

MULTIPLE-USE FOREST VALUES, SILVICULTURAL IMPACTS OF TIMBER
MANAGEMENT, AND SUSTAINABILITY OF FOREST MANAGEMENT IN
UGANDA'S BUDONGO AND MABIRA FOREST RESERVES

by

Peter Ndemere

A dissertation
submitted in partial fulfillment of the
requirements for the
Doctor of Philosophy Degree

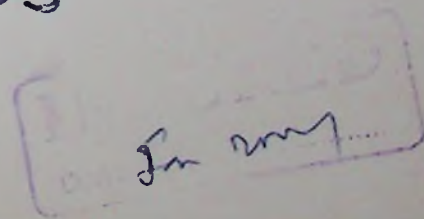
State University of New York
College of Environmental Science and Forestry
Syracuse, New York

August, 1997

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Abstract

NDEMERE, Peter. Multiple-use Forest Values, Silvicultural Impacts of Timber Management, and Sustainability of Forest Management in Uganda's Budongo and Mabira Forest Reserves. Typed and bound Ph.D. dissertation, 238 pages, 9 tables, 17 figures, August, 1997.

This study examined multiple-use values, silvicultural impacts of timber management, and the sustainability of forest management in two of Uganda's most important tropical forest reserves. Field data for the study was collected between June and December of 1995.

Multiple-use forest values consisting of six major tropical forest outputs were evaluated in a total of five timber management and two unlogged nature reserve compartments in the two forests, taking into consideration the relative importance of the outputs expressed as weights assigned by three groups of forestry professionals.

A comparison of the multiple-use values of the two forests indicated that timber management compartments which were treated with arboricide or charcoal refining and enrichment planting after logging had higher summed scores of assigned forest output weights x compartment output magnitudes than those which were only treated with arboricide or selectively logged without any amelioration. Unlogged and untreated nature reserve compartments had the lowest summed scores.

Silvicultural impacts of the five timber management prescriptions were examined by evaluating and comparing tree genera richness, evenness, and structure of timber management and unlogged nature reserve compartments in the two forests. The evaluation indicated that while there were significant differences in tree genera richness between most compartments, there was no evidence to support the commonly held view that nature reserve compartments had higher tree genera richness and evenness than timber management ones. The data revealed that tree genera diversity of timber management compartments was similar to or higher than that of nature reserve compartments. There were no major differences in forest structure between all the compartments studied in either forest.

An assessment of the sustainability of management of the two forests, based on International Tropical Timber Organization criteria, indicated that the current forest management regime for the two forests is potentially sustainable mainly due to the presence of a sizable professional staff with substantial management experience, and a legally secure forest estate. Forest management constraints included poor financing, political interference, a high growth rate of a population dependent on subsistence agriculture, widespread illegal activities, and limited investment in supplementary forest production projects such as agroforestry and expansion of industrial plantations.

Key words: Tropical forest management, multiple-use forest values, sustainable management

Author's name in full: Peter Ndemere

Candidate for the degree of: Doctor of Philosophy

Date: August, 1997

Major Professor: Dr. Norman Richards

Faculty: Forestry

State University of New York, College of Environmental Science and Forestry,
Syracuse, New York

Chapter 1. INTRODUCTION

1.1 Background

1.1.1 Importance of Uganda's tropical forests

Tropical forests play a very important role in Uganda's economy. Until the early 1990s when circular sawmill technology was re-introduced in the country to process plantation species, about 90% of all timber supplies for the domestic and export markets have been produced from the tropical forests since the early 1970s (Carvalho and Plumptre, 1991).

Besides timber supplies, recent estimates of Uganda's energy consumption indicate a 96% dependence on wood fuels, equivalent to 18.3 million m³ of round wood per annum (World Bank, 1986), a significant part of which is derived from tropical forests. Tropical forests also contribute to agriculture through amelioration of microclimate, water catchment, and prevention of soil erosion; in addition to creation of jobs in forestry activities, maintenance of a rich biodiversity and a growing ecotourism industry. Some of the forests are also a home to Pygmy communities.

Uganda's forests cover a total area of approximately 35,000 km² (8% of total land area), of which 43% are under gazetted government ownership and management. Of the government owned forests about 40% is tropical high forest, 10% is montane catchment forest, 48% is savanna woodland, while the remaining 2% consists of industrial plantations and smaller wood lots of mainly *Comifer* and *Eucalyptus* species (Aluma, 1987; Kamugisha and Comelia, 1996). Little tropical

high forest remains outside government forest reserves under private ownership and on public land (Struhsaker, 1987).

The forest reserves are managed by the Forest Department, an agency in the Ministry of Natural Resources, which has since the early 1930s efficiently managed a well protected forest estate, despite problems of encroachment by farmers and widespread timber poaching of the past two decades. Much of this estate was under formal working plans with timber management being the dominant management objective and its exploitation controlled on a sustained yield basis (Howard, 1991). However, one of the more recent forest management developments is a policy shift towards multiple-use forest management emphasizing non-timber values, whereby forest reserves are to be partitioned into protected nature reserves, buffer zones, and a reduced area for intensive timber management.

1.1.2 Development of tropical forest management in Uganda

Tropical forest reserves were established early this century by the British colonial government for multiple-use (Philip, 1962) although timber exploitation has been the dominant use up to the present time. Large scale industrial timber exploitation and systematic management commenced in the early 1930s in Budongo Forest and by 1944 in the central forest reserves of which Mabira Forest is a part (Karani, 1989).

The initial management plans prescribed a salvage felling cycle of 70 years to remove senescent stock followed by a 30 year felling cycle, with an assumed

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The initial management plans prescribed a salvage felling cycle of 70 years to remove senescent stock followed by a 30 year felling cycle, with an assumed

rotation of 100 years. On further consideration, the advantages of uniform crops with monocyclic felling were recognized during the early 1950s (Dawkins, 1958). The management policy was therefore changed to conversion of the forests to monocyclic working starting with a salvage cycle of 40 to 50 years followed by conversion to a 70 to 80 year rotation uniform system.

Several pre-harvest silvicultural treatments were carried out mainly to eliminate non-commercial tree species and deformed stems using arboricides followed by further treatment by enrichment planting and/or charcoal refining after the salvage cycle, on an experimental basis (Karani, 1989). With the completion of the salvage fellings during the current decade, there is an urgent need to evaluate the silvicultural impacts of timber management on the forests and to determine their multiple-use values and sustainability of their management in order to realize the diverse current forest policy objectives.

Like in many other tropical countries, natural forest management in Uganda has recently become a controversial issue due to concerns about increasing deforestation and environmental degradation in the country. The 1992 Uganda National Environmental Action Plan and FAO publications reported estimated annual deforestation rates of 500 km² and 650 km², respectively (NEAP, 1992). If this rate were to continue unabated, most of the country's forests would be lost within less than a century (Banana and Gombya, 1996).

As with other sectors of the economy, a sharp decline occurred in the operations of the forestry sector starting in 1974 when wood-based industries were expropriated after expulsion of their foreign owners by President Idi Amin. The

political instability which characterized this period stalled the work of the Forest Department and its research branch, as there were limited financial and material resources available to effectively manage the forests. These problems resulted in widespread illegal encroachment by agriculture and timber poaching in the forest reserves (Howard, 1991).

Since late 1980s, however, there have been concerted efforts by government and donors to rehabilitate the forestry sector. One of the major elements of the rehabilitation program was to revise the Forest Policy to re-emphasize sustainable multiple-use forestry, with the following main aims: (1) to maintain and safeguard enough forest land to ensure the long term supply of forest products for the domestic and possibly for export markets; (2) to manage the estate so as to optimize economic, social and environmental values; and (3) to promote a wider understanding of the benefits of forests and trees among the population (Forest Department, 1990).

