% is high moorland (Table O1). There are a number of scattered grasslands on the northern slopes and two conifer plantations at Kapkwata and Suam in the northeast.

The most important areas of this reserve for plant species conservation lie in the high montane heath and moorland zones, which are rich in shrub and herb species endemic to Mount Elgon, or shared only with other high East African mountains. Examples include various species of giant *Lobelia, Senecio, Helichrysum, Erica,* and *Philippia* as well as smaller 'ground-cover' species like *Alchemilla elgonensis* and *Carex runssoroensis.*

There are 112 tree species (26% of the country's total) listed for this reserve (Appendix A), but a complete checklist would undoubtedly include a lot more. Elgon represents the only known Ugandan locality for *Senecio amblyphyllus, Senecio elgonensis, Senecio barbatipes* and *Philippia excelsa,* and a further 14 species occur only on this and other mountains of eastern and northeastern Uganda: *Juniperus procera, Stoebe kilimandscharica, Euphorbia obovalifolia, Manilkara butugi, Pittosporum viridiflorum, Protea kilimandscharica, Hypericum roeperianum, Hypericum quartinianum, Cassipourea malosana, Catha edulis, Buddleia polystachya, Cussonia spicta, Schefflera volkensii* and *Schrebera alata.* An important timber tree that is considered to be endangered is *Juniperus procera* (FAO, 1986).

Fauna: The fauna of this reserve is reasonably well known and includes 144 species of forest bird (44% of the country's total), two species of diurnal forest primate (17% of the country's total), and 36 species of forest swallowtail and *Charaxes* butterfly (53% of the country's total) (see Appendices B, C, D for species lists). Most of the species are widely distributed in suitable montane habitats throughout East Africa, but many show considerable subspecific variation between populations in different areas. In many cases, Mount Elgon represents the western range limits of species or races that occur in the highlands of Kenya and northern Tanzania. Thus Elgon is the only site record for Jackson's francolin *(Francolinus jacksoni)* in Uganda, and bronze-naped pigeon *(Colomba delegorguei),* Hartlaub's turaco *(Tauraco hartlaubi),* and tacazze sunbird *(Nectarinia tacazze)* are restricted to Elgon and a few other mountains along the eastern border. There is an endemic race of the white-starred forest robin *(Pogonocichla stellata elgonensis),* and eastern races of the robin chat *(Cossypha caffra iolaema)*, montane nightjar *(Caprimulgus poliocephalus poliocephalus),* oriole finch *(Linurgus olivaceus elgonensis)* and the Abyssinian crimson-wing *(Cryptospiza salvadorii kilimensis)* reach the western limits of their ranges at Mount Elgon. Threatened species known from this reserve are elephant *(Loxodonta africana)* leopard *(Panthera pardus),* and lammergeier *(Gypaetus barbatus).*

Seven mammal species were recorded from the reserve during the ground survey, including two species of primate, a duiker and a hyrax that were sighted or heard, and four species (a duiker, bushbuck, elephant and buffalo) whose presence was inferred from their distinctive spoor. The distributions of records are shown in Fig. O3. Duiker (probably *Sylvicapra grimmia)* was apparently quite abundant in and around the crater where it was recorded in 14 compartments, representing 11% of the total surveyed. Elephant *(Loxodonta africana)* and buffalo *(Syncerus coffer)* were recorded only in the north-eastern part of the reserve, in 4% and *2%* of compartments respectively. One hyrax *(Heterohyrax brucei)* was seen near the crater rim, and a bushbuck *(Tragelaphus scriptus)* skull was found near the hot spring at the top of the Suam gorge, which could well have been left there by hunters. Blue monkeys *(Cercopithecus mitis)* were recorded in 8% of the survey compartments, up to an altitude of about 3,000 m and black and white colobus *(Colobus guereza)* were recorded in 9% of compartments to about 3,300 m. Redtail monkeys *(Cercopithecus ascanius)* were not seen, although recorded from the area in former times (Synnott, 1968; Kingdon, 1971).

Economic Importance: It has long been recognised that this reserve plays a crucial role as a water catchment, serving around one million people to the north and west. Water for Mbale and Kapchorwa towns comes from the reserve, and the Ugandan Railways pipes water nearly 40 km from the river Lwakaka inside the reserve to Tororo.

Timber is of secondary importance, with some pitsawing taking place particularly in Manjiya and South Bugisu Counties, and two sawmills located at Kapkwata in the northeast of the reserve. One of the sawmills is no longer working and the only concession is held by Kapkwata Sawmills and applies to softwood plantations and natural forest in that area. Approximately 1,500 ha of softwood plantation have been established since 1957. A timber enumeration was carried out in the natural forest between 1954-56, and Lockwood Consultants (1973) estimated a total annual allowable cut of 8,500 m^3 for trees exceeding 50 cm dbh for the period 1973-2000. However, much of the forest has subsequently been cleared to make way for agriculture, so these figures can no longer be considered even indicative.

At present, the greatest source of direct revenue generated from the reserve comes from agricultural crops grown in illegal cultivation plots (see below). A pastoralist population (the Benet) lives on the northern slopes between about 2,500-3,000 m where they graze their cattle, sheep and goats on the high pastures. The Bagisu eat smoked bamboo shoots from the reserve, and the lower forests are extensively used as a source of building poles, firewood, medicinal plants, wild vegetables etc.

Hunting is widespread, and the quarry includes black and white colobus whose skins are used in local circumcision ceremonies.

Present Status: The reserve has been extensively damaged by agricultural encroachment, with approximately 200 km^2 of the lower lying forest practically cleared of trees (Fig. O1.2, Table O1). The area affected includes almost half of the mixed forest, which has been replaced with maize, matoke and vegetable crops, grown by people most of whom live outside the reserve. Encroachment has been a problem for some time (Synnott, 1968) but became more serious in the mid-1970s, and has since escalated. It can be attributed to five inter-related causes: (i) a high population density in adjacent lands (ii) a breakdown of law and order, and disregard for Forest Department authority (iii) economic difficulties which have reputedly led Forest Department staff to accept personal favours in exchange for cultivation rights, (iv) the adoption of the taungya forest management system, without adequate controls and follow-up, and (v) tribal conflicts which have forced people to take refuge in the reserve.

In February 1983 an area in the north of the reserve was degazetted in order to provide land for the resettlement of the Benet pastoralists who have traditionally occupied the northern slopes. There is some confusion over the size and location of the area affected, which is either as shown in Fig. O1 (39 km^2; after Forest Department headquarters maps) or extends further west to the Kaptokwoi river including an additional 21 km^2 (a total of 60 km^2 according to local departmental staff). The new boundary has not been marked, and many of the Benet have not moved from their homesteads higher up the mountain.

Apart from the Benet, there are very few people actually residing within the reserve. There are a few houses in the lower Bukwa valley, above Bulago and south of Bugitimwa.

Hunting activity was recorded in 4% of the survey compartments (Fig. O1), and large mammal populations appear to be very low. I was accompanied on a three-day hike by a hunter from Bugisu, who confirmed that large mammal populations on the Ugandan side of the border were very much higher until about ten years ago. Ugandan hunters now travel to the Kenyan National Park in search of quarry. Elephant and buffalo populations appear to be very much lower than was the case in 1968, when the last Working Plan was written (Synnott, 1968), and no signs of bushpig were seen, although this species is normally considered resilient to hunting pressure.

Management: The reserve is administered from the Mbale and Kapchorwa district forest offices, and can be considered to be extremely well staffed with seven forest officers, seven foresters, 23 forest rangers and a large number of forest guards and other staff stationed at Mbale, Budadiri, Buteza, Buwalasi, Mutufu, Mugembe, Bufumbo, Bulago, Bulucheke, Bubulo, Bumbo, Bududa, Kapchorwa, Sipi, Kapkwata, Suam and Tegeres. There are forest station buildings at Suam, Kapkwata, Kapchorwa, Bulago, Nkokonjeru, Bulucheke and Bumbo. There is no vehicular access to the reserve, except on the main Kapchorwa-Suam road which passes through the reserve for a short distance near Kapkwata.

The latest Working Plan covers the period 1968-78 and prescribes for the management of the area as a protection forest, with the production of timber from the natural forest and softwood plantations as secondary objectives.

Conservation Importance:

- a great many people are directly dependent on the protection of Elgon's water catchment;
- the combined area of the Ugandan and Kenyan reserves is sufficiently large to maintain viable populations of many of the larger and rarer species, such as elephant and leopard, that are vulnerable to extinction in smaller reserves;
- the higher lying zones of the mountain are rich in endemics;
- the area has great potential for the development of tourism;
- the reserve supports at least three species of animal considered to be globally threatened with extinction or nearly so.

Threats: The greatest threat is continuing encroachment. Population densities in the lands bordering this reserve are amongst the highest in Uganda, the 1980 census figures for Bumbo, Buwabwala, Bulucheke, Bukigai, Bududa, Bufumbo, Busulani, Bumasifwa, Bulago, and Buginyanya being 236, 425, 444, 801, 460, 545, 461, 550, 505 and 527 persons/km^2 respectively. Population densities bordering the reserve in the subcounties of Sebei are somewhat lower with an average of 110 persons/km^2. Excessive hunting is a serious problem which has severely reduced the populations of many large mammals. It is quite likely that waterbuck *(Kobus defassa)* and giant forest hog *(Hylochoerus meinertzhageni)* are already extinct on the Ugandan side of the mountain, and elephant and buffalo populations are now so low as to warrant deep concern. Timber harvesting operations also threaten the reserve, mainly because they open up new land to cultivation. This applies particularly to areas at Bulucheke and Kapkwata.

Recommendations Specific to this Forest:

- all encroachment of this forest should be stopped, and those responsible evicted;
- once this has been done, priority should be given to the restoration of forest cover in areas that have come under cultivation. The methods to be adopted in achieving this will vary from place to place but could include natural regeneration, aerial seeding and enrichment planting. Research should be carried out to determine the most appropriate methods;
- future management of the forest and surrounding areas needs to be carefully planned by all the local and national authorities concerned. This should be facilitated by a forthcoming project of sustainable development and forest conservation planned by the Ministry of Environment Protection in collaboration with IUCN (see Chapter Six);
- when management zones are designated (Chapter Six, Recommendation 1), special consideration should be given to the preservation of as much as possible of the remaining lower altitude forest, which represents both the richest and most threatened type. Strict protection should be afforded to all the higher-lying areas of the reserve, as well as representative portions of the dry north-eastern and wet western mixed montane forest communities. This is probably most appropriately done by designating a large part of the forest reserve as National Park (Chapter Six,

Recommendation 7), although Forest Park status for the whole of Mount Elgon may provide a viable alternative. The protected zone should be designed in such a way that it is contiguous with the Kenyan National Park as much as possible, thus enabling undisturbed passage of forest wildlife;

- tourism and other forms of income generation that do not cause environmental degradation should be actively promoted;
- no more forest land should be cleared under the taungya management system;
- immediate measures should be taken to protect the wildlife of this reserve, by establishing game ranger posts at strategic locations and initiating regular anti-poaching patrols.

Principal Reference Material:

Dale, I.R. (1940). The Forest types of Mount Elgon. *J.E.A. and Uganda Nat. Hist. Soc. XV,* Vols I and 2.

Hamilton, A.C. and R.A. Perrott, (1981). A study of altitudinal zonation in the montane forest belt of Mt Elgon, Kenya/Uganda. *Vegetatio* 45: 107-125.

Hedberg, O. (1951). Vegetation belts of the East African Mountains. *Svensk Botamisk Tidskrift* 45(1): 140-202.

Howard, P.C. (1986). Environmental catastrophe looms. The New Vision, 5 Dec 1986 pp. 8-9.

Langdale-Brown, I., H.A. Osmaston, and J.G. Wilson, (1964). The vegetation of Uganda. Entebbe: Government Printer.

Otte, K. (in press). Deforestation at Mt Elgon, Uganda, and its effects on ecosystem and land use. Proceedings of an International Symposium on African Wildlife, Kampala 8-10 Dec. 1986.

Synnott, T.J. (1968). Working Plan for Mount Elgon Central Forest Reserve. 1st Revision. Period 1968 to 1978. Entebbe: Uganda Forest Department.

Webster, G. (1954). Working Plan for Mount Elgon Central Forest Reserve, 1954-1958. Entebbe: Uganda Forest Department.

Table O1. Areas (km^2) of different vegetation types and their condition in Mount Elgon Forest Reserve

Condition	Vegetation types						
	Mixed forest (types 1,2)**	Poor forest (type 3)**	Bamboo (types 5,6,7, 8,9)**	Grass, moor (types 10,11, 12,13)**	Bush (type 4)*	Plant'n (type 14)**	TOTAL
Undisturbed	110	230	219	262	67	1	889
Encroached	103	72	8	2	15	0	200
TOTAL	213	302	277	264	82	1	1089

* Totals taken from Forest Department type maps. There is an 8% discrepancy between the total area derived from these figures and that given in the working plan.

** Forest Department vegetation-type codes.

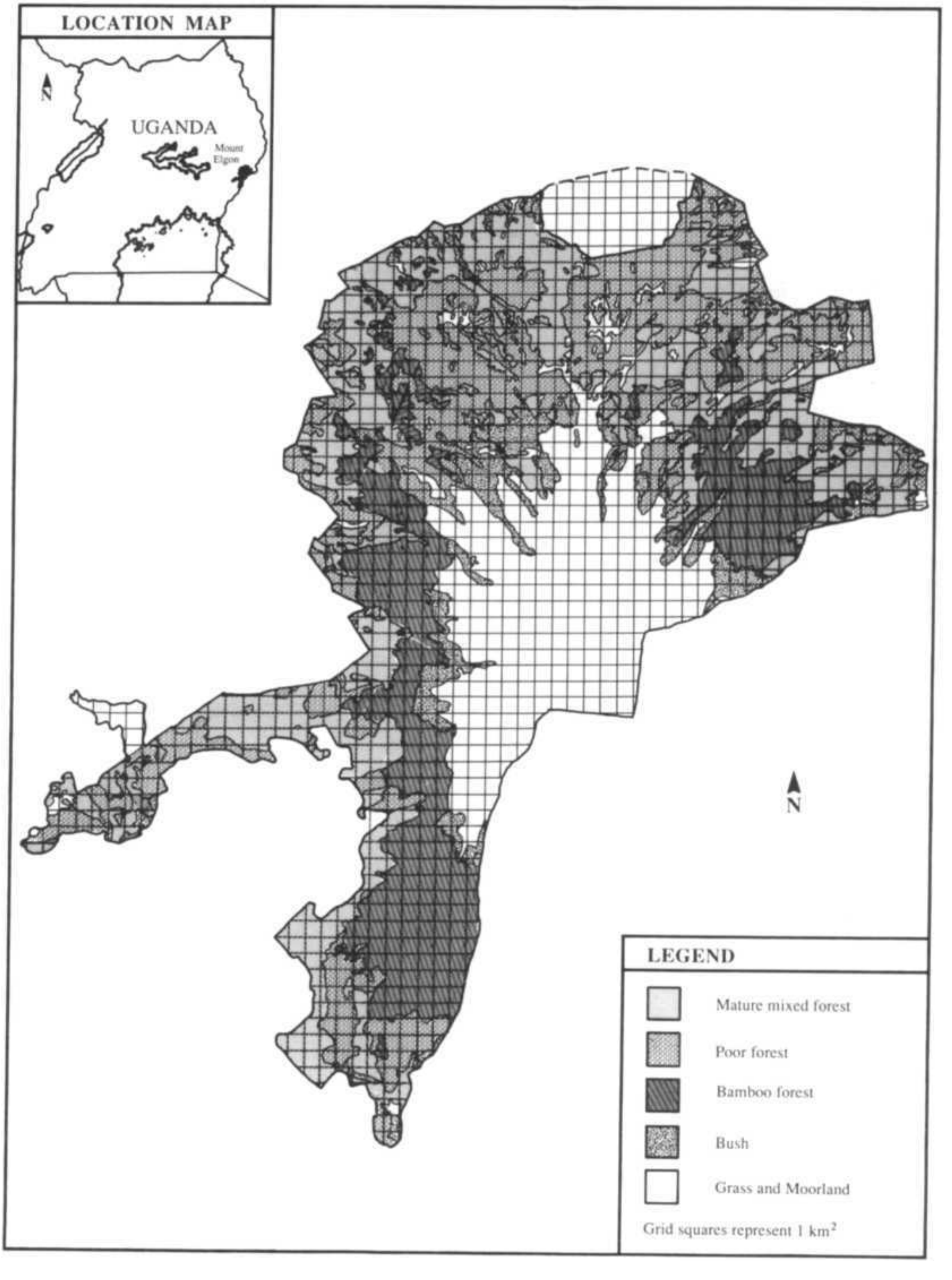


Fig. O1 *Mount Elgon forest types*

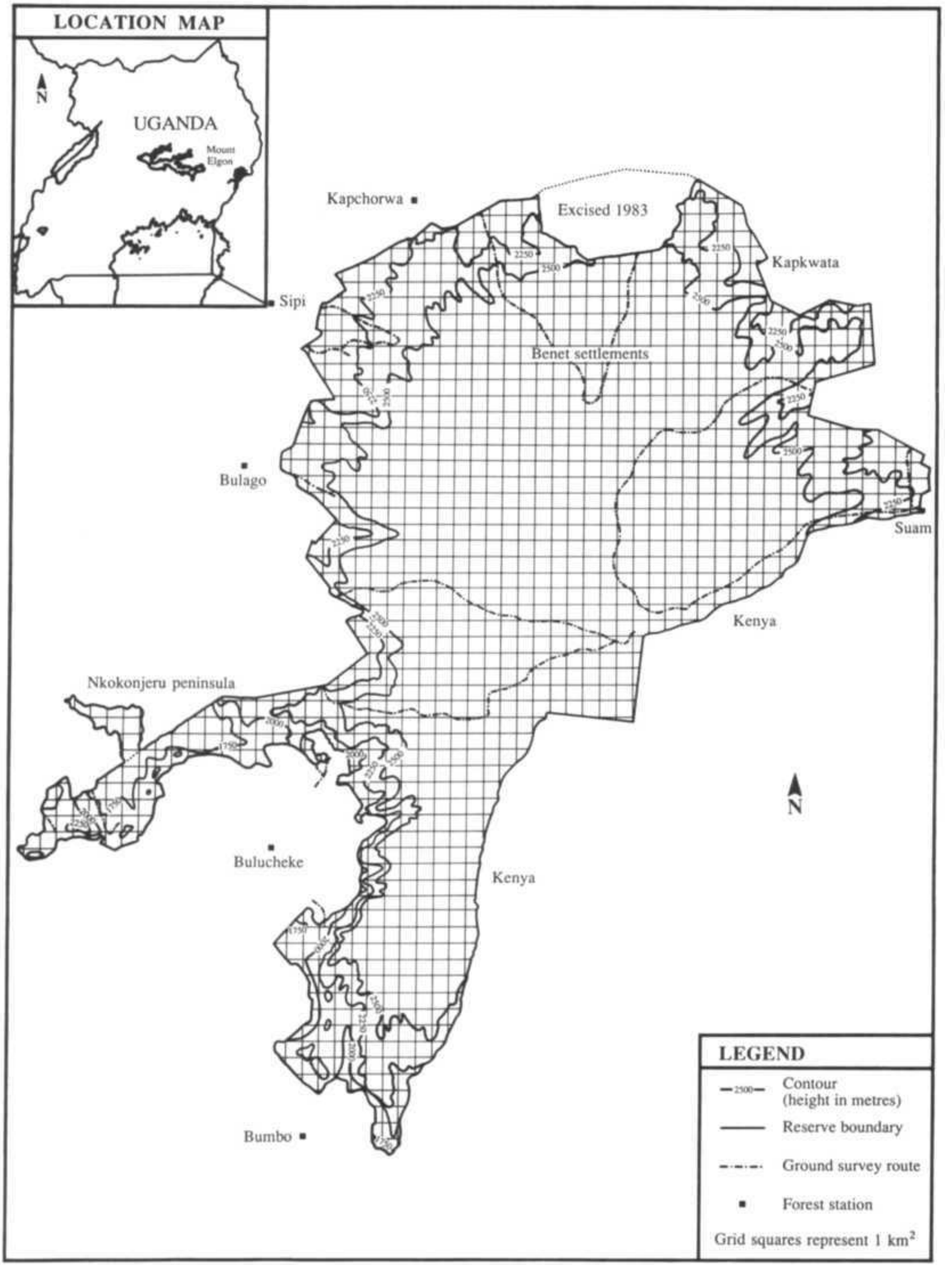


Fig. O1.1 *Mount Elgon ground survey routes and altitudinal zones*

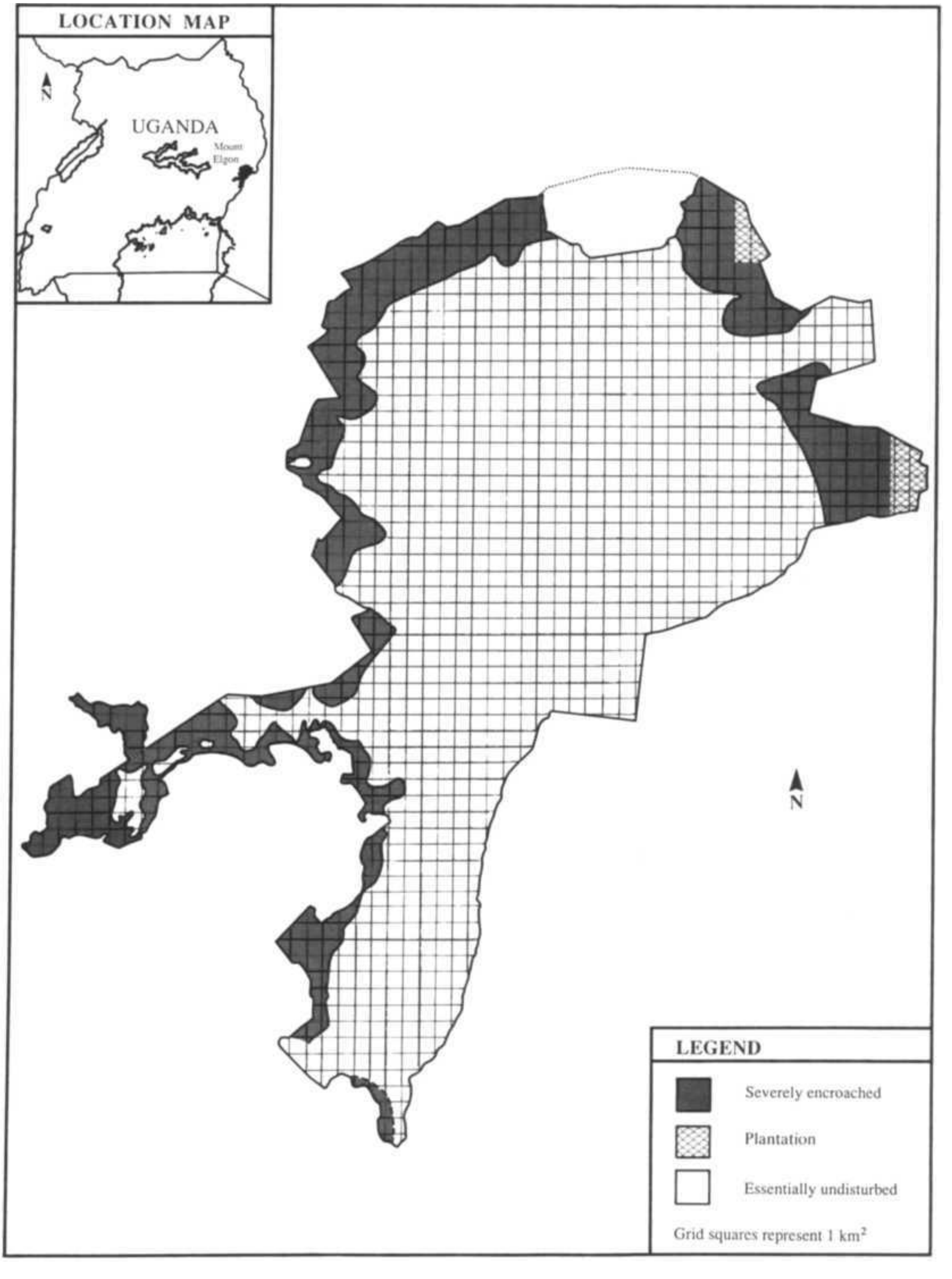


Fig. O1.2 Present status of Mount Elgon Forest Reserve

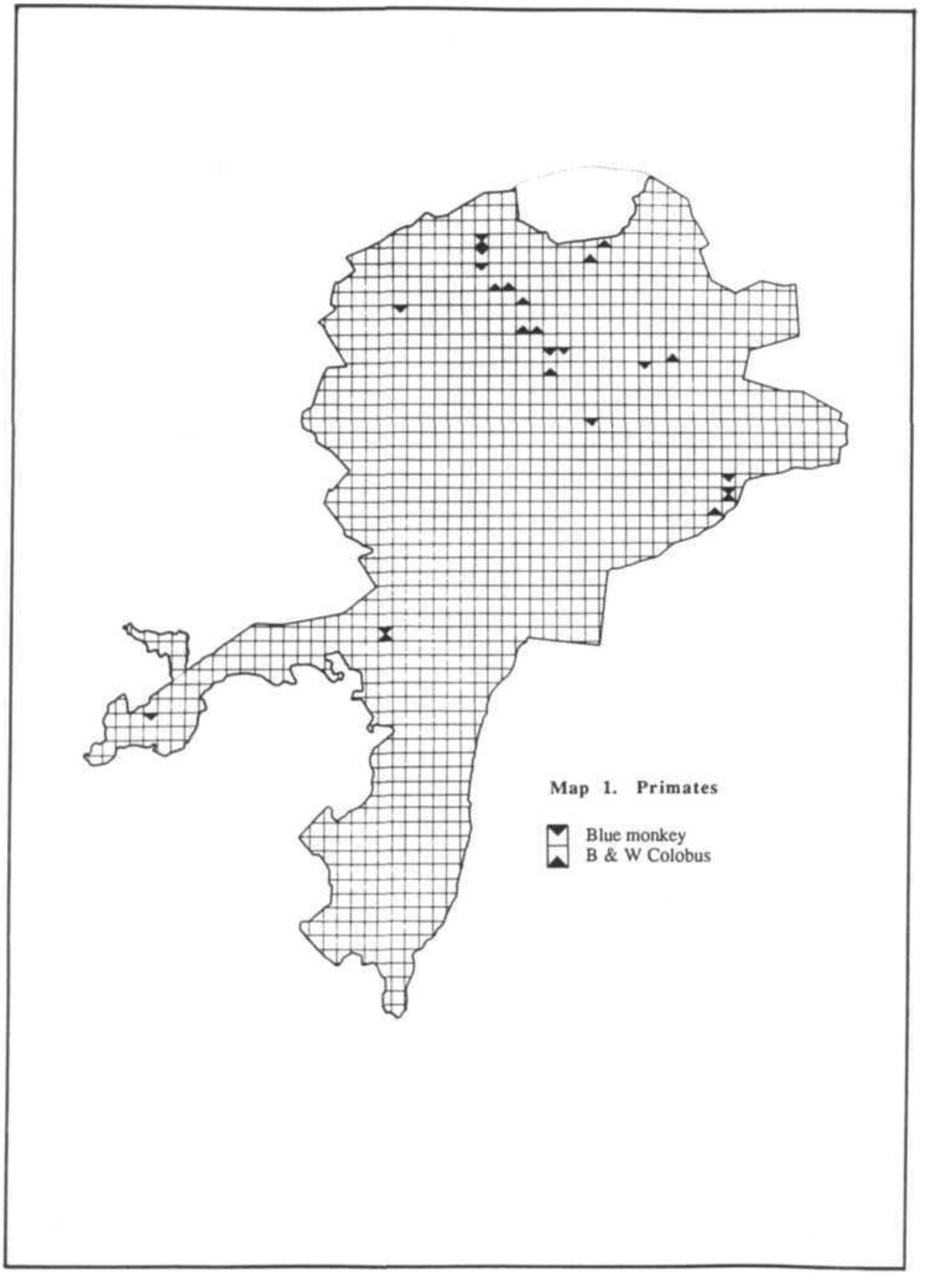


Fig. O3 *Distribution of large mammal records made during the ground survey of Mount Elgon*