In spite of the good intentions of the forest policy, Uganda's current population estimated to be 20.1 million people, growing at an annual rate of 2.2% (World Factbook, 1997), and the corresponding demand for forest products by a fast expanding economy with annual GDP growth averaging 7% since 1986 (Ministry of Finance, 1996), will soon severely restrict areas likely to be set aside and retained as strictly protected forest reserves. There is also considerable concern and some skepticism about the sustainability of the current tropical forest management regime, especially in regard to the pre- and post-exploitation timber management silvicultural treatments that have been applied since the early 1930s

and their presumed adverse effects upon the fauna and floristic composition of the forests (NARO, 1991; Struhsaker, 1997).

These environmental concerns have already prompted a government decision to set aside 20% of the tropical forest reserves as strictly protected nature reserves, and a further 30% as buffer zones where only limited timber exploitation will be allowed, leaving 50% for timber management (Forest Department, 1990). In a related development, 300,000 ha of tropical forests have been re-designated to National Parks status which precludes forest products extraction. This has instantly taken about 60% of the forest reserves out of timber production, leaving only 600,000 ha available for timber management (Kamugisha and Comelia, 1996). The forestry sector has never before experienced pressures of comparable magnitude and at stake are environmental stability and the livelihoods of the majority of Ugandans who predominantly depend on an economy based on a forest/agriculture life support system.

1.1.3 Sustainability of tropical forest management

Despite the skepticism about current tropical forest management, recent studies have indicated that sustainable tropical forest management is technically possible and that well managed production forests retain most of the biodiversity of primary forests, both in terms of numbers and diversity of species they support (Barbier, 1995; Hartshorn, 1990; Kemp et al., 1993; Johnson and Cabarle, 1993). The main contentious issue therefore, is not whether sustainable forest management is possible but how human demands on the forests can be

reconciled with biological possibilities in specific socio-economic environments, as has been observed by Kemp et al. (1993).

Sustainable forest management implies keeping human uses of forests at a level compatible with maintenance of ecological processes that sustain them. Even if timber production is the primary management objective, sustaining some level of environmental services and biological diversity should be part of the package, along with maintaining the capacity of the forests to meet diverse human needs, besides those for employment and wood products (Johnson and Cabarle, 1993). Also, due to forest clearance and fragmentation, conservation of biodiversity of tropical forests in future will increasingly mean conservation in managed forests (Boyle and Sayer, 1995).

In order to conserve Uganda's tropical forests for present and future generations, current forest management policy makers and planners ought to be concerned with finding an acceptable balance among the various intensities of forest land use, ranging from strict nature reserves at the forest reserve core, to agroforestry practices (including plantation monocultures) outside of forest reserves, with timber management buffer forest linking the two "extremes" of land use. Effective and sustainable forest management will therefore, require improved understanding of the multiple-use values of forests, the impacts of forest management and utilization on both the biological forest resource and on the livelihoods of local communities, and the overall sustainability of forest resources management. Unfortunately, such information is not readily available in Uganda.

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This study was therefore aimed at contributing to current initiatives for providing some of the above information so as to enable forest resource policy makers and planners to prescribe effective management strategies for achieving current sustainable multiple-use forestry objectives.

1.2 Objectives of the study

The overall objective of this study was to assess the extent to which forest management for timber production enhances long-term ecological functions of tropical forests, while providing socio-economic needs of Uganda's industries and local communities. The assessment was based on Bodongo and Mabira case study tropical forests which are Uganda's most ecologically and socio-economically important tropical forests. Specific study objectives were to:

- (i) appraise and compare multiple-use values of two case study tropical forests as represented in constituent timber management and unlogged nature reserve compartments (management units), given the relative importance of the multiple-use values to major stake holders;
- (ii) evaluate the silvicultural impacts of major timber management prescriptions on the case study forests;
- (iii) assess the sustainability of forest management of the two case study forests.

1.3 Research approach and scope

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The above objectives were mainly achieved by a review of available literature and analysis of field data collected in the two case study forests from June to December of 1995. Budongo and Mabira forests are representative of the five principal tropical forest timber management silvicultural prescriptions that have been applied in Uganda since the early 1930s, and also represent the country's two major tropical forest communities located in the rural western Rift Valley area and the central peri-urban Lake Victoria shore region, respectively.

The research methodology of the study involved use of the multiple-use value criteria summation appraisal decision matrix method (Canham, 1990) to evaluate six major tropical forest (management) value criteria (hereafter called valuation criteria consisting of forest outputs) as represented in management units (compartments) given their relative importance (expressed as weights ranging from -10 to +10, with negative weights expressing costs or undesirable outputs) to 3 groups of 31 forestry professionals consisting of: central administrators; field-based staff; and research and teaching staff, who were present at the time of data collection. The valuation criteria consisted of: commercial timber/charcoal-wood production; local job creation; non-timber/charcoal-wood products for local communities; wildlife habitat maintenance; biodiversity conservation; and forest road construction.

The multiple-use value appraisal was followed by a silvicultural stand diagnosis in order to determine the silvicultural impacts of various timber management prescriptions on the case study forests, measured by important



stand parameters consisting of: tree genera (with stems ≥ 10 cm DBH) richness, evenness, dominance, and regeneration. Finally, an assessment of the sustainability of management of the two case study forests was made based on seven International Tropical Timber Organization (1992) criteria which consisted of: resource security; the continuity of timber production; the continuity of non-timber products; conservation of flora and fauna; level of environmental impact; socioeconomic benefits; and level of planning and adjustment to experience.

As mentioned earlier, various sources were used to obtain information for this study. In general, these sources belong to one of four categories:

(i) Empirical field data. Most of the data used in the appraisal of multiple-use forest values and evaluation of impacts of timber management on forest composition and structure was collected in the case study forests during the summer of 1995. The data consisted mostly of information on multiple-use value appraisal criteria (major forest outputs) magnitudes and silvicultural stand parameters.

(ii) Unpublished government / project reports. The information on forest management prescriptions, employment opportunities, and on indicators of criteria for measurement of sustainability of forest management was obtained from unpublished government documents, maps, and project reports prepared by various Uganda government resource management agencies.

(iii) Personal communication and office files. Some forest management information could not be obtained from sources already mentioned above and was provided at my request by the staff of Makerere University, the Forest Department

and the Forestry Research Institute at their head offices in Kampala and field stations located in or near the forests.

(iv) Published sources. These were used where relevant, especially in dealing with the theoretical aspects of this study.

The study is organized in two parts. The first part which gives a coverage of a literature survey consists of chapters 2 and 3 which deal with the theoretical and practical aspects of sustainable multiple-use management as they apply to tropical forests, and a review and analysis of the history of Uganda's tropical forest management and utilization since the pre-colonial era at the turn of the 19th century to the present time, respectively. The second part of the study covers two chapters which describe the research methodology and present results and discussion of the appraisal and comparison of multiple-use values and an evaluation of the silvicultural impacts of timber management (chapter 4), and assessment of sustainability of forest management (chapter 5) of the two case study forests. At the end of the second part is chapter 6 which consists of a summary of the major findings of the study, conclusions, and recommendations for further work.

1.4 Limitations of the study

This study involves comparisons of various timber management compartments in which different silvicultural prescriptions in form of timber harvesting and ameliorative treatments were applied. Because the treatments were not replicated it was not possible to precisely control the various sources of variation between treatment areas due to limited degrees of freedom. Even if the

treatments had actually been replicated, it would still be difficult to provide exactly reproducible experimental plots in a tropical forest due to high species variability.

Secondly, due to inadequate historical information on forest stand characteristics, treatment effects could only be assessed by comparison between treated compartments and untreated nature reserve compartments, and not by comparisons of characteristics of a particular stand or compartment before and after treatment. This gave rise to the problem of making inferences about treatment effects from different areas treated in different ways, as has already been observed by Synnott (1980).