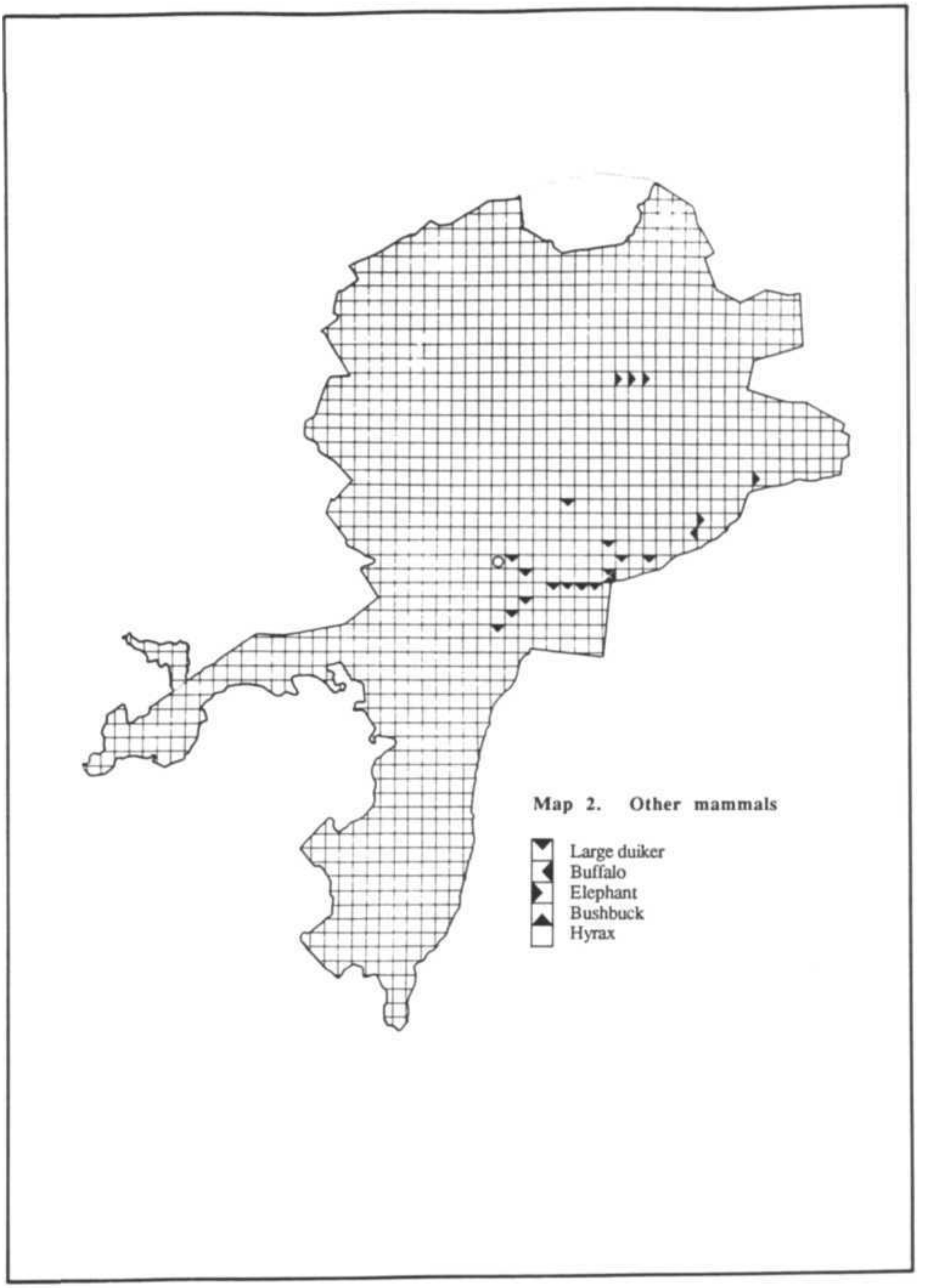


Fig. ***O3.1*** *Distribution of large mammal records made during the ground survey of Mount Elgon*

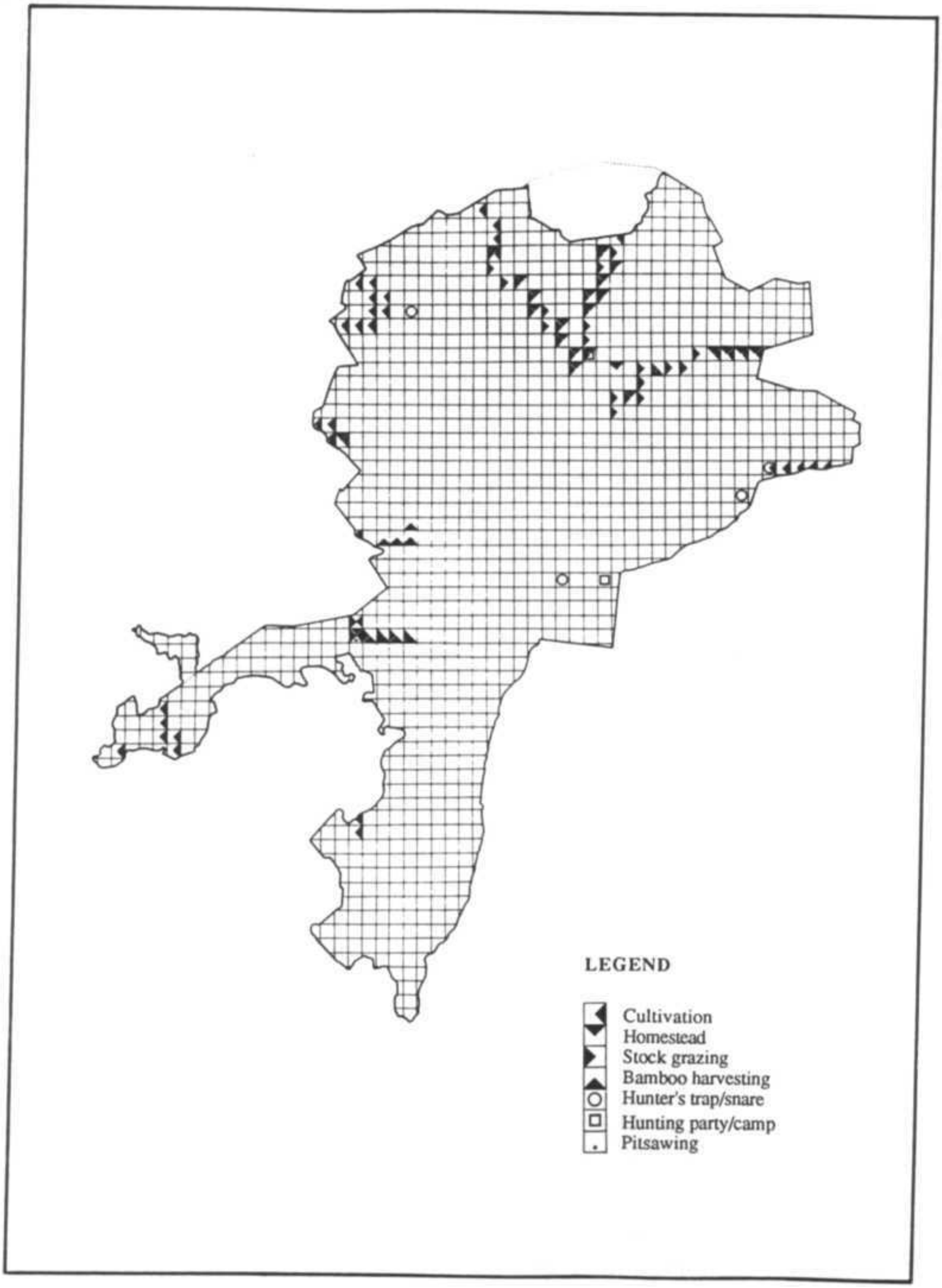


Fig. O4 *Distribution of human activities recorded during the ground survey of Mount Elgon*

Appendix P. Profile of the Rwenzori Forest Reserve

Date Established: 1941

Geographical Location: On the border between Uganda and Zaire, overlooking the western rift valley. The reserve lies in Bwamba County, Bundibugyo District; Burahya and Bunyangabu Counties, Kabarole District; and Busongora and Bukonjo Counties, Kasese District, 0°06'-0°46' N, 29°47'-30°11 E. Covered by Uganda Department of Lands and Surveys map sheets 56/I, 56/III, 65/II, 65/IV, 66/I (Series Y732) at 1:50,000.

Area: 996 km^2, originally demarcated by cut lines and cairns with direction trenches at all corners. Short sections of boundary, principally on ridgetops, have been planted with lines of *Cupressus* or *Eucalyptus*. There has been no boundary maintenance for more than a decade. The reserve is contiguous with Zaire's Virungas National Park (7,800 km^2) along about 50 km of international boundary which runs through the centre of the massif.

Altitudinal Range: 1,700-5,110 m. 28 km^2 lies below 2,000 m, 110 km^2 at 2,000-2,250 m, 160 km^2 at 2,250 m and 698 km^2 above 2,500 m.

Physical Features: The Rwenzori is an extremely steep and rugged mountain range which includes Africa's third highest mountain peak (Margherita, 5,109 m). It comprises very old Basement Complex rocks which were extruded from the surrounding plains at the time the western rift valley was formed. The soils derived from these Pre-Cambrian rocks are of generally low fertility, except on parts of the northern ridge where there are some residual effects of volcanic ash originating from the Fort Portal plateau. Climatic conditions are closely related to altitude, influenced by prevailing easterly winds and a two-peak annual rainfall pattern with the wettest months from March to May and August to November. Rwenzori is a wet mountain, and rain falls on most days, even in the 'dry' seasons. The mountain peaks are permanently snow covered. No climatic data are available.

Survey Work Conducted under this Project:
- a ground survey, involving about 45 days of hiking in the mountain at various times between August 1985 and September 1986. (Routes followed are shown in Fig. P1.1);
- two man-weeks of ornithological survey work, including about 2,700 metre-net-hours of mist netting work at 2,100 m in the Mubuku valley (Fig. P1.1) during August 1987.

Vegetation: The natural vegetation is determined largely by factors related to altitude, with five distinct zones distinguishable. In the lower-lying areas to about 2,400 m the vegetation is a very broken montane forest characterised by species such as *Symphonia globulifera, Prunus africana, Albizia* spp., *Dombeya* spp. etc. There are few large trees and the canopy is very broken, except in the valley bottoms and ridgetops where gradients are comparatively gentle. The montane forest merges into a zone of bamboo *(Arundinaria alpina)* forest, which forms almost pure stands in many areas up to 3,000 m. This is replaced at altitudes to about 3,800 m by a tree heath vegetation type in which the giant heathers, *Philippia trimera* and *P. kingaensis* form dense thickets commonly exceeding 10 m in height (on the poorer soils) and the better sites are characterised by a mixture of small trees (including *Rapanea rhododendroides*, *Hypericum lanceolatum*, *H. keniense* and *Hagenia abyssinica)* over a tangled undergrowth. Above this, up to the snow line at about 4,400 m, is an Afro-alpine moorland zone. No vegetation type map is available for this reserve, but Fig. P1 shows the distribution of forest, bamboo and higher altitude communities as depicted on the Department of Lands and Surveys' 1: 50,000 scale map series. Approximately 234 km^2 (23%) of the reserve lies below 2,400 m (broadly the montane forest zone), 338 km^2 (34%) at 2,400-3,000 m (bamboo zone), 281 km^2 (28%) at 3,000-3,800 m (tree heath zone), 129 km^2 (13%) at 3,800-4,400 m (alpine zone) and 14 km^2 (1%) above the snowline.

Very little is know about the trees of the montane forest on Rwenzori, since botanists have tended to concentrate their efforts on the unusual communities of interesting plants at higher altitudes. Thus only 75 species of forest tree (18% of the country's total) are listed for this reserve (Appendix A). Two of these *(Hypericum bequaertii* and *Schefflera polysciadia)* are known only from Rwenzori, whilst seven others are restricted to Rwenzori and the other montane forests of the southwestern border areas of Uganda (Bufumbira volcanoes, Bwindi, and Kalinzu): *Senecio erici-rosenii, Senecio adnivalis, Erica kingaensis, Philippia johnstonii, Vernonia sp.* aff. *V. adolfi-friderici, Ficalhoa laurifolia* and *Ocotea usambarensis.*

Fauna: The fauna of this reserve is reasonably well known, although that of the lower montane forest has received little attention. It includes 89 species of forest bird (27% of the country's total), 4 species of diurnal forest primate (33% of the country's total) and 15 species of forest swallowtail and *Charaxes* butterfly (22% of the country's total) (see Appendices B, C, D for species lists). None of these species are unique to Rwenzori, although a great many Albertine Rift endemics occur here, and there is a high level of sub-specific endemism. For example, 19 species of bird endemic to the Albertine Rift occur in this reserve (Prigogine, 1985), and distinct subspecies of many mammals and birds have been recognised from Rwenzori, including the Rwenzori colobus monkey *(Colobus angolensis ruwenzorii),* Rwenzori hyrax *(Dendrohyrax arboreus ruwenzorii)* and Rwenzori leopard *(Panthera pardus ruwenzorii).* Salt (1987) recently published a list of invertebrates he collected from the top of the mountain in 1948-49 which includes 25 species that are new to science, out of a total of 60 named species. Threatened or near-threatened species that are known to occur in this reserve are: elephant *(Loxodonta africana),* chimpanzee *(Pan troglodytes),* l'hoest's monkey *(Cercopithecus l'hoesti),* leopard *(Panthera pardus),* bamboo warbler *(Bradypterus alfredi)* and Shelley's crimson-wing *(Cryptospiza shelleyi).*

Eleven species of large mammal were recorded from the reserve during the ground survey, either by direct sighting or auditory cues (in the case of four species of primate and hyrax) or by indirect methods (in the case of eight species). The distributions of records are shown in Fig. P2. Signs of elephant were recorded in 10% of the 193 km^2 compartments covered by the survey, of leopard in 0.5% of compartments, of bushbuck *(Tragelaphus scriptus)* in 0.5%, of a large duiker

(Cephalophus nigrifrons?) in 11%, of giant forest hog *(Hylochoerus meinertzhageni)* in 1%, of bushpig *(Potamochoerus porcus)* in 1% and of hyrax in 7%. Of the primates, blue monkeys *(Cercopithecus mitis)* were recorded in 21% of compartments, l'hoest's monkeys in 1%, chimpanzees in 6% and Rwenzori colobus monkeys in 7% of compartments.