The above problems were further complicated by the limited Forest Department characterization of silvicultural treatments which were defined in broad operational terms, without precise description or measurement of the original stand parameters. The effects of logging, amelioration, and timber poaching on species diversity and basal area for each tree size group confound with the initial variability of the forest, a situation that would not be entirely overcome by replication or more careful field instructions for silvicultural treatments (Synnott, 1980). An attempt was, therefore, made to minimize variation between case study compartments by taking samples from well drained forested sites (excluding swamp forest and encroached areas) and where possible from adjacent compartments.

Thirdly, in the appraisal of multiple-use forest values, it was not possible to use all known forest outputs valuation criteria or to measure in quantitative terms some of the valuation criteria used due to the limited time and financial resources available for this study. There were also problems with finding appropriate

measurement techniques and/or data for appraising values like recreation and forest ecosystem services such as water yield and amelioration of microclimate.

In spite of the above limitations, an attempt was made to obtain the most reliable data available. The importance of the contribution of tropical forests to Uganda's socio-economic development would seem to justify even such a limited approach of this study. The overall value of the study, therefore, lies mostly in the development of a methodological framework for addressing some of the problems pertaining to sustainable multiple-use tropical forest management and its general implications for current and future forest management policy and planning in Uganda.

and increasing to high intensity management by the early 1960s, with much greater physical disruption. As forest resource management agencies were gradually set up throughout the tropics, the main emphasis was on demarcating and protecting "permanent forest reserves". At this time the objective (of mainly colonial governments) was to maintain forest cover on environmentally sensitive areas and to ensure supplies of forest products, especially timber (Hamilton, 1984; Sayer, 1991). In most tropical countries such as Uganda, forest reserves were established in which the extraction of timber and non-wood products was allowed on condition that permanent forest cover was maintained (Howard, 1991).

The forest management environment started to change radically with the technical advances of the Second World War. Heavy duty tracked vehicles became widely available for logging and road construction and power saws gained wide use. The industrial growth after the war demanded wood products which created high demand for tropical timber as timber from temperate sources was in short supply and also expensive as investments in forest management in the temperate region created a significant price differential (Sayer, 1991).

Improved availability of modern medicines, health care and food gave rise to an increase in population especially in the tropical region. This population growth generated increased demand for resources such as permanent agricultural land which gave rise to deforestation. In Uganda, for instance, there are indications that if it were not for extensive disturbance by subsistence farming, about 20% of the country's land would be covered by closed forest (Langdale-Brown, 1960; Hamilton, 1984).

As deforestation intensified, forest management agencies found themselves unprepared for the dramatic increase in pressure on tropical forest resources and forest legislation enacted in days when pressures were less proved inadequate, inappropriate and unenforceable in the changed circumstances (Sayer, 1991). The transition to independence which was followed by political turmoil and the economic decline did not help the already declining resource situation in many tropical countries.

Powerful industrial logging interests found it easy to circumvent or even ignore forest management plans and the increasing rural people on the brink of subsistence could hardly be denied access to the only unoccupied lands available. Corruption and ill-advised land allocations by government officials, both in resource management and politics also added to the problems that led to unprecedented tropical forest degradation, clearance and fragmentation, especially during the period from 1950 to 1990 (Sayer, 1991). Given this situation, the need for sustainable tropical forest management to reverse the current trend cannot be overemphasized.

2.3 Principles and aims of sustainable forest management

Sustaining the productivity of the earth's natural resources will be one of the most critical issues of the next century (Hart and Sands, 1990). The development of more sustainable land use systems can no longer be seen as an abstract academic subject but as an urgent need that has to be addressed today if provision of food, fuel, fiber and fodder for present and future generations is to be

ensured (Hart and Sands, 1990), One of the ways of achieving this goal is through sustainable forest management (World Resources Institute, 1989, Kemp et al., 1993). Forest management encompasses enterprise and resource husbandry. As an enterprise, forest management involves mobilization of human, financial and material resources to achieve chosen objectives relating to the forest. The technical elements of silviculture, inventory and harvesting are ways of achieving some of these objectives of sustainable management (Synnott, 1980).

Although "sustainable forest management" is often referred to in forest science literature, there is no general agreement on its meaning. Few forestry experts define sustainability in terms of natural forest management (Johnson and Cabalre, 1993). Instead emphasis is usually placed on a continuous yield of timber (e.g. Hartshorn, 1990; Keto et al., 1990; Smithsonian, 1990; Schmidt, 1987), while some cite the maintenance of other forest values, such as biodiversity and ecological functions but without specifying what is to be sustained (e.g. Perl et al., 1991; Goodland et al., 1990; Wyat-Smith, 1987).

The International Tropical Timber Organization (ITTO), has come up with a more comprehensive definition linked to operational criteria in the field. According to ITTO (1992), sustainable forest management is defined as:

"...the process of managing permanent forest land to achieve one or more clearly specified objectives of management, with regard to the production of a continuous flow of desired forest products and services, without undue reduction of its inherent values and future productivity and without undue undesirable effects on the physical and social environment".

Despite the lack of a generally accepted definition for sustainable forest management most of its proponents agree that action must be taken to develop land use systems that are both economically viable in the short run yet not environmentally degrading in the long run; which in essence implies maintenance of resource productivity (Hart and Sands, 1990). Hence, sustainable forest management objectives imply the need to maintain forest production at levels that do not exceed resource productivity.

Successful regeneration and conservation of biodiversity are usually cited as good criteria of viable ecosystems and therefore sustainable management (Sayer, 1991, Poore et al 1989). Biological diversity also ensures the stability and resilience of ecosystems in the face of changing environments such as those caused by global warming (Sayer, 1991). By definition, tropical forest management should keep human uses of the forests at a level compatible with the maintenance of the ecological processes that sustain them (Johnson and Cabarle, 1993).

Sustainable forest management is therefore, dynamic and not necessarily a single management practice. It may include a spectrum of management systems, ranging from passive protection to use of synthetic inputs like fertilizers and prudent use of pesticides to control diseases and weeds (Hart and Sands, 1990). Sustainable forest management of tropical forests is a goal, justified by continued demand, but not a rigid target. It is flexible and should relate to specific local objectives, practices and resources (Johnson and Cabarle, 1993); Palmer and Synnot, 1992).

Palmer and Synnott (1992) have identified some of the principal conditions necessary for sustainable forest management to include: long-term security of operation and tenure, operational control, a suitable financial environment, and adequate information; while Jordan (1985) has emphasized maintenance of structural diversity of stands, minimizing soil disturbance, maintaining soil organic matter, and control over the size and shape of disturbed management areas. The ITTO (1992) has also prepared a set of criteria and indicators of sustainability of tropical forest management which have been used in this study to assess the sustainability of tropical forest management in Uganda. The criteria consist of: resource security, continuity of timber and non-timber products, conservation of biodiversity, level of environmental impact, socioeconomic benefits, and planning and adjustment to experience.

2.4 Theory and practice of multiple use forest management

2.4.1 Evolution of multiple-use forest management

The use and management of forests has changed through the centuries. During classical antiquity, the sanctity of the forests was a result of an awareness of the benefits of forests and the knowledge about useful resources available to society from the forests (Sponsel et al., 1996). This development began with the period of unplanned multiple-use of the forests by native forest dwellers for food and other basic needs. With the development of agriculture, forest use changed to more organized management for production of mainly range and wood for timber and fuel as commodities in the developed world (Steen, 1976; Kreuschmer, 1961).

In the developing countries of the tropical region, most of the remaining closed forests are on reserved public land and are mainly managed for timber although local people still depend on them for some basic needs like food, fuel, and shelter (Poore et al., 1989).