Economic Importance: This reserve plays a vital role as one of the country's most important water catchment areas. Approximately half a million Ugandans are directly dependent on the reserve as a source of domestic water, and for its role in the prevention of flooding and associated hazards. The water which flows from the Rwenzori Forest Reserve is crucial to the valuable fisheries of Lakes Edward and George; it is used for irrigated agricultural production at Mubuku in the dry plains below the mountain; and it is being exploited as a source of hydro-electric power by the Kilembe mine and communities near Kisinga. The potential for future exploitation of water derived from the reserve is enormous.

Exploitation of forest produce, particularly bamboos and building poles, but also bushmeat, honey, firewood, medicinal compounds, etc. is of local importance. There is no commercial exploitation of forest products. There are some important footpaths through the reserve linking Bundibugyo and Kabarole Districts across the northern spur of the mountain. Tourism has enormous potential, and at present about 300 visitors spend 6-7 nights within the reserve each year, providing about 6000 man-days of direct employment to local porters and tourist guides.

Present Status: Fig. P3 shows the distribution of human activities recorded during the ground survey. In general terms, the reserve is affected by human activities to a much lesser extent than many of the country's other forest reserves. Encroachment was recorded in ten (5%) of the survey compartments, involving two livestock enclosures and about 20 ha of land under cultivation within the reserve. Bamboos are used locally for building and fencing, and are harvested by the local Konjo people wherever they grow close enough to the boundary to make exploitation worthwhile. Bamboo cutting was recorded in 12 (6%) of the survey compartments (Fig. P3). There appears to be very little pressure on the reserve for building poles, firewood and sawn timber, since most homesteads have sources of these products close at hand outside the reserve. There are very few trees of sufficient size and quality to make pitsawing worthwhile.

Hunting is extremely widespread, being recorded from 30% of the compartments surveyed in all areas of the mountain (Fig. P3). The Konjo are one of the few tribes in Uganda who hunt primates. Animals are normally trapped in simple snares, or pursued with dogs and spears. The impact of this hunting activity has apparently been severe, since buffalo now seem to be extinct on the Ugandan side of Rwenzori, and species such as bushbuck, bushpig, hyrax and giant forest hog which used to be extremely common here in c. 1960 (R. Bere, pers. comm.), are now little in evidence. The night-time screams of hyrax in the high valleys are now heard as isolated calls, where formerly 'the night scene was deafened by their screeching' (Yeoman , 1985).

Management: The reserve is managed from the Kasese, Kabarole and Bundibugyo District Forest Offices, and is under the direct charge of about five forest guards. There is no departmental infrastructure, and the closest vehicular access points are all 2-3 km from the boundary. The latest Working Plan covers the period 1.6.61 to 30.6.71, (subsequently extended to 30.6.76) and prescribes for the whole area to be designated to a 'protection working circle', with the primary objective of maintaining the vegetation cover to minimise soil erosion and protect water supplies. Under the prescriptions of the Working Plan, a Nature Reserve was to have been selected and established by 30.6.61, but this was not done. At present there is no active management of the area, except for occasional forest guard patrols. The (now dormant) Mountain Club of Uganda has erected some simple mountain huts at seven locations in the central part of the reserve, for use by mountaineers. Most of these are still used, though somewhat derelict.

Conservation Importance:

- this reserve is one of the country's most important water catchment areas;
- it is important as one of the richest sites in the country for endemic species, most of which are associated with the higher altitude zones of the reserve;
- the reserve supports at least six species of animal considered to be globally threatened with extinction, or nearly so;
- it is a site of such unique splendour and scientific importance, that it would warrant World Heritage Site status, as an extension of Zaire's Virungas National Park which is already nominated under this important international convention;
- the Rwenzori (fabled 'Mountains of the Moon') are well known internationally, and already attract fair numbers of overseas visitors. The potential for tourism development is enormous.
- as part of a large transnational network of protected areas, Uganda's portion of the Rwenzori is important for the conservation of species that live at low densities and which therefore require large areas of land in order to maintain viable breeding populations;
- although the lower-lying forest is little known biologically, its location close to the site of a postulated pleistocene refugium (Hamilton, 1981) has probably resulted in a diverse present-day community of forest species, including many Congo basin species near the eastern limits of their ranges.

Threats: The greatest threat to the integrity of this forest is posed by high levels of hunting activities which are having a severe impact on many of the larger mammals. Agricultural encroachment into the reserve has not yet become too serious, but the high human population densities in the neighbouring lands must be cause for concern. At the time of the last population census in 1980, the population densities in the settled parts of Harugali, Bukuku, Mugusu, Kisomoro, Kabaale, Bugoye, Kilembe, Kyarumba, Kisinga, Bwera and Karambi subcounties, which surround the reserve, were about 150, 160, 170, 200, 120, 100, 290, 180, 300, 450 and 430 persons/km^2 respectively. The use of forest products other than bushmeat by local communities is probably not a serious threat, although a study of this would be useful. In the immediate vicinity of the 'central tourist circuit' there are some localised problems associated with tourist activities, including litter and sanitation, and destruction of vegetation around the mountain huts to provide firewood.

Recommendations Specific to this Forest: Detailed recommendations for this reserve are given in Howard (1988), and include the following:

- the reserve should be given elevated conservation status as a National Park, zoned into a totally protected 'core area' and a 'traditional use zone' in which traditional use of non-animal forest products is permitted under a strict system of regulation. Alternatively, the 'core area' could be designated as National Park, leaving the 'traditional use zone' as Forest Reserve;
- the reserve should be nominated for inclusion on the World Heritage List;
- a new management plan should be prepared, infrastructure provided, tourist facilities developed, anti-poaching and boundary patrols initiated, and a conservation education programme amongst the local communities embarked upon.

Principal Reference Material:

Howard, P.C. (1988). Proposal for the establishment of a new National Park in the Rwenzori Mountains, Uganda. 26pp. WWF Project 3235: Unpublished Report.

Leggat, GJ. and A. Beaton (1961). Working Plan for the Ruwenzori Forest Reserves. First revision for the period 1st July 1961 to 30th June 1971. Entebbe: Uganda Forest Department.

Osmaston, H.A. and D. Pasteur (1972). Guide to the Rwenzori. Kampala: Mountain Club of Uganda.

Prigogine, A. (1985). Conservation of the avifauna of the forests of the Albertine Rift. pp 277-295 In: Conservation of tropical forest birds. ICBP Technical Publication No.4. Cambridge: ICBP.

Salt, G. (1987). Insects and other invertebrate animals collected at high altitudes in the Ruwenzori and on Mount Kenya. *Afr. J. Ecol.* 25(2): 95-106.

Yeoman, G. (1985). Can the Rwenzori be saved: *Swara* 8 (3): 8-12.

Yeoman, G. (1989). Africa's Mountains of the Moon. Journeys to the Snowy Sources of the Nile. London: Elm Tree Books.

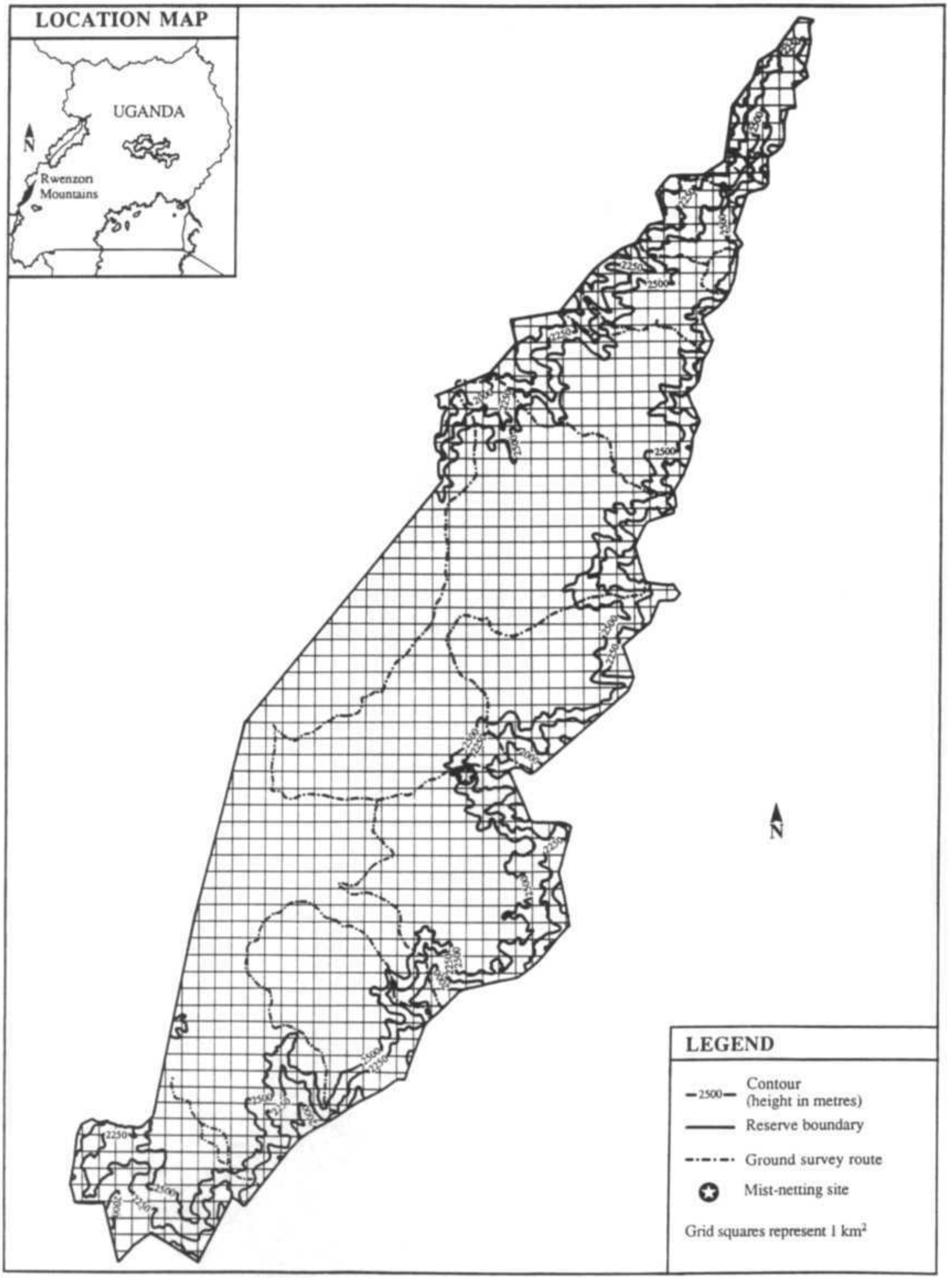


Fig. P1 *Rwenzori forest types*

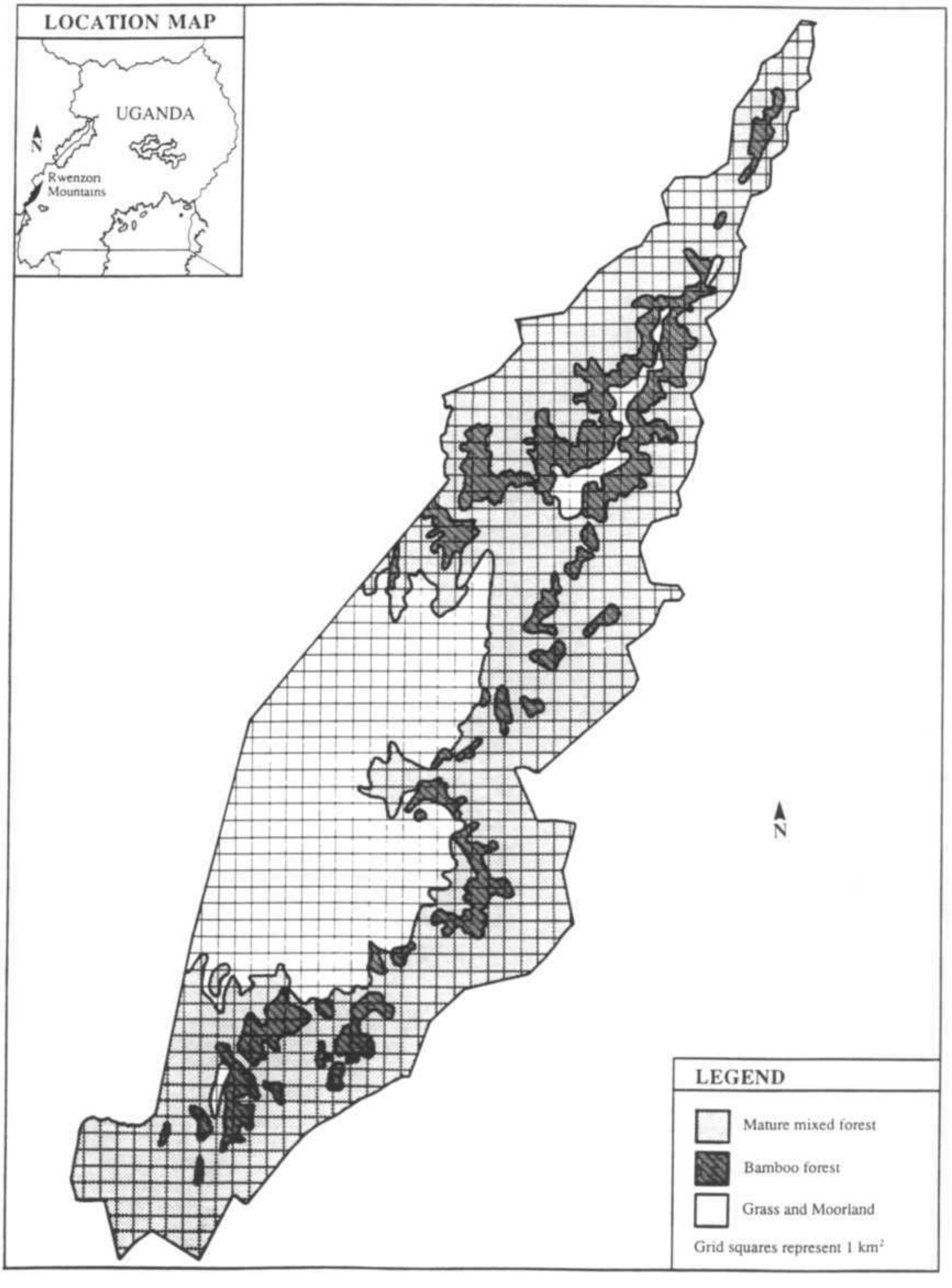


Fig. P1.1 *Rwenzori ground survey routes, mist netting site and alliiudinal zones*

Fig. P2 *Distribution of large mammal records made during the ground survey of Rwenzori*

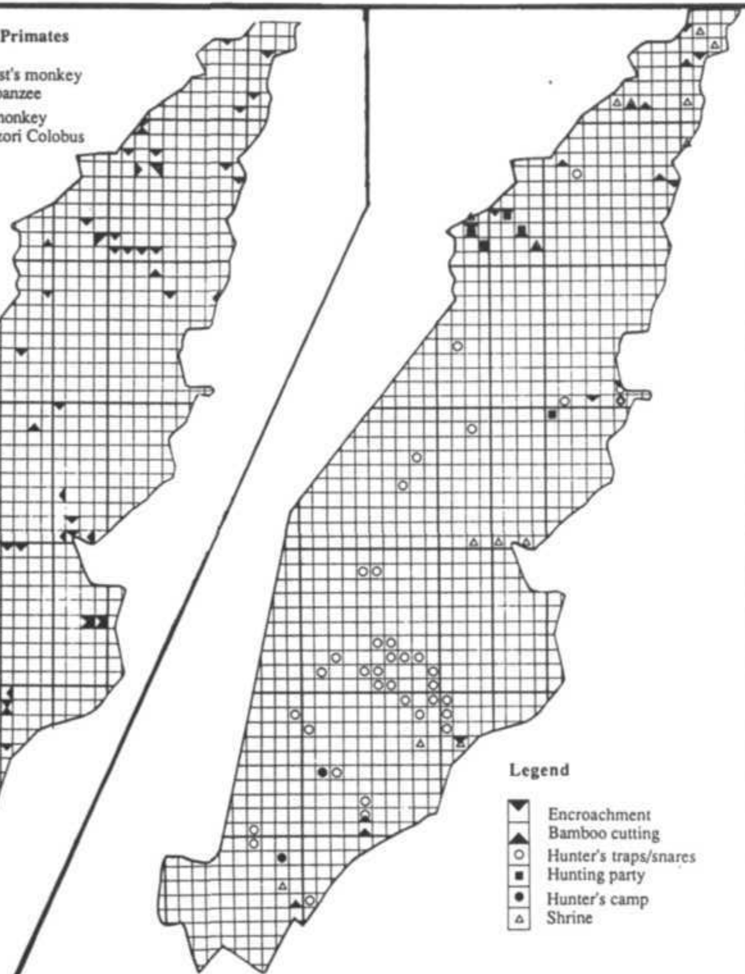


Fig. P3 *Distribution of human activities recorded during the ground survey of Rwenzori*

Appendix Q. Limitations of the methods used.

The methods used in carrying out the fieldwork, and analysing the data presented in this report are, I believe, the most appropriate available for this kind of work. Nevertheless, it must be recognised that they were selected for their cost-effectiveness in providing a broad overview of nature conservation issues, and were not intended to provide the level of precision and accuracy that would be possible if time and resources were unlimited. Many of the limitations of the methods used are self apparent, but it is worth summarising some of the key constraints, so that the reader is fully aware of them.

Limitations of the survey data

The survey data resulting from traverses of each forest on foot are limited, and to some extent biased because:

- not all areas of each forest were visited, so extrapolation is risky;
- no attempt was made to measure attributes such as the basal area of trees that had been felled, or the areas of individual encroachment plots, so assessments of disturbance are of unknown accuracy.
- the ground surveys tended to over-sample disturbed habitats, because this is where the paths into a forest pass, and access is possible.
- the baseline data on the status of large terrestrial mammals is based on an assessment of the proportion of survey compartments in which a species was recorded, and no attempt was made to document population densities. These data therefore provide an opportunity to monitor changes in the distributions of these species, but not changes in their population status.

Limitations of the primate censuses

The primate censuses were carried out by conducting replicate censuses along 4-6 km transects. Such censuses have become a standard method of assessing primate population densities, and are commonly used for comparisons of different sites, and comparisons at the same site at different times. Unfortunately, the method has a number of shortcomings, which makes it extremely difficult to interpret the results:

- there is normally considerable variation in the number of primate groups encountered along the same transect on different days, so reasonable precision can only be achieved by conducting a large number of replicate censuses
- it is not known what proportion of the primates present in a census area are actually detected during a census: some observers may be more astute than others.
- the initial disturbance in cutting a transect may affect patterns of range use by resident primates, thus affecting census results, for some time after a transect is establsihed.
- when a group of primates is detected, it is rarely possible to assess the number of individuals present, so population or biomass densities are even more difficult to assess than group densities.

In this report I have presented primate census data in terms of the number of groups of each species detected per square kilometre of forest, at 20 different sites. The results (tabulated in Appendices E-L and summarised in Table 2.7) would seem to indicate considerable variation in population densities between forests, and between different areas of the same forest. However, such comparisons may not be valid, because they assume that:

- the mean number of individuals per group is the same at each locality;

- there are no behavioural differences between populations that would affect our ability to detect them, and result in a different proportion of the animals present being censused at different sites.

Further work is required to ascertain whether these assumptions are valid, before comparing group densities between sites, or even, group densities at the same site over a period of time.

One further caveat regarding the interpretation of primate census data, is that the census results presented from any particular locality within a forest may not be typical of that forest as a whole, and it would clearly be wrong to calculate total populations for particular forests by extrapolation from such data. For example, primate population densities in Kalinzu/Maramagambo seem to vary by a factor of three between good and bad sites (if we accept the above assumptions). The primate censusing routes used in Bwindi (Impenetrable) Forest were at high altitudes, where primate population densities are conspicuously low, and the route taken in Semliki was through swamp-margin forest that may not be typical of that forest.

Limitations to tree species diversity assessments

Measurement of the number of species of tree that occur per unit area is one of the most basic methods of evaluating vegetation diversity. There are, of course, a great many ways of using small-plot enumeration data to calculate indices of diversity and equitability, but a discussion of these is beyond the scope of this report.

Species-area relationships are useful for the comparison of different sites, provided that comparable methods are used. Unfortunately no internationally accepted standards have yet been established. Nevertheless, most assessments of this type now use contiguous square or rectangular plots, in which trees exceeding 10cm diameter at breast height are enumerated. The shape of the enumeration plot is critical in determining species accumulation rates: for example, a 1 ha plot of 1000 x 10 m that traverses a range of forest types from dry ridge-top, through mid-slope to swamp-margin and riverine forest, is likely to include many more species than a 1 ha square plot of 100 x 100 m located in the same general area that does not encompass such a range of forest types on account of its shape. Similarly, the species-area relationships reported here, that were derived from enumeration of separate 20 x 20 m subplots at 200m intervals along primate census routes, are not strictly comparable with enumeration data derived from contiguous plots elsewhere in the world (Table 2.5), or even the near-contiguous plots assessed as part of this study. Research is needed to evaluate the extent to which the shape of plots and arrangement of sub-plots affects the results of species-area assessment.

Limitations of the scoring systems used in Chapters Two and Four

Scoring systems have great value as a means of rationalising management decisions because they necessitate the definition of criteria upon which decisions are based. Once such criteria have been defined, the success of deriving meaningful scores depends upon the quality of the information available. In this report, I have attempted to show how a scoring system could be used to rationalise the establishment of new Nature Reserves in Uganda's forest reserves. In doing so, I used incomplete and outdated information which, although the best available, is often barely adequate for the job. Some of the problems and limitations of my system, and its derived scores, are listed below.

Scores for the importance of different forests in species conservation:

- The use of incomplete species lists introduces bias, which tends to under-value those forests that have not been adequately sampled, and simultaneously over-value those forests that are well sampled (because the scoring system gives a higher value to 'rare' species than common ones, and rare species appear even rarer if records are incomplete)

- The indicator groups used may not be the most suitable indicators of the value of individual forests for species conservation. They were selected for practical reasons including ease of identification and data collection, rather than ecological characteristics, and may prove to be an inappropriate choice.

- The use of old species lists may introduce bias because some species may have become locally extinct.

- The definition and use of forest species is inexact, and affects the scores derived for certain groups (e.g. birds, butterflies).

- The scoring system favours rarity in a narrow, Ugandan context, not an international one. Species which have a restricted distribution in Uganda are not necessarily rare or endangered internationally. For example, Semliki Forest scores highly for species conservation importance because it is the only Ugandan locality for many west African species on the eastern limits of their ranges. In an international context it could be argued that Semliki Forest is not as important as the scores suggest, because many of the 'special' species that occur there are actually widespread and common elsewhere.

- The scoring system recognises only two attributes of a species assemblage: the number of species, and the rarity of each. Other important attributes are ignored, such as population size and the likelihood of a forest being able to sustain viable populations of particular species in the long-term. For example, the scoring system does not distinguish between a forest in which two old bull elephants occur, and another which supports a herd of 200.

- The final scores give equal weighting to each of the indicator taxa, so individual species belonging to small taxa carry much more weight than those belonging to large taxa. Thus, because there are 327 forest oirds known from Uganda's forests, but only 12 diurnal primates, each species of primate is given a weighting 327/12 = 27 times greater than each bird.

Scores for the suitability of different forests for commercial forestry

- These scores are particularly problematic because they depend upon very old inventory data, and take no account of any harvesting that has taken place since.

- Even if recent inventory data were available, the scoring system is based upon consideration of standing timber volume rather than regenerative capacity. For the purposes of assessing the long-term suitability of an area for commercial forestry, regenerative capacity should be of greater concern.

- The scoring system takes no account of where there has already been investment in sawmilling equipment, which may be an over-riding practical consideration.

Appendix R. Status of threatened animals in Uganda's principal forest reserves

Listed below are the fourteen species of animal listed in IUCN's Red Data Books of threatened animals that are known from Uganda's forests, together with a brief report on their present status in the forests covered by this programme. Alongside the name of each of the threatened animals is the category into which it falls. These categories are:

ENDANGERED:	animals in danger of extinction and whose survival is unlikely if the causal factors continue operating.
VULNERABLE:	animals that are likely to move into the 'endangered' category in the near future if the causal factors continue operating.
RARE:	animals with small world populations that are not at present 'endangered' or 'vulnerable', but are at risk.
INDETERMINATE:	animals considered to be either 'endangered', 'vulnerable' or 'rare', but where there is not enough information to say which of the three categories is appropriate.

1. **Mountain Gorilla, *(Gorilla gorilla beringei)*** ENDANGERED
This subspecies of gorilla has a world population estimated at only about 600 individuals. There are only two isolated populations, one in the 375 km^2 Virungas Volcanoes area straddling the border between Uganda, Rwanda and Zaire, and one in the 321 km^2 Bwindi (Impenetrable) forest in Kabale and Rukungiri Districts, Uganda.

Status in Uganda: No observations of this species were made during the course of this programme, but its status in the Bwindi (Impentrable) forest is being evaluated under WWF Project 3631 which began in August 1986. A census of gorillas is being carried out and will probably reveal a total population in the forest close to 300 individuals, more than twice the previous etimates of 100-150 (Butynski, 1989). The Ugandan portion of the Virunga Volcanoes gorilla range is inadequately protected as the 24 km^2 Mgahinga Forest Reserve, an area that has suffered agricultural encroachment (now under control). Gorillas move between this reserve and neighbouring protected areas in Rwanda and Zaire, where they are afforded much better protection.

2. **Chimpanzee, *(Pan troglodytes)*** VULNERABLE
The chimpanzee occurs in suitable habitat throughout western equatorial Africa, but rarely at densities exceeding four animals/km^2 (Ghiglieri, 1984). The species is threatened by habitat destruction throughout a large part of its range, by capture for biomedical research and other programmes, by hunting pressure, and in some areas by fanners suffering damage to their crops.