In the US where the practice of multiple-use forest management has a long history (Barongan, 1983) it was not until the 1930s that advocates of wildlife began to consider forests as habitats for wildlife rather than as commodities (Reiger, 1975). But it was not until after World War II that the concept of multiple-use received much attention outside the Forest Service (Clary, 1986). Prior to the 1950s Forest Service planning was relatively uncomplicated because the management of timber, range, and non-commodity resources seldom interfered or conflicted with each other. Recreation and wilderness uses were not yet controversial as there was little pressure to reconcile them with other national forest uses (Wilkinson and Anderson, 1987).

For a long time, forest management for timber production has been the single dominant objective of forest ownership and reservation (Cubbage et al., 1993). This has largely been because timber is often used to generate income for financing forest ownership and to support other uses for which a financial value is more difficult to assess or administer. Also since trees are the dominant ecological component of the forest ecosystems, the value of non-timber resources can often be enhanced by judicious manipulation of the timber component. Although society still ascribes high monetary value to timber resources, intangible values have increasingly become important forest resources (Hays, 1987; Rid, 1965). Besides,

in certain situations the values of other resources far outweigh the value of timber and there are many sites such as low productivity or inaccessible sites on which the pursuit of timber production is not an economical undertaking (Poore et al., 1989).

However, contemporary forestry on public and private lands increasingly appreciates the need to provide for the multiple-resource values that characterize forest ecosystems (Cubbage et al., 1983). The choice between dominant use or multiple-use management depends on many factors that include the unique attributes of the ecosystem itself which determines both the availability of specific resources and the degree to which management can develop the resources for economic use.

The methods by which management is planned and administered affect economic efficiency of resource utilization. The objectives of the owner of the forest land, whether an individual or society, are another determinant factor. It is the owner who has the ultimate decision making authority regarding the choice and pattern of resource management, if any, that are implemented by the forest manager (Clawson, 1975; Davis, 1969). As the world human population and standards of living increase, demand for a diverse array of forest resources also increases while the area of commercial forestry land declines into the next century, particularly in developing countries (FAO, 1974).

Forest management is the process of organizing forest ecosystems so that they produce a continuous flow of whatever resources are desired from that forest, whether they be timber, wildlife, aesthetic experience, or any other resource or

combination of resources of the forest (Davis, 1969). The resources are made valuable by their desirability to society. Fundamental economic concepts such as supply and demand, and non-economic considerations such as concern for endangered species and for maintaining environmental quality, play a role in determining their value (Gregory, 1987).

Nearly every practice that a forester uses to manage a particular resource also affects other resources in the forest; and the more resources that are derived from a given forest area, the greater is the likelihood that the management and use of one desirable resource will affect another (Clawson, 1975). The multiple uses of the same forest area makes forest management a complex task of ensuring resource sustainability. However, there is often a fine line between outright careless exploitation of a resource and conservation based use that ensures resource renewability (Cubbage et al., 1983).

2.4.2 Main concepts and definition of multiple-use forest management

Forest resource management is aimed at optimizing the supply of ecosystem-based resources relative to their demand and striving to minimize the inherent multiple-use value conflicts (Behan, 1981; Convery, 1980). Management is typically implemented by means of forest management plans that identify the objectives of the landowner, outline prescriptions required to manage the forest, and describe a program of resource evaluation to ensure that ownership objectives for the forest are attained. Generally, the greater the number of resources that are desired from a particular forest, the more comprehensive will be the management

plans and the greater the number of owners of a particular forest, the more difficult it will be to identify ownership objectives and to express them in terms of the many resources in the forest (Cubbage et al., 1983; Zivnuska, 1961).

Multiple-use forest management is therefore a difficult notion to define, let alone administer (Award, 1986; Barber, 1984). While foresters around the world understand multiple-use as a concept, they have faced difficulties when it comes to implementing it in a management scheme. In the US where multiple-use management by the Forest Service evolved from legislative intent and the need to broaden support for forestry (Clary, 1986), the difficulty in defining it has led to some people like Clawson (1975) calling it a slogan, while others have described it as a somewhat implausible doctrine that requires land managers to juggle hunting, fishing, timber production, grazing, mineral development, watershed protection, wildlife preservation, and recreation on the same lands (Beck et al., 1983).

Nevertheless, the phrase multiple-use has been a powerful symbol in forestry for many decades (Shands, 1988; Glascock, 1972). Like other effective symbols, the phrase has many meanings and is encountered in legal statutes, economics, political dialogs, public policy, and resource management, where the meaning of "multiple-use" depends on which of these contexts are being discussed (Bowes and Krutilla, 1989; Leisz, 1980). In land-use controversies, for instance, proponents of wilderness as well as of tree farms have both called on the symbol of multiple-use in support of their advocacy because the symbol has at least some validity in describing aspects of these disparate forms of forest management and

because its use has demonstrable power to convey political legitimacy (Wondolleck, 1988).

Numerous attempts to define exactly what multiple-use is have been made over the last half century without producing general agreement (e.g. Alward, 1986; Coggins, 1982; Worrel, 1970; hall, 1863; Zivnуска, 1961). Despite its ambiguity, multiple-use forest management has obvious appeal as it suggests something generally held to be central to wise use of forest resources.

2.4.3 Multiple-use interactions

Multiple-use forestry is philosophy of resource utilization that provides a theoretical basis for developing qualitative and quantitative predictions of resource interrelationships (Connaughton, 1962). In the abstract sense, there are an infinite variety of resources in forests with both use and non-use values (See Fig. 2.1).

This multiplicity of resources available in forests and the multiplicity of their uses reveal the challenge to modern forest management in regard to choosing which resources should be used and in giving society access to them. In the practical sense, however, the forestry profession recognizes a broad categorization of the variety of resources. Convenient and commonly accepted categories can be found in forest policy statements and legislation relating to forests (Cubbage et al., 1983). In most cases they include timber, fuelwood, range, watershed, and wildlife and fisheries, collectively known as multiple-uses (Clawson, 1975). In Uganda, major multiple-use values of tropical forests consist of mainly direct use and option value resource categories.

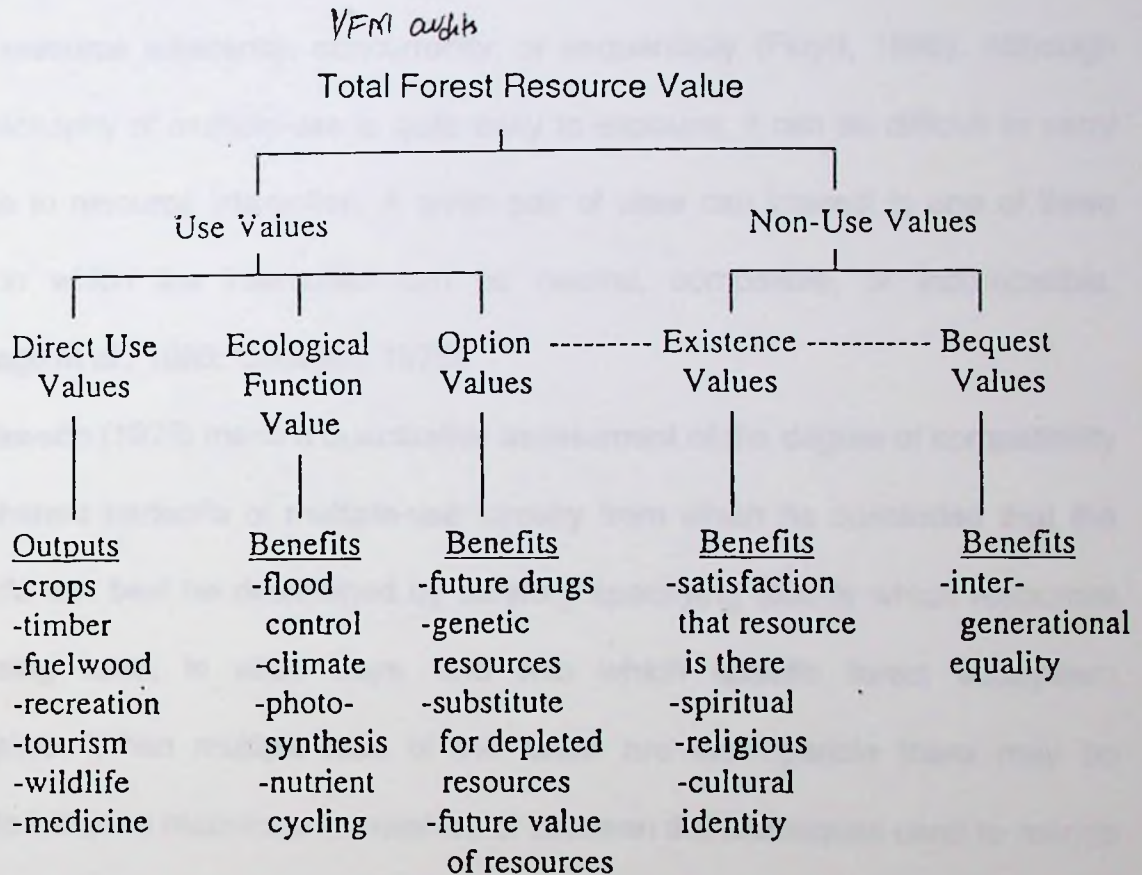


Fig. 2.1 Multiple-resource values of forests (After Young, 1992).

The degree to which forest lands are managed for any of these multiple-uses depends on the goals of ownership. The concept of multiple-use implies that on any given acre of forest land, the opportunity exists to utilize more than one forest resource adjacently, concurrently, or sequentially (Floyd, 1996). Although the philosophy of multiple-use is quite easy to espouse, it can be difficult to carry out due to resource interaction. A given pair of uses can interact in one of three ways in which the interaction can be neutral, compatible, or incompatible. (Cubbage et al., 1983; Clawson, 1975).

Clawson (1975) made a quantitative assessment of the degree of compatibility and inherent tradeoffs of multiple-use forestry from which he concluded that the tradeoffs can best be determined by carefully specifying exactly which resources are being used, in what ways, and with which specific forest ecosystem constraints. When multiple-uses of the forest are incompatible there may be conflicts between resources themselves or between the techniques used to manage them. In the former case, it may be necessary to separate directly conflicting resources either in space, allocating each resource to different areas, or in time by allocating each resource to a given area in different seasons, years, or decades. In Uganda, for instance, a forest zoning model has been adopted in order to resolve conflicts between wood production and nature conservation in tropical forest reserves (See Fig. 2.2).

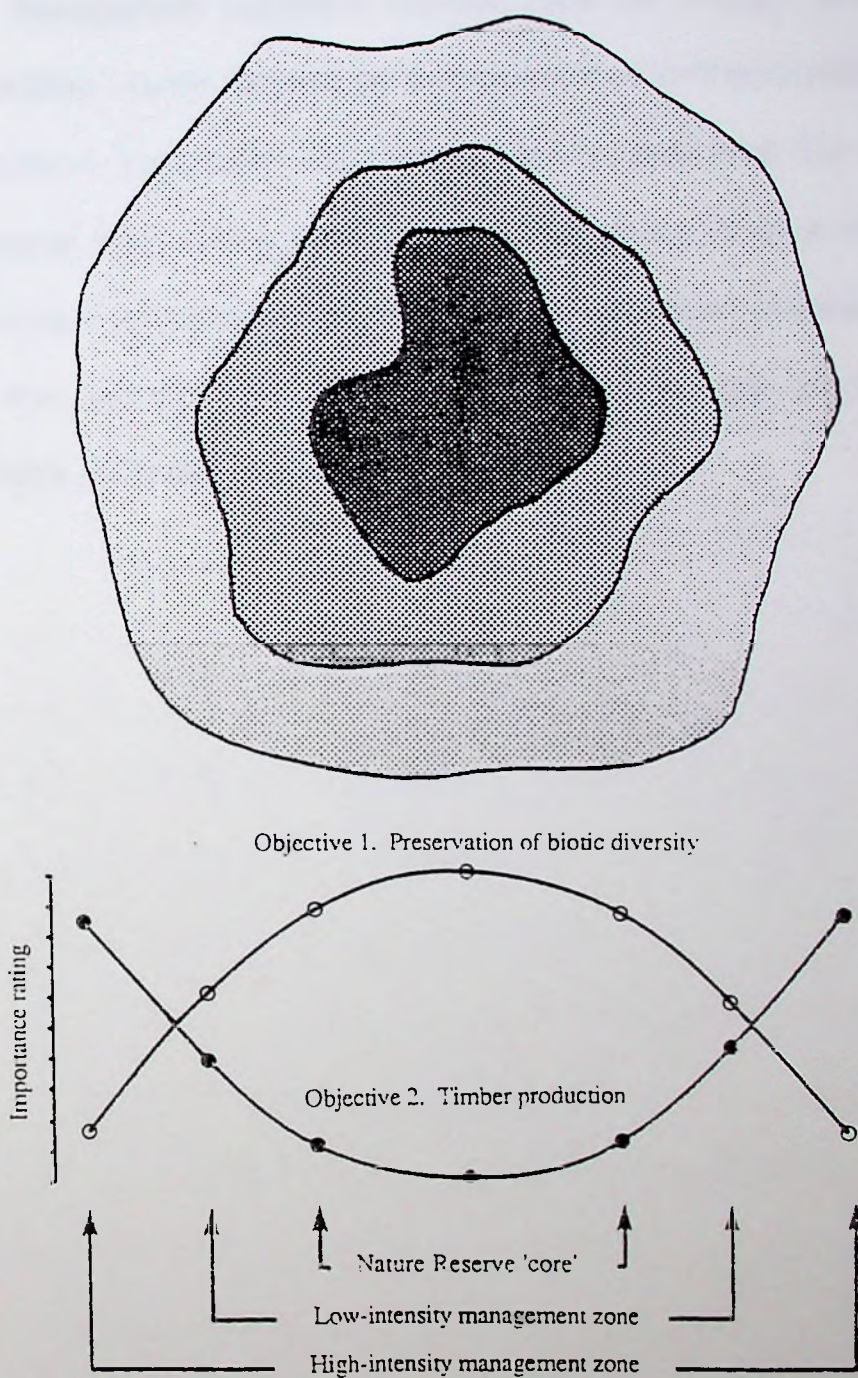


Fig. 2.2 A model of a forest reserve with a totally protected core area surrounded by concentric zones in which management intensity becomes progressively more intensive towards the forest boundary (After Harris, 1984).

Management technique conflicts may be brought about by the precise guidelines usually required for management of individual resources. Under these conditions, the conflict may be resolved by evaluating the range of alternative practices that can be used for the management of each resource. The forest manager may choose to refine or modify techniques to create compatibility or to partition resource uses either spatially or temporally to avoid resources use conflicts (Cubbage et al., 1983).

Lake Victoria, and is bordered by Zaire in the west, Kenya in the east, the Sudan in the north, and Rwanda and Tanzania in the south (See Fig. 3.1).

The central part of the country is characterized by gentle topography of flat-topped hills and broad, often swampy, valleys lying at an elevation of 1,000 m to 1,500 m above sea level. In the west, is to be found more spectacular scenery dominated by the Rift Valley and its associated mountains and lakes. In the east, the border follows a line of raised landscape associated with larger Miocene volcanic Mountains Elgon, Kadam and Moroto.

Most of Uganda lies on very ancient sandy clay, loamy soils (Ferralitic). These are reasonably fertile, although they represent one of the final stages in tropical weathering with little reserves of weatherable minerals. Few patches of better soils (Eutrophic) with higher weatherable minerals are associated with the more recent land forms along the western Rift Valley and the volcanoes of the eastern border areas (Lands and Surveys Department, 1967).