Status in Uganda: Chimpanzees were recorded from all the forests of western Uganda during the course of this programme. They were found at altitudes from about 750 m in the Semliki Forest Reserve to about 2,750 m in the Rwenzori Mountains. The locations of all records - direct sightings, calls, sleeping 'nests' and other signs - are provided in the profiles of each forest (Appendices E-L and P). In the seven forests where ground survey work was carried out, chimpanzee records were made in as few as 3% of the km^2 survey compartments in the Semliki Forest to as many as 30% of the survey compartments in the Kalinzu/Maramagambo Forest, giving some idea of the species' relative abundance at different sites. I have used these figures as an index of relative abundance in providing the following very rough estimates of chimpanzee populations in each forest. The figures are based on studies of chimpanzees at Kibale Forest, which indicate densities of about four animals/km^2 in the best undisturbed habitats (G.I. Basuta, pers. comm.), declining to about 0.3 km^2 after logging (Skorupa, 1987). I am using a baseline figure of 2.0 animals/km^2 for the whole of the forested portion of Kibale forest, and I am ranking Kibale Forest as a mid-density chimpanzee site (based on my experience of this forest compared with others). Other mid-density sites are defined as those in which chimpanzees were recorded from 10-20% of survey compartments, low density sites (0.7 animals/km^2) are those in which records were made in fewer than 10% of survey compartments, and high density sites (3.3 animals/km^2) those in which records were made in 20-30% of survey compartments. Accordingly, the Semliki Forest is ranked as a low-density site with a chimpanzee population of about 150 animals; the Kibale, Bugoma, Bwindi and Kasyoha-Kitomi forests, and the lower-lying forested portion (250 km^2) of the Rwenzori reserve are ranked as mid-density sites with total populations of 860, 600, 640, 660 and 500 animals respectively; and the Kalinzu/Maramagambo, Itwara, and Budongo forests are ranked as high-density sites with total populations of 1,820, 220 and 1,400 animals respectively. Since few chimpanzees exist outside these reserves, this would give a total Ugandan chimpanzee population of (very approximately) 6,800 individuals.

The greatest threat to Uganda's chimpanzees is loss of habitat through agricultural encroachment of reserves (as has already taken place in the Semliki and Kibale reserves); degradation of habitat through logging and other forest management activities; trapping for medical research; and accidental capture in snares and animal traps set for other animals (G.I. Basuta, pers. comm.).

3. L'hoest's monkey, *(Cercopithecus l'hoesti)* VULNERABLE

The L'hoest's monkey shows a disjunct distribution with separate populations in the Nigeria/Cameroon/Fernando Po region and the Albertine Rift area of eastern Zaire/western Uganda/Rwanda/Burundi. It is essentially a montane forest species, considered to be threatened by deforestation and hunting (Oates, 1985).

<u>Status in Uganda</u>: This species is now known from six major forest blocks in southwestern Uganda, including two reserves (Kasyoha-Kitomi and Itwara) where it had not been recorded prior to this research programme. Ground surveys were carried out in all these areas under this programme, and line transect primate censuses were conducted at a total of nineteen sites in five of them (A. Kisubi, in prep.). L'hoest's monkeys were sighted in 2% of survey compartments in the Itwara and Rwenzori Forests, 4% of compartments in the Kasyoha-Kitomi Forest and 11% of compartments in the Kalinzu-Maramagambo Forest (Appendices L, P, K and H) under this programme, and in 9% of compartments in the Bwindi Forest

by Butynski (1984). These figures are considered indicative of the relative abundance of this species in the different forests. It is uncommon and rarely seen in the Kibale, Itwara, Rwenzori and Kasyoha-Kitomi forests, where census statistics indicate densities generally well below one group per square kilometre (Appendices E, L, P, K; A. Kisubi, in prep.). Group sizes in these forests are usually in the range of 2-15 individuals (pers. obs.; A. Kisubi, unpublished data; Struhsaker, 1975). The species is apparently not as rare in the Bwindi and especially the Kalinzu-Maramagambo Forests, where both group densities and mean group size are appreciably higher. Butynski (1985) estimated a total population of about 1,100 animals in the Bwindi Forest, based on a figure of just under one group of 17 individuals per square kilometre in the favoured marginal areas of the reserve. A. Kisubi (in prep.) estimated densities of between 0.5 and 2.7 groups per square kilometre at six widely separated sites in logged and undisturbed areas of the Kalinzu-Maramagambo Forest. The species was found at relatively high densities (1.5 gps/km^2) in the lower-lying areas of the reserve (at 1,000 m) as well as at higher altitude, and was more abundant in logged areas of forest at 1,700 m than in adjacent undisturbed areas. Here it was frequently seen feeding on the fruits of the colonising tree, *Musanga leo-errerae* (pers. obs.), often in groups of 30-40 individuals (a maximum group size of 67 has been recorded here; A. Kisubi, pers. comm.).

In the Rwenzori Forest Reserve this species is hunted (illegally) by the Bakonjo people who occupy the lower slopes of this mountain range. Elsewhere it is threatened by encroachment of forest reserve land by agriculturalists, and by logging which may lead to population declines at some sites (Skorupa, 1987).

4. Uganda red colobus monkey, *(Colobus badius tephrosceles)*

INDETERMINATE

Red colobus monkeys occur throughout tropical Africa, and have evolved into a number of quite distinct forms in different parts of their range. The Uganda subspecies is restricted to the Kibale Forest of Uganda and a few forests of northwestern Tanzania, probably extending into Burundi and, perhaps, eastern Zaire. It is threatened by habitat loss and degradation throughout its limited range (Oates, 1985).

Status in Uganda: The species occurs only in the Kibale Forest, where it is the most abundant primate. Densities of about 6 groups of 50 individuals per square kilometre are found in undisturbed *Parinari*-forest communities, with somewhat lower densities elsewhere (Struhsaker, 1975; Skorupa, 1987; Appendix E). Taking a somewhat conservative estimate of 100 individuals per square kilometre throughout the forested portion of Kibale Forest Reserve, the total population would be around 40,000 individuals.

The Kibale Forest population is by far the largest remaining (Oates, 1985). It is threatened by agricultural encroachment, which already affects 18% of the reserve (Appendix E), and by logging of the forest, which reduces population densities by as much as 70% (Skorupa, 1987).

5. Elephant, *(Loxodonta africana)* VULNERABLE

Although elephants occur widely throughout sub-Saharan Africa, they have become the focus of major international concern in recent years on account of very drastic reduction in the sizes of populations and the extent of occupied range (Mackinnon and Mackinnon, 1986). Elephants are threatened as a result of the expansion of human settlement, and ivory poaching.

Status in Uganda's forests: Signs of recent elephant activity were seen in all of the forests covered by this programme, with the exception of Mabira, and Bugoma. However, there were only two forests in which it was recorded in more than 10% of the km^2 compartments covered by ground survey work, indicating that populations are everywhere low (Appendices E-P). Game Department staff in Kibale Forest estimate that there may be about 50-150 animals there, and an estimate of 30 is reported by Butynski (1986) for the Bwindi Forest. Based on these estimates, and the number of signs of elephant I have seen in these forests compared with others, I believe it unlikely that any of Uganda's forests harbours more than 50 permanently resident elephants, and most of them probably provide refuge for far fewer than this. The only possible exception to this would be the Sango Bay forests, in which signs of elephant were recorded from 32% of survey compartments, indicating a population of perhaps 50-100.

Game Department staff at Bugoma Forest told me that the elephant population there had been drastically reduced by ivory poachers in the mid to late 1970s and Butynski (1986) reports elephant poaching in Bwindi in 1976. This was probably a period when elephant populations throughout Uganda's forests were under particular pressure, but poaching has continued to the present day. In 1985, after NRA forces had taken control of western Uganda, an elephant reportedly died of bullet wounds close to our camp on the edge of Kasyoha-Kitomi Forest, and seven elephants were shot for their ivory in neighbouring Kibale Forest, at about the same time (S. Kramer, pers. comm.).

Most of Uganda's forest reserves are relatively small areas, surrounded by densely populated agricultural lands. Elephants frequently cause serious damage to farmers' crops when they move out of the reserves, and they are considered by foresters to be incompatible with intensive forest management activities. There is considerable doubt as to whether it is possible (or even desirable) to maintain populations of elephants in the smaller of these isolated reserves. However, elephants play an important ecological role in the maintenance of natural forest ecosystems, and should be protected wherever possible. In Uganda, this should be within the context of larger protected area systems, including those of the Budongo Forest-Murchison Falls National Park complex, the Kalinzu/Maramagambo-Queen Elizabeth National Park complex, the Rwenzori Forest-Virungas National Park complex (including possibly the Kibale and Semliki Forests), and the trans-national Mount Elgon reserve.

6. Leopard, *(Panthera pardus)* VULNERABLE

Leopards occur widely across Africa, the Middle East and Asia. They are persecuted by people suffering livestock depredations, and are hunted for their skins.

Status in Uganda's forests: There is very little information available on the status of this species in Uganda's forests, although it is thought to occur in most of them. I found a pile of old faeces which I attributed to leopard high in the Rwenzori, but came across no direct evidence of its occurrence elsewhere. I have received one recent report of a leopard seen on a duiker carcass in Kalinzu Forest, and two reports of leopards in Mabira, one crossing a road at night, and the other walking through the forest during the day.

Leopards are probably now extinct in the Bwindi Forest (Butynski, 1984), and evidently occur at very much lower densities than used to be the case in Rwenzori (Howard, 1988). This may be the result of reduced availability of prey, or the more direct consequence of leopard hunting.

7. Nahan's francolin, *(Francolinus nahani)* RARE

This bird is known only from a few localities in lowland forest in eastern Zaire and western and central Uganda. In Uganda it is known from the Bugoma, Budongo, Kibale, Semliki and Mabira forests, where it may be more common than the few records suggest, since eight were collected in Bugoma by sprinkling grain on a forest track (Britton, 1980). No records of the species were made during this study.

8. African green broadbill, *(Pseudocalyptomena graueri)* RARE

This bird is known only from the Itombwe Mountains and the mountains west of Lake Kivu in eastern Zaire, and from the Bwindi (Impenetrable) Forest in Uganda, where it appears to be a rare resident of the higher altitude zone (Britton, 1980; Collar and Stuart, 1986). No records were made under this programme, but T. Butynski (pers. comm.) reports having seen the species in Bwindi three times in the past eighteen months.

9. Grauer's rush warbler, *(Bradypterus graueri)* VULNERABLE

This bird occurs only in a few highland swamps in eastern Zaire, Rwanda, northern Burundi and southwestern Uganda. Although it is not a forest species, it is included here because the Mubwindi Swamp in the Bwindi Forest is an important locality, where the bird is apparently quite common (pers. obs.; Britton, 1980). Elsewhere, the bird is threatened by swamp drainage (Collar and Stuart, 1986).

10. Chapin's flycatcher, *(Muscicapa lendu)* RARE

This bird is known only from two mountain ranges in eastern Zaire, Uganda's Bwindi Forest, and two forests in western Kenya. It is rare throughout its range (Collar and Stuart, 1986). In the Bwindi Forest, it has been found in the lower-lying areas at around 1,500 m (Keith and Twomey, 1968), but there are no recent records.

11. Kibale ground thrush, *(Turdus kibalensis)* INDETERMINATE

This bird is known only from two adult male specimens captured in secondary habitat in the northern part of Kibale Forest in 1966 (Collar and Stuart, 1986). It has not been recorded since then, despite continued interest in the birds of Kibale from staff of New York Zoological Society's Kibale Forest Project, including extensive mist-netting activity in various forest types around the project headquarters at Kanyawara Forest Station.

12. Forest ground thrush, *(Turdus oberlaenderi)* RARE

This bird is known only from a few localities in low to medium altitude forest in eastern Zaire, and from the Semliki Forest in Uganda (Collar and Stuart, 1986). In the Semliki Forest it may be a seasonal visitor, since birds have only been caught here in July. It has been found on the forest floor in areas of almost pure ironwood, *Cynometra alexandri*, and is said to avoid denser areas of tangled secondary growth (Keith, 1968).

13. African giant swallowtail, *(Papilio antimachus)* RARE

This, the largest of Africa's butterflies, occurs throughout the forests of west and central Africa from Sierra Leone to western Uganda (Williams, 1968). Here it is recorded from the Semliki, Budongo, Kalinzu/Maramagambo, Kibale and Bwindi Forests, where it is rare. Only one individual was seen during the course of this research programme, at 1,450 m in the Kibale Forest during May.

14. Cream-banded swallowtail, *(Papilio leucotaenia)* VULNERABLE

This butterfly is known only from a few montane forests in the Kivu region of eastern Zaire, Rwanda, Burundi and extreme southwestern Uganda. It is reported to be sometimes common in the Bwindi (Impenetrable) forest (Williams, 1969).

References:

Britton, P.L. (Ed.) (1980). Birds of East Africa: their habitat, status and distribution. Nairobi: East Africa Natural History Society.

Butynski, T.M. (1984). Ecological survey of the Impenetrable (Bwindi) Forest, Uganda, and recommendations for its conservation and management. Unpublished report. New York Zoological Society.

Butynski, T.M. (1985). Primates and their conservation in the Impenetrable (Bwindi) Forest, Uganda. *Primate Conservation* 6: 68-72

Butynski, T.M. (1986). Status of elephants in the Impenetrable (Bwindi) Forest, Uganda. *Afr. J. Ecol.* 24: 189-193.

Butynski, T.M. (1989). Impenetrable Forest Conservation Project. WWF Project 3631 Progress report No. 7.

Collar, N.J. and S.M. Stuart, (1985). Threatened birds of Africa and related islands. The ICBP/IUCN Red Data Book. Cambridge: ICBP/IUCN.

Ghiglieri, (1984). The chimpanzees of Kibale Forest. New York: Columbia University Press.

Howard, P.C. (1988a). Proposal for the establishment of a new National Park in the Rwenzori Mountains, Uganda. 26pp. WWF Project 3235: Unpublished report.

Keith, S. (1968). Notes on birds of East Africa, including additions to the avifauna. Amer. Mus. Novit. No. 2321: 1-15.

Keith, S. and S. Twomey, (1968). New distributional records of some East African birds. *Ibis* 110:537-548.

Kisubi, A. (in prep.). Abundance and response of wild primates to forest habitats in western Uganda. Unpublished MSc. thesis, Makerere University.

Mackinnon, J. and K. Mackinnon, (1986). Review of the protected areas system in the Afrotropical realm. Gland: IUCN.