The climate of Uganda is diverse, influenced by the country's latitudinal position between 1°S and 4°N, and by varied elevation and topography. Seasonal movements of the Inter-Tropical Convergence Zone (ITCZ) determine the general rainfall pattern, with rainy seasons during April - May and October - November around the Equator, and 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 northeast with less than 750 mm and the wettest being the high mountains and islands on Lake Victoria which receive over 2,000 mm per annum (Lands and Surveys Department, 1967).

Mean annual temperatures are influenced by elevation, the warmest (above 30°C) areas lying in the Rift Valley and the coolest (below 10°C) being the highlands of the southwest and eastern parts of the country. Climatic conditions favorable for the formation of tropical forests are found in parts of the southern half of the country where rainfall exceeds 1,500 mm per year and is evenly distributed throughout the year, and on mountains in the northeast where the low temperatures at high elevation moderate water loss during the long dry season (Hamilton, 1984).

Uganda is ecologically very diverse. This is largely due to its location in the eastern part of central Africa, in a zone of overlap between ecological communities characteristic of the dry East African savanna, and those of the West African rain forests. Seven of Africa's 18 Plant Kingdoms are represented, more than in any other country on the continent (White, 1983). They encompass habitats as diverse as glacier-topped mountains, lowland rain forest, and dry deciduous *Acacia* woodland. In terms of species numbers, Uganda ranks among the top ten in Africa for all major groups (MacNeely et al., 1990; Stuart et al., 1990) and among the top ten in the world for mammals (Howard, 1995).

A very high proportion of the vegetation of Uganda has been modified by cutting, cultivation, burning, and grazing. As a result, it is difficult to discern the broad distribution of the original natural vegetation. Instead, in the wetter areas to the northwest of Lake Victoria and the western highlands there is a mosaic of forest and derived savanna communities. The mountains have suffered least deforestation to date and still support relatively large areas of natural or semi-

natural montane forest, high montane grassland and Afro-Alpine communities. Elsewhere, annual or biennial grass fires, coupled with traditional subsistence farming systems, have caused considerable changes in vegetation which is now more than 80% fire climax and of several seral communities (Langdale-Brown et al., 1964; Hamilton, 1984).

3.2.2 People, land use, and economy

According to the 1996 population estimates, Uganda's human population is 20.2 million with an annual growth rate of 2.24 percent (World Factbook, 1997). Population estimates of 1991 indicated an average population of 85 people per square kilometer with 89 percent of the population living rural areas, making Uganda to be the fourth most populated country in Africa and one of the least urbanized on the continent (World Resources Institute, 1991).

Agriculture is the main economic activity in Uganda accounting for about 60 percent of Gross Domestic Product (GDP) and more than 90 percent of exports, with coffee being the most important, followed by cotton, tea and tobacco (Hamilton, 1984; Howard, 1991). The majority of farmers are small holders living in scattered homesteads, of whom about 80% farm less than two hectares of land with very limited use of tractors and other inputs such as irrigation, fertilizers, and pesticides (World Bank, 1993).

A small number of farmers consisting mainly of foreign business interests own large plantations of coffee, tea and sugarcane. In spite of the country's over-dependence on agriculture, preliminary studies have indicated under-utilization of

agricultural land, with only about five million hectares of land presently under cultivation out of 17 million hectares considered potentially arable (Langlands, 1974, World Bank, 1993).

3.2.3 Distribution and extent of forest cover

Uganda's tropical forests occur in three distinct geographical zones where their formation is supported by favorable rainfall regimes. These zones lie along the eastern rim of the Rift Valley escarpment in the western part of the country; in a broad belt around the northwestern shores of Lake Victoria; and on scattered mountains in the eastern part of the country (See Fig. 3.1).

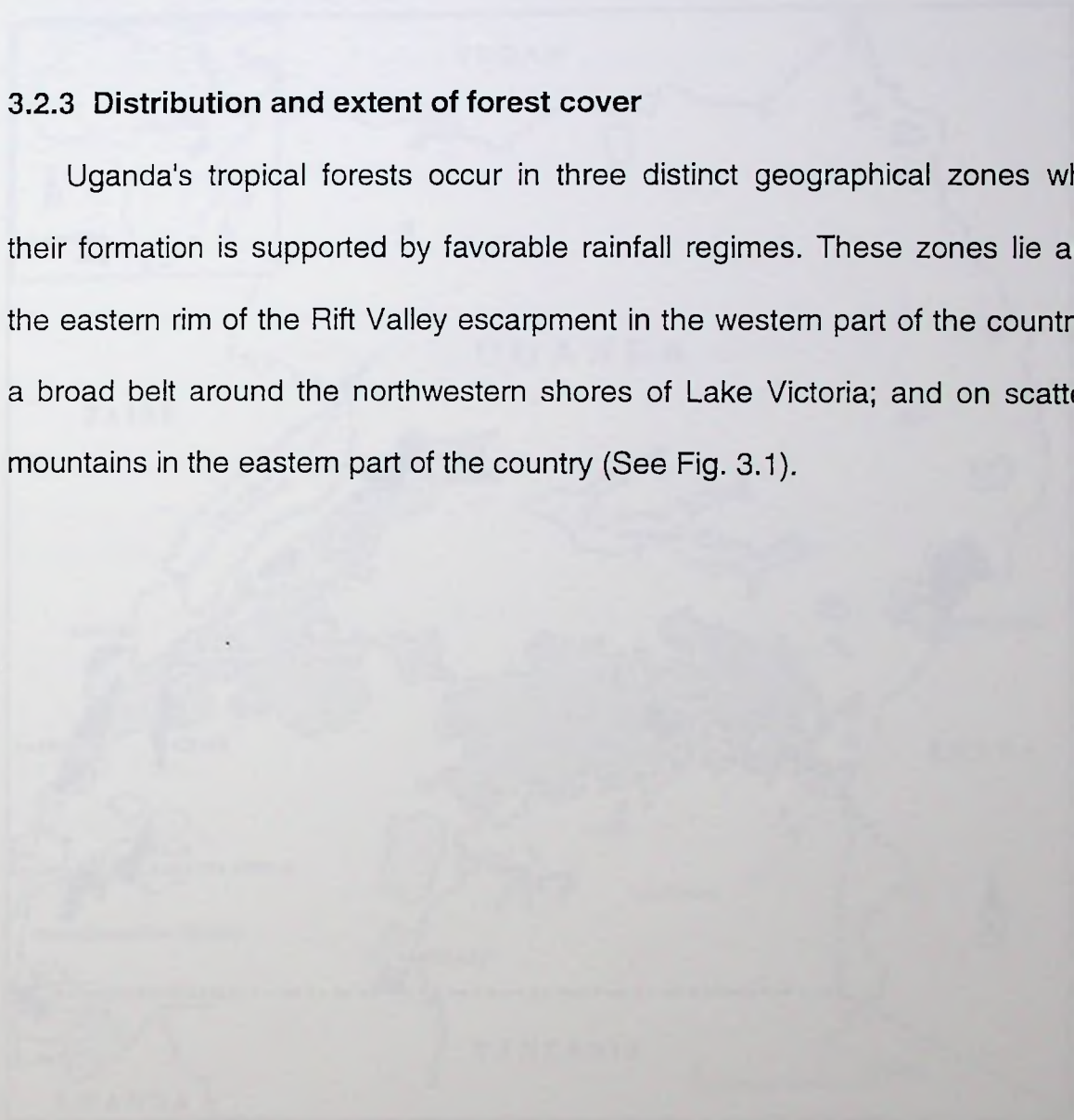


Fig. 3.1 Map of Uganda showing the distribution of the extensive forest cover. The forest cover is concentrated in the western part of the country, along the eastern rim of the Rift Valley escarpment, and in a broad belt around the northwestern shores of Lake Victoria. The forest cover is also scattered on mountains in the eastern part of the country.

About 20% of Uganda's land surface would probably be covered by closed forest had it not been for extensive disturbance by man during the last half century. Little forest area remains today covering about 35,000km² (a mere 8%) of Uganda's land surface, of which 43% is gazetted as protected forest reserves (Table 3.1).

Table 3.1. Gazetted Forest Reserves in Uganda (Aluma, 1987)

Forest Type	Area (km ²)
Savanna woodland	7,200
Tropical moist forest	5,900
Montane forest	1,500
Plantations	300
TOTAL	14,900

3.2.4 Forest types

Uganda's tropical forests vary considerably in structure and composition from one area to another. To a large extent these differences can be related to the elevation at which the various types occur, but climate, edaphic and historical factors are also important. Langdale-Brown et al. (1964) have classified the tropical moist forests into three broad forest types of which two occur in areas below 1500 m elevation:

(i) Medium elevation evergreen forest: This type occurs at 1060 m - 1500 m and is similar to lowland tropical rain forest, being structurally complex and rich in plant species including many epiphytes, lianas, and large trees with impressive buttressing; but differing on account of the greater elevation, lower temperature and rainfall characteristic of areas in which it occurs. Three sub-types are recognized, each being named after characteristic trees:

- *Piptadeniastrum-Uapaca* type on Lake Victoria Islands,
- *Piptadeniastrum-Albizia-Celtis* type of drier lake-shore forests, and
- *Parinari excelsa* type characteristic of forests at 1200 m - 1500 m along the western Rift Valley.

(ii) Medium elevation moist semi-deciduous forest: The distinction between this forest and the evergreen type is somewhat arbitrary, but serves to recognize 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 recognized with the first two being older and may represent later seral stages of the latter two:

- *Celtis-Chrysophyllum* forest characteristic of the drier areas north of L. Victoria;
- *Cynometra-Celtis* forest of lower altitude zones along the western Rift Valley;
- *Albizia-Chlorophora* forest areas to the north of Lake Victoria, and;
- *Albizia-Markhamia* forest occurring in the country's mid-west at 1200 m -1500 m.

(iii) **High elevation forest:** This type occurs in areas above 1500 m, and tends to be less species-rich than those found at lower altitudes, with a very broken and irregular canopy and trees of lower stature. There are four distinct types in this category depending on elevation and moisture availability:

- *Prunus* moist montane forest in the moist southwestern Uganda and Mt. Elgon;
- *Arundinaria* montane bamboo forest at 2300 m - 2700 m and/or;
- *Hagenia-Rapanea* forest zone of low trees above 2750 m, and;
- *Juniperus-Podocarpus* dry montane forest on the drier northern slopes of Mt. Elgon and the Karamoja mountains between 1500 m and 2700 m.

In addition to forest types associated with topographic and climatic factors, there is considerable local variation related to site factors such as past management activities, soil type, and drainage conditions. Many of the areas designated as forest reserves have a long history of human occupancy. A large proportion of forest has expanded considerably in areas that were abandoned early this century as a result of rinderpest, sleeping sickness or tribal strife, especially around Lake Victoria and along the western Rift Valley (Langdale-Brown et al., 1964; Hamilton, 1984).

Eggeling (1947) has described three main stages of the process of vegetation succession in Uganda by which grassland is overtaken by colonizing forest, which eventually gives rise to the mature climax type. The first stage involves the colonization of savanna by one or two types of colonizing forest, dominated by *Maesopsis eminii* on better soils or by an irregular mixture of species including *Olea Welwitschii*, *Sapium ellipticum* and *Phyllanthus discoideus* on poorer soils. This stage lasts for only one generation because the main constituent species will not regenerate under shade, and is replaced by a mixed forest rich in species of large trees including *Entandrophragma* and *Khaya* species (mahoganies) and *Cynometra alexandri* (ironwood). The mixed stage may last for several generations but tends to gradually be replaced by a climax type in which as much as three quarters of large trees are ironwood (*Cynometra alexandri*).

3.3 Pre-colonial Forest Utilization and Management History

3.3.1 First settlement of Uganda and indigenous forest utilization

By the time of the coming of Europeans in the mid 1800s, present day Uganda was settled by Bantu and Nilotic tribes who had migrated from West Africa and North Africa, respectively, several centuries earlier (Were and Wilson, 1970). Some of the most important themes that characterize the early pre-colonial era include the emergence of hunting and gathering societies, the subsequent development of food production, iron working and tool making, the rise of Kingdoms, and the movement towards centralized state formation.

Although details about this early pre-colonial period are sketchy and based largely on archeological findings and oral traditions, there is evidence that as early as the fourth century BC, African cultivators, hunter-gatherers, and herders lived in the dense rain forests that surround the Lake Victoria basin (Were and Wilson, 1970). Intensive shifting cultivation eventually cleared most of the forests which later grew back (Philip, 1962; Synnott, 1971). Epidemics of diseases affecting man or his domestic animals are known to have caused massive local depopulation allowing reforestation (Paterson, 1993). The considerable stretches of colonizing forest in central Uganda could also have been due to depopulation during the nineteenth and twentieth centuries as a result of tribal conflicts (Hamilton, 1984).

Archeological records suggest that cultivation started in Uganda between 300 and 400 BC (Phillipson, 1977) and was accompanied by the first appearance of iron implements, which must have facilitated forest clearance. Forest clearance is recorded in pollen diagrams from western Uganda (Livingstone, 1967) and in the central region around Lake Victoria (Kendall, 1967), although the dates of clearance are only approximations. The Bantu cultivators who inhabited the forests used iron technology to make weapons and farming tools. As the forests dwindled, the hunter-gatherers moved their homes to more remote mountain sites where some of their descendants, the Pygmies of western Uganda, still live today.

Prior to the colonization of present day Uganda by the British at the turn of the last century, some parts of the country had well developed political groupings, notably the Kingdoms of Buganda, Bunyoro, Ankole and Kooki. In these Kingdoms wooden canoes played a major role in armed tribal conflicts which were frequent between the various Kingdoms. Historical records show that the King of Buganda, for instance, could assemble as many as 200 canoes for his army (Karani, 1989). The forests were also very important for hiding from the enemy and laying ambushes during warfare. For instance, the British had a very difficult time dislodging the Bunyoro Kingdom warriors who used Budongo Forest for hiding from colonial military expeditions (Paterson, 1993; Were and Wilson, 1970).

Fishing, hunting and trade in ivory with Arab merchants from the East African coast brought wealth to the Kingdoms. Fish drying which required fuelwood cutting was commonly practiced, but the population was small and the forests regenerated themselves. Cultivation of yams and bananas only required partial clearing of forest trees leaving trees that were either too large to be felled or were valued for their products such as nuts, fuelwood, and bark for making cloth (Karani, 1989). Some tree species such as *Cordia* and *Ficus* were also used for making bark cloth (from *Ficus*), musical instruments, household utensils, and wooden canoe-like dug out containers for brewing local beer. Wild coffee was also harvested from the forests and used for ceremonial purposes.

3.3.2 Indigenous management of traditional sacred forests

Some forests were traditional community resources important for cultural and historical reasons. These were historical sites for clans or families and associated with supernatural spirits after whose identity they were named. Some were traditional sites for the local community where members would go to consult with ancestral spirits, or religious worship and presentation of sacrificial offerings.

Traditional sacred forests were managed under a rather informal system (Gombya, 1995). Their control was presided over by a person whom the community accepted as the care-taker and believed to be possessed by the spirit after which the forest was named. Sacred controls were used to regulate the use of the forests by traditional beliefs and some penalties for misuse. There were no written rules to describe forest management; instead the community grew up knowing the 'dos' and 'don'ts' surrounding the forests which were passed down to future generations through oral instruction and cultural traditions.