Oates, J.F. (1985). IUCN/SSC Primate Specialist Group Action Plan for African Primate Conservation; 1986-90. (Draft). Gland: IUCN.

Skorupa, J.P. (1987). The effects of habitat disturbance on primate populations in the Kibale Forest, Uganda. Unpublished PhD. thesis. University of California.

Struhsaker, T.T. (1975). The red colobus monkey. Chicago and London: University of Chicago Press.

Williams, J.G. (1969). A field guide to the butterflies of Africa. London: Collins.

Appendix S. Enumeration data for trees exceeding 10 cm dbh in 1 ha plots in a lightly pitsawn area of climax *Parinari* forest, and an adjacent area of *Parinari* forest that had been mechanically harvested over a period of 3 - 10 years prior to the enumeration. Each plot comprised 25 subplots of 20 m x 20 m positioned at 200 m intervals along 5 km primate censusing routes, shown as routes A and B on Fig. H1.1 (Appendix H). Data are from Kisubi (unpublished).

Table SL Enumeration data for route A. (lightly pitsawn Parinari forest)

	No. of stems in diameter class (cm)							
Species name	11-20	21-30	31-40	41-50	51-60	61-70	70+	TOTAL
Craterispermum laurinum	61	5	-	-	-	-	-	66
Strombosia scheffleri	-	5	9	14	4	1	-	33
Cassipourea gummiflua (?)	16	6	1	2	-	-	-	25
Funtumia africana	14	2	5	2	-	-	-	23
Markhamia platycalyx	11	3	2	5	-	-	-	21
* *Drypetes* sp. (No. 183)	7	5	1	3	1	4	-	21
Celtis durandii	6	5	3	1	-	-	-	15
Unidentified Sp. 1	9	2	-	-	-	-	-	11
Pleiocarpa pycnantha	10	1	-	-	-	-	-	11
Diospyros abyssinica	1	4	4	1	-	-	-	10
Parinari excelsa	-	-	-	1	4	1	4	10
Unidentified Sp. 2 (Rubiaceae)	10	-	-	-	-	-	-	10
Xymalos monospora	8	1	-	-	-	-	-	9
Oxyanthus speciosus	8	-	-	-	-	-	-	8
* *Cassipourea ruwenorensis*	8	-	-	-	-	-	-	8
* *Drypetes bipindensis* (?)	1	6	-	-	-	-	-	7
Tabernaemontana holstii	6	1	-	-	-	-	-	7
Uvariopsis congensis	6	-	-	-	-	-	-	6
* *Beilscmeidia ugandensis*	-	1	3	1	-	-	-	5
* *Connarus longistipitatus*	4	-	-	-	-	-	-	4
* Unidentified Sp. 4	4	-	-	-	-	-	-	4
Linociera johnsonii	2	1	1	-	-	-	-	4
Spathodea campanulata	1	-	1	-	1	-	-	3
* *Leptonychia mildbraedii*	3	-	-	-	-	-	-	3
* *Trichoscypiia submontana*	-	-	-	-	1	-	1	2
* *Premna angolensis*	-	1	1	-	-	-	-	2
* *Ficus brachylepis*	-	-	-	1	-	-	1	2
Rothmannia urcelliformis	2	-	-	-	-	-	-	2
* Unidentified Sp. 5	2	-	-	-	-	-	-	2
* Unidentified Sp. 6 (Rubiaceae)	2	-	-	-	-	-	-	2
Chrysophyllum gorungosanum	-	-	-	-	-	-	1	1
Maesopsis eminii	1	-	-	-	-	-	-	1
* *Ritchiea albersii*	1	-	-	-	-	-	-	1
Ficus eryobotroides	-	-	-	-	-	-	1	1
* *Pseudospondias microcarpa*	-	-	-	1	-	-	-	1
* *Canthium vulgare*	1	-	-	-	-	-	-	1
* *Macaranga schweinfurthii*	-	-	-	-	1	-	-	1
* *Casearia engeleri*	-	1	-	-	-	-	-	1
* *Rauvolfia oxyphylla*	1	-	-	-	-	-	-	1
* *Ficus pseudomangifera* (?)	-	-	-	-	-	1	-	1
* Unidentified (7 species)	5	1	-	-	-	-	1	7
48 species	211	51	31	33	13	6	9	354 stems

* Species marked with an asterisk were not encountered in the enumeration of adjacent logged forest.

Table S2. Enumeration data for route B (mechanically harvested *Parinari* forest)

Species name	No. of stems in diameter class (cm) 11-20	21-30	31-40	41-50	51-60	61-70	70+	TOTAL
Craterispermum laurinum	61	8	-	-	-	-	-	69
* *Trenta orientalis*	42	8	1	-	-	1	-	52
Fu.ntu.miaafricana	32	6	-	-	-	-	-	38
* *Musanga leo-errerae*	27	4	-	-	-	-	-	31
* *Carapa grandiflora*	1	4	9	9	1	1	-	25
Celtis durandii	6	4	3	4	1	-	-	18
* *Sapium ellipticum*	-	3	4	4	2	1	-	14
Strombosia scheffleri	1	3	4	6	-	-	-	14
* *Ficus capensis*	10	1	-	-	-	-	-	11
Linociera johnsonii	3	-	2	1	-	-	-	6
* *Fagara macrophylla*	3	-	-	-	2	1	-	6
Parinari excelsa	1	-	-	-	-	-	5	6
Xymalos monospora	5	-	-	-	-	-	-	5
* *Ficus vallis-choudae*	3	1	-	-	-	-	-	4
Oxyanthus speciosus (?)	4	-	-	-	-	-	-	4
* *Prunus africana*	3	1	-	-	-	-	-	4
Diopyros abyssinica	-	-	-	3	-	-	-	3
* *Phyllanthus discoideus*	2	-	-	-	1	-	-	3
* *Cassine buchananii*	2	1	-	-	-	-	-	3
* *Myrianthus holstii*	-	-	1	2	-	-	-	3
Unidentified Sp. 1	3	-	-	-	-	-	-	3
* *Newtonia buchananii*	3	-	-	-	-	-	-	3
Pleiocarpa pycnantha	3	-	-	-	-	-	-	3
* *Maytenus undata*	2	1	-	-	-	-	-	3
* *Allophyllus dummeri*	1	1	-	-	-	-	-	2
* *Polyscias fulva*	2	-	-	-	-	-	-	2
Tabernaemontana holstii	2	-	-	-	-	-	-	
Markhamia platycalyx	2	-	-	-	-	-	-	2
* *Croton macrostachyus*	2	-	-	-	-	-	-	2
Cassipourea gummiflua (?)	1	-	-	1	-	-	-	2
Unidentified Sp. 2 (Rubiaceae)	1	1	-	-	-	-	-	2
Spathodea campanulata	-	-	-	1	-	-	-	1
Ficus eriobotryoides	-	-	-	-	-	-	1	1
Chrysophyllum gorangosanum	1	-	-	-	-	-	-	1
Unidentified Sp. 3	1	-	-	-	-	-	-	1
* *Ekebergia senegalenis*	1	-	-	-	-	-	-	1
* *Syzygium guineense*	1	-	-	-	-	-	-	1
Maesopsis eminii	1	-	-	-	-	-	-	1
* *Ehretia cymosa*	-	1	-	-	-	-	-	
Rothmania urcelliformis	1	-	-	-	-	-	-	1
* *Linackeria schweinfurthii*	1	-	-	-	-	-	-	1
Uvariopsis congensis	1	-	-	-	-	-	-	1
42 species	236	48	24	31	7	4	6	355 stems

* 21 species marked with an asterisk were not encountered in the enumeration of adjacent lightly pitsawn forest.

Appendix T. Schedule of questions administered to a sample of 135 male householders in the rural areas of Bwamba (see Chapter Five)

1. Please provide the following details about yourself: your age, sex, level of education achieved, marital status (number of wives), number of children, age of first born child, number of brothers and sisters by the same mother, birth place, present occupation, and the number of people in your household.

Section A: Agriculture and Agricultural Product Marketing Facilities

2. What is the area of the land you have under cultivation?
3. What crops do you grow on your land? (List food and cash crops separately, in order of importance)
4. a) Are you able to obtain surplus food for sale?
   b) If yes, which crops do you obtain surplus food from?
5. Among the crops you grow which one is the most important in terms of generating income for you?
6. Where do you market your crops?
7. What mode of transport do you use in transporting your produce to the buying centres?
8. a) Do you belong to any co-operative society?
   b) If yes, why did you join this society?
   c) If no, what is hindering you from joining any of these societies?
9. What in your opinion do you see as outstanding problems to co-operative societies in your area?
10. What types of livestock do you keep?
11. What use do you make of this livestock and their products?
12. What problems do you face in your crop production?
13. What problems do you face in your livestock production?
14. a) If a completely new type of crop/livestock was introduced to this area, would you accept to take it up?
    b) If no, why?
15. a) Do you use agrochemicals on your crops?
    b) If yes, which types?
    c) If not, why?
16. Do you apply any form of manure to your crops?
17. Do you keep any crop/livestock sales and yields records?
18. a) Do you practise any crop rotation?
    b) If yes, how do you rotate your crops?
19. If there was a demonstration (teaching) farm nearby, what agricultural or livestock management methods would you want to learn about?
20. a) Has government helped you in any way in your agricultural production processes?
    b) If yes, how?
21. What measures do you take to conserve your soils against possible erosion?
22. What kind of tools do you use in your agricultural production?
23. What can you suggest to government to help you improve agriculture in this area?

<u>Section B</u>: Forest Resources

(i) In Relation to Firewood and Building Poles

24. Is there enough firewood in this area for your requirements?
25. How long does it take to collect one load of firewood?
26. How long does such a load of firewood last members of your family?
27. What is the approximate distance of the place from where you collected firewood last time?
28. a) Is the firewood which you have in your house from your own land?
    b) If not, where does it come from?
29. Are there enough trees to provide you with your building pole requirements in this area?
30. When did you last use building poles?
31. How many did you use and of what length?
32. What tree species did you use as building poles and rafters?
33. Where did they come from?
34. Were they satisfactory (i.e. big enough, strong enough, long enough, plenty of them for the building you were constructing?)
35. How much did they cost?
36. Do you look after trees growing on your land or do you leave them to survive naturally?
37. Do you use charcoal?
38. How much do you pay for a sack of charcoal?
39. Compared to firewood, is charcoal more convenient to use?
40. How do you get timber for making doors, windows and furniture?
41. What tree species in the forest reserve or elsewhere do you find suitable for providing timber?

(ii) In Relation to the Value of Natural Forests

42. a) When did you last eat wild animal meat?
    b) What type of animal did it come from?
43. In the last ten years, have you made use of a forest reserve for any of these things? (Options provided: medicines, agriculture, firewood, building poles, palm oil nuts, hunting, fishing, passage to neighbouring locality, bamboos, others)
44. In what ways does the existence of large forests nearby help you? (Options provided: stabilising climate, improving rainfall, preventing floods, providing a steady flow of stream water)
45. Which one of the two forest reserves in Bwamba do you find more helpful to you?
46. In what ways is it helpful to you?
47. Is there any way in which the existence of large forests nearby is harmful to you (e.g. as a reservoir of diseases, a refuge for crop pests, or a refuge for harmful animals)
48. In what ways do animals in the forest reserves help you? (Options provided: provision of meat, provision of skins, provision of medicine, they control the numbers of other animals which might become pests)
49. Do animals living in the forest harm you in any of the following ways: (Options provided: transmitting diseases, damaging crops, killing livestock)
50. Do you think wild animals should be protected? Give your reason for or against.

(iii) In Relation to Tree Planting

51. a) In the past five years, have you planted any trees?
    b) If so, how many; of what type; why did you plant them; where did you get the seedlings?
52. Do you have any land where you could plant trees?
53. If tree seedlings were made available (free) in your village would you be willing to plant them?
54. What types of trees would be useful to you?
55. If you planted trees together with your food crops, how well would the crops grow? (Options provided: better, worse, depends on the crop, do not know)
56. Which of the following crops are beneficial to plant with trees? (Options provided: coffee, cocoa, maize, palm oil trees, others)

(iv) In Relation to Forest Reserve Management

57. Why did government set aside the Semliki Forest Reserve? (No options provided)
58. Why did government set aside the Rwenzori Forest Reserve? (No options provided)
59. In these forest reserves do you think that people are allowed to:
    - freely collect firewood for their own use?
    - freely collect building poles?
    - carry out pit-sawing?
    - freely collect bamboo?
    - freely collect medicine?
    - make beehives from forest trees and keep bees?
    - go hunting?
    - walk through the forest?
    - cultivate land in the forest?
    - freely collect palm nuts to make palm oil for sale?
60. Have you ever cultivated land inside a forest reserve?
61. Do you think those with cultivation plots inside forest reserves should be:
    - allowed to continue cultivating freely?
    - allowed to build houses and settle in the forest?
    - allowed to cultivate specified areas with a cultivation permit?
    - evicted from the forest reserve?
62. Government has announced that it will not allow cultivation in Forest Reserves after January 1987. What do you think they should do with parts of the Semliki Forest Reserve which have been cultivated in the past? (Options provided: degazette some of the forest reserve, replant the cultivation plots with useful trees, co-operate with villagers in planting trees whilst allowing these people to use the plots temporarily (taungya system), leave the forest to natural regeneration)

Section C: Trade

63. What is your main source of income? (Options provided: sale of agricultural products, trade, payment for community services (e.g. teaching, church work, government jobs)
64. What are your main personal/family expenses in order of value? (Options provided: alcoholic drinks, clothes and bedding, fish and other foodstuffs, building materials, household hardware, school fees, others)

65. Do you conduct business outside Bwamba? If so, at each of the trading centres where you trade, please specify (in order of value) the three most important things you sell, the three most important things you buy, and how you transport your goods.
66. Which one of the following facilities do you think would be most beneficial to trade in Bwamba? (Options provided: regular mail service, telephone link, regular bus service to Fort Portal, banking facilities in Bundibugyo, loans, facilities for processing agricultural products, business training school, improvement of Fort Portal/Bundibugyo road)

Section D: Population Demography and Family Planning

67. Where are each of your brothers and sisters (by the same mother) living today (or if they have died, where were they living at the time of death)?
68. How many children would you like to have?
69. How many children can you afford to support?
70. Have you ever deliberately practised birth control/spacing, either by avoiding sex or by using artificial methods.
71. Where is your nearest family planning clinic?
72. If artificial birth control/spacing facilities were made freely available in your village would you make use of them? (Options provided: often, sometimes, never)
73. Are you in favour of making artificial birth control/spacing facilities freely available? Give your reasons.

Section E: Land Tenure System

74. How long have you lived on this land?
75. How did you acquire the land you are living on?
76. Total size of land (Interviewer must go out and measure it).
77. a) Is your land enough to support you with your family?
    b) If not, where do you get extra land for cultivation?
78. a) Do you 'lend' part of your land to friends, relatives or neighbours for cultivation purposes?
    b) If yes, how do they pay you?
79. a) Do you have a land title?
    b) If yes, of what benefit is it to you?
80. a) In the past ten years, have you seen people migrating to live in this village?
    b) Over the same period, have people left this village to settle in other areas?
    c) If yes, which areas do they go to?
81. a) Are there land disputes in this village?
    b) If yes, where are these disputes settled?
82. a) Does government assist people to acquire land?
    b) If yes, in what ways does it assist people to acquire land?
83. How do non-government organisations like churches, women's clubs, youth groups and mixed groups acquire land?
84. a) What do you see as outstanding problems affecting the present land tenure system in Bwamba
    b) Suggest ways by which these problems can be overcome.

Appendix U. Summary of scientific and management principles relevant to protected area planning

Biological considerations in protected area planning

The most important single objective in establishing protected areas in the natural forest is to ensure the survival of as many as possible of the country's forest-adapted plants and animals. We know little or nothing about the majority of these species, so the selection of areas for protection can only be based on an understanding of biological principles. Studies of the impact of logging on wildlife communities (reviewed in Chapter Three) show that not all plants and animals are threatened by forest exploitation, and some may actually benefit from habitat disturbance. Those that are able to adapt to logged-forest habitats will doubtless survive as long as some kind of forest vegetation persists. Others, however, are eliminated or reduced to very low population densities as a result of disturbance, and it is for these species that protected areas are crucial. As more and more of the natural forest is logged, the relatively small areas of undisturbed forest that are protected will become increasingly isolated as islands of habitat suitable for the survival of many species. They will also become increasingly important in protecting 'core' breeding populations of plants and animals that are selectively exploited by man, serving as refuges from which these species can disperse to re-colonise areas that have been over-exploited.

In recent years, a considerable amount of research in various parts of the world has been directed at establishing sound scientific principles for the optimal design and selection of protected areas. Much of this work is of relevance here, and it is worth summarising some of the main conclusions.

- **Protected areas should be as large as possible.** This requirement often brings about conflict between those responsible for wildlife conservation and those involved in resource exploitation. Understandably, many view the locking away of extensive tracts of land, or large volumes of usable timber, as a waste of potentially useful resources. It is therefore important to understand why large areas are required for conservation purposes. There are three main reasons.

  Firstly, large areas are necessary to maintain viable breeding populations of animals and plants that live at low densities. A viable population is one that is able to survive indefinitely in the natural state, despite occasional environmental catastrophes, food shortages and outbreaks of disease. Such a population has to include a reasonable number of genetically distinct breeding individuals if it is to remain 'fit' and capable of survival. The minimum number of individuals of any given species that is required varies widely for different species and different environmental conditions, but as a general rule-of-thumb, a figure of several thousands is widely accepted (Mackinnon and Mackinnon, 1986; Soule, 1987). The area of habitat that is required to maintain populations of this size can be calculated quite easily from a knowledge of the densities at which particular species occur. In the case of most species of rainforest tree, for example, densities of less than one per hectare are usual, so areas of at least 3-4,000 ha of the richest habitat are required in order to safeguard viable populations of most trees. Viable populations of animals such as chimpanzees (which achieve densities of only 2-4 per 100 ha) or leopards (which may each require 1,000 ha of rainforest habitat) cannot be supported in most of Uganda's forests, and we must therefore expect some species extinctions.

Secondly, large areas are desirable so that they contain as many different habitats as possible, including those characteristic of different catenary situations and different successional stages. The more habitats an area contains, the greater the number of species supported, and the greater the complexity of ecological interaction.

Thirdly, and related to the above, large areas are required to cater for the requirements of animals that are highly mobile and need a large area in which to satisfy their living requirements.

The principle that protected areas should be as large as possible is derived largely from studies of animal and plant distributions on oceanic islands, and island biogeographic theory (MacArthur and Wilson, 1967; Diamond, 1975). The relevance of this fundamental theory to protected area design, selection and management has been reviewed by Soule and Wilcox (1980), Frankel and Soule (1981), Wilcox (1984) and Soule (1986). Significantly, the theory predicts that a protected area 'habitat island' that contains 10% of the original habitat will be unable to support more than 50% of the area's original species in the long term (Diamond, 1975).

- **Protected areas should be connected to one another** by corridors of natural or semi-natural habitat that enable animals to move between adjacent reserves; and should be located close to one another in clusters, rather than dispersed. This ensures the maximum possible exchange of genetic material between adjacent sub-populations, and increases the effective area of each protected area.

- **Protected areas should be of a compact shape,** preferably circular, so as to minimise 'edge effects', such as colonisation by opportunistic species characteristic of adjacent disturbed habitats.

- **The protected area network should ensure the protection of representative samples of all ecological communities, and preserve locally distinct varieties of species.** This is particularly relevant to Uganda's 'transition' forests, most of which include no unique species, but which nevertheless constitute unique combinations of species. There is a tendency for greater genetic variation within transition zones than elsewhere, so these areas are especially important for the conservation of species genotypes (Pielou, 1979). Accordingly it is necessary to create a large number of geographically scattered protected areas representing the full range of different communities characteristic of different altitudinal and climatic conditions, soil conditions, and geographical areas. To some extent this is incompatible with the need to set aside large reserves and cluster them together (see above), and some degree of compromise is required in the design of an appropriate network of protected areas that includes several large areas, and a larger number of smaller, scattered ones. As mentioned above, it is particularly important that the largest reserves include as many different ecological communities as possible, an objective which is probably best achieved by ensuring that they cover the greatest possible altitudinal range.

- **The selection of protected areas should be biased in favour of certain types of habitat.** The rationale for this is that not all areas are equally important to species conservation. The habitats of greatest importance are those that are rich in species (because their protection is likely to result in the greatest number of species protected per unit area); those that include unique features such as endemic species, or unique combinations of species; those that represent ancient climax forest (because they are the least replaceable habitats); and those that are known to be important to species that are threatened by habitat degradation or over-exploitation. Areas that served as Pleistocene forest refugia are particularly important for the establishment of protected areas because they are species-rich, and often include the habitats of threatened plants and animals (Kingdon, 1971, 1973; Hamilton, 1974, 1981, 1984; Grubb, 1982; Padua and Quintao, 1982; Keast, 1985).

- **Protected areas should protect 'key resources' of importance to particular species.** Although very little is yet known about Uganda's forest wildlife, future research will undoubtedly identify 'key resources' that are considered critical to the survival of particular species, which can then be protected. These 'key resources' may, for example, be breeding or roosting sites, or seasonally important feeding areas.

- **Protected areas should be kept relatively free of human disturbance,** to ensure the maintenance of ecological integrity. Rainforest ecosystems are amongst the most complex communities of species on earth, and the most fragile. Because of the close inter-dependence of species, any unnatural disturbance is likely to have far-reaching ecological effects. Thus, the loss of a single species of plant may result in the extinction of between ten and thirty species of animal (Raven, 1976).

Management considerations in protected area planning

The success of a system of forest protected areas in maintaining biological diversity will ultimately depend upon a commitment and ability to manage it in an appropriate way far into the future. It is therefore vital to consider the management implications of alternative protected area planning strategies and design a system that is pragmatic and workable. Much can be learned from past experience in the designation and management of forest Nature Reserves (see Chapter Four), and appropriate measures taken to avoid the mistakes that, with hindsight, can be seen were made in the past. When evaluating the suitability of an area for higher protection status, three management considerations need to be addressed: its suitability for timber production; the feasability of protecting it; and its potential as a multiple-use area.

- **Suitability for timber production:** It will be difficult to establish large protected areas in forests that have a high potential value for timber production because of the likely conflict between the demands for exploitation and those for protection. There are a great many site factors that contribute to an area's potential long-term value for sustainable timber production, including soil type, drainage, aspect, and rainfall, but the most immediate demands for exploitation usually arise from consideration of the volume of standing timber and the ease with which it can be extracted. Realistically, therefore, areas that are particularly heavily stocked with timber, or can be easily exploited should only be considered for the establishment of major protected areas when there are strong biological arguments in favour.

- **Feasibility of adequate protection**: There is very little object in designating an area for protection unless such protection can be enforced. Past experience has shown that areas close to densely populated agricultural lands, and those that lie on rich soils with high agricultural potential are difficult to protect. On the other hand, remote areas, and those that lie adjacent to National Parks, large agricultural enterprises, or established institutions, may be far easier to protect. Over the past decade or so, the Forest and Game Departments have been largely unable to provide any form of active Nature Reserve protection, and the level of disturbance suffered has been closely related to an area's geographical location. In case this situation persists, or recurs at some time in future, it would be wise to locate some of the pprotected areas where they are afforded a large degree of natural protection, by virtue of a remote location.

- **Potential for multiple-use:** Protected areas have great potential value for many non-consumptive uses that are complementary to their central role in the preservation of biotic diversity. If suitable areas are selected they can be used for education, research, recreation and tourism, and consequently provide a wide variety of socio-economic benefits. From the outset, protected areas should be designed and managed to fulfil as many of these roles as possible. This can best be done if they are strategically located in areas that are easily accessible and close to other tourist attractions; if they offer visitors particular highlights such as chimpanzee or gorilla viewing, and facilities such as picnic sites and forest trails; if they are located in areas with a long research history where much is already known of the forest's ecology; and if educational facilities can be provided (Mackinnon *et al,* 1986). One of the most obvious benefits of locating protected areas where they can be developed as multiple-use facilities is that they tend to become more widely recognised for what they are, and are consequently better protected. This is particularly apparent in the Budongo and Kibale Nature Reserves (see Chapter Four), which have remained relatively intact as a result of their use as teaching and research facilities.

The IUCN Tropical Forest Programme

Already published:

1. The Gola Forest Reserves, Sierra Leone
   Wildlife conservation and forest management
   A.G. DAVIES (OUT OF PRINT)
2. Transmigration and the Environment in Indonesia
   The past, present and future
   ANTHONY J. WHITTEN, HERMAN HAERUMAN,
   HADI S. ALIKODRA and MACHMUD THOHARI (OUT OF PRINT)
3. Conservation Planning in Indonesia's Transmigration Programme
   Case studies from Kalimantan
   JOHN DAVIDSON (OUT OF PRINT)
4. The Management of Tropical Moist Forest Lands
   Ecological Guidelines
   DUNCAN POORE and JEFFREY SAYER (OUT OF PRINT)
5. Buffer Zone Management in Tropical Moist Forests
   Case studies and guidelines (OUT OF PRINT)
   SARA OLDFIELD
6. L'Equilibre des Ecosystèmes forestiers à Madagascar
   Actes d'un séminaire international
   LALA RAKOTOVAO, VERONIQUE BARRE et JEFFREY SAYER
7. Hunting and Wildlife Management in Sarawak
   JULIAN CALDECOTT
8. Rare Tropical Timbers
   SARA OLDFIELD
9. La Conservation des Ecosystèmes forestiers de l'île de la Réunion
   C. DOUMENGE et Y. RENARD (OUT OF PRINT)
10. La Conservation des Ecosystèmes forestiers du Cameroun
    STEVE GARTLAN
11. La Conservation des Ecosystèmes forestiers d'Afrique centrale
12. La Conservation des Ecosystèmes forestiers du Congo
    PHILIPPE HECKETSWEILER
13. La Conservation des Ecosystèmes forestiers du Zaïre
    CHARLES DOUMENGE
14. La Conservation des Ecosystèmes forestiers du Gabon
    CHRIS WILKS
15. Forest Conservation in the East Usambara Mountains, Tanzania
    ALAN HAMILTON

In preparation:

16. The Conservation of Mount Kilimanjaro
    Edited by WILLIAM D. NEWMARK
17. Conservacion de los Ecosistemas Forestales de Guinea Ecuatorial
    JOHN E. FA
18. Conservação dos Ecossistemas Florestais na República Democrática de Sao Tomé e Príncipe
    P.J. JONES, J.P. BURLISON, A. TYE
19. La Conservation des Ecosystèmes forestiers de la République centrafricaine
    FLORENCE PINGLO et PHILIPPE HECKETSWEILER

Series editors: Mark Collins and Jeffrey Sayer

The IUCN Forest Conservation Programme

The IUCN Tropical Forest Programme has been renamed the IUCN Forest Conservation Programme, following the 1990 IUCN General Assembly. The series of publications produced through the Programme has also been renamed, and this title and those listed below are the first in the new series. All titles already published or in preparation under the IUCN Tropical Forest Programme series are listed on the inside back cover.

1. Rainforest Buffer Zones
   Guidelines for Protected Area Management
   JEFFREY SAYER

2. The Management of Tropical Moist Forest Lands
   Ecological Guidelines
   Second Edition
   DUNCAN POORE and JEFFREY SAYER

Series editors: Jeffrey Sayer, Jill Blockhus and Morag White

Published by IUCN with the financial support of WWF-International

This book is part of
THE IUCN CONSERVATION LIBRARY

For a free copy of the complete catalogue please write to:
IUCN Publications Services Unit,
219c Huntingdon Road, Cambridge, CB3 0DL, UK
or
IUCN Communications Division
Avenue du Mont-Blanc, CH-1196 Gland, Switzerland