Spiritual sanction and penalties were used for rule enforcement which combined religious as well as practical and material aspects of forest management together (Gombya, 1995). For instance, it was believed that if a person set off to go to the forest without reporting the purpose of his mission to the care-taker or changed the purpose while in the forest, he would get lost there. Entry into the forest on an individual basis, was also highly discouraged. Women were restricted from entering the forest and everybody was not allowed

to defecate or have sexual intercourse in the traditional sacred forests as these were sacred areas (Gombya, 1995).

To enforce these rules, elders continually reminded the community about the dangers that awaited those who violated them. Some common threats of spiritual punishment were very scary and an effective deterrent. They included the offender's home being afflicted by insect invasions, crop failure and infertility. Penalties often included returning to the forest whatever product had been removed and fines of animals or food. Relatives of the offender also had to cleanse the wrath of the spirits by making religious offerings.

Obstinate offenders who failed to comply with the penalties were cursed by the elders and considered out-casts and despised members of their communities (Gombya, 1995). These rules of control achieved considerable success in preventing over-exploitation of the forest resources and ensured the conservation of the forests. The continuation of this management regime could have probably helped to guarantee conservation of these forests had it not been for the coming of colonialists with radically different ideas about forest use and management.

3.4 The rise of British control: 1894-1930

3.4.1 Colonial penetration and conquest

The arrival of European missionaries, explorers, and entrepreneurs since the mid 1800s marked the beginning of a sociopolitical process which culminated in the 1894 declaration by Britain of a protectorate authority over the Buganda

Kingdom, whose agents then helped the British to subjugate the entire country (Were and Wilson, 1970). The colonial period which lasted until 1962 revolutionized Uganda by thrusting the country into the world economy and introducing western medicine, education, law, administration, and government.

By 1899 the British were concerned about the high expense involved in administering their newly acquired territories; so they decided to reform the economy of Uganda (Were and Wilson, 1970; Karani, 1989). The main issue at stake was the well established system of land ownership which was largely in the hands of the various Kingdoms. In 1900 the British government signed a flawed agreement with the Kingdom of Buganda which established British authority over it in exchange for "protection" against real and imaginary enemies.

Free-hold titles were granted to the King and his family and chiefs while about half of the Kingdom became British Crown land and no longer the property of its former users or occupants, although many peasants were allowed to cultivate their former lands (Were and Wilson, 1970). Hut tax was also imposed and collected by the local chiefs on behalf of the colonial government. Other similar agreements shortly followed with the Kingdoms of Toro, and Ankole where all uncultivated land became British Crown land. There was some resistance to these agreements and payment of taxes by local people but the British had been adept in the methods of indirect rule whereby local chiefs were used to implement their unpopular policies.

Cash crops such as coffee, wheat, sugarcane, chilies, tea, cotton, cacao, and vanilla were also introduced to finance administrative costs under the direction of the Scientific and Forestry Department (Forest Department, 1951). Most of these crops proved unsuitable for small scale production except for cotton while coffee and tea were good for large scale estates. There were some considerations for British settlers to establish these agricultural estates as they had done in Kenya, but these were dropped because Ugandans were already quite well conversant with modern agricultural practices (Were and Wilson, 1970).

The development of relatively large estates of coffee, rubber, sugarcane, cotton, and later tea necessitated extensive forest clearing. By 1898, it was realized that forest areas needed protection by reservation and to protect wild rubber, which was also being harvested on a commercial scale (Karani, 1989). This time heralded the era of colonial control of forest resources. In these early colonial days, Baltic Fir (Scots Pine) was imported into Uganda for construction works (Forest Department, 1951). Consequently, forest development as a means of import substitution was an early theme which persists to today.

The building of the railway from Mombasa on the Indian ocean to Kisumu on the shores of Lake Victoria took a vast amount of timber for building bridges, railway sleepers and support services and infrastructure (Forest Department, 1951). Up to 1930, the government, either within the Forestry Department or as part of Public Works Department, run sawmills and the shipping service on Lake

Victoria connecting Uganda to the railhead at Kisumu was also powered with fuelwood from the forests (Karani, 1989).

Even as early as 1908, it was realized that fuelwood plantations would have to be established near the large towns, both within the sparsely wooded savanna areas and the tropical moist forest zones. In the exploitation of tropical forests there was no attempt to regulate the yield of forest products and even the extent of the forests was not known (Forest Department, 1951). Modern forest management in the country can be said to have started in the early 1930s when the colonial administration recruited British professional forestry staff.

3.4.2 Establishment of the forestry service

The forestry service was created in 1898 with the appointment of the first Director to the Scientific and Forestry Department of Uganda (Forest Department, 1951). A Forestry Department was established as a separate body in 1917 and was renamed the Forest Department in 1927. The first trained foresters (who were British expatriates) arrived in 1921, but it was not until 1929 that forest policy was given serious attention by the colonial government and the Forest Department top-down bureaucracy was organized into approximately its present form (See Fig. 3.2). The Department was headed by a Chief Conservator (presently called a Commissioner) of forests at the departmental headquarters, assisted by Forest Officers, Rangers and Guards in an administrative structure quite similar to that of the military.

3.4.3 Demarcation of forest reserves

The process of acquiring land by the Forest Department was gradual and to a degree unsystematic; and it was not until the late 1940s that the boundaries of the forest estate, more or less as they now stand, became established. In the Buganda Kingdom the legal basis for government involvement in forest control was the Buganda Memorandum of Agreement of 1900 between the colonial government and the Buganda Kingdom as amplified and clarified by the Uganda Memorandum of Agreement (Forests) of 1907 and the Forests Ordinance of 1913 (Hamilton, 1984). By these "agreements", all large blocks of forest were declared Crown land, coming under colonial government ownership and control, leaving out only the smaller forests on private land.

The agreements with the Toro, Ankole and Bunyoro Kingdoms in 1900, 1909, and 1933, respectively, declared all forests in the entire Kingdoms to be under government control. These various agreements prohibited exploitation of Crown forests without permits and stipulated fees, except for certain products such as firewood and poles for private household use, which could be extracted without payment of a fee (Forest Department, 1951). In the absence of centralized traditional authority in some parts of the Uganda, all land in such areas was also declared Crown land. Thus, forest reserves were established with a minimum of formality and included partially forested as well as savanna grasslands, especially in the drier areas.

3.4.4 Early colonial forest exploitation

The earliest commercial activity in the tropical forests was collection of wild rubber from *Landolphia* and *Clitandra* vines and later from the tree *Funtumia elastica*. The first tapping concession was granted to a British company in 1902 and rubber production reached a maximum in 1910. However, Ugandan rubber faced severe competition from plantations elsewhere, and exports had virtually ceased by 1919. There was only a brief resurgence in wild rubber collection during the Second World War (Osmaston, 1959).

Initial commercial timber harvesting began around Lake Victoria in Minziro Forest in 1907, Mabira Forest in 1911 and in the western part of the country in Budongo Forest in 1919; in most cases initially by pitsawing (Karani, 1989). In the period up to 1926, much of the harvesting was undertaken directly by government run mills, an involvement which came to be regarded as unfortunate because milling costs exceeded revenue and the diversion of staff and finance to exploitation undermined long term planning (Hamilton, 1984).

3.5 The colonial Forest Management Regime: 1930 - 1962

3.5.1 Forest policy evolution

Two reports dealing with forestry were written during the 1920s; the earlier one, by Troup (1922), was not adopted by the government, but many of its suggestions were incorporated in the second report by Nicholson (1929). Nicholson's report had a major impact on the development of forestry in Uganda (Forest Department, 1930). The document clarified the aims of the government

forest service and the establishment of a bureaucratic departmental structure which as mentioned earlier, has remained basically unaltered to the present time. Nicholson stressed the fact that forests and trees play important roles in the environment, both in direct economic ways and indirectly by modifying the climate, protecting water supplies, and preventing excessive soil erosion. He believed that Uganda would benefit from a greater forest vegetation cover than at that time, and advocated for widespread forest protection and also major afforestation schemes. Multiple-use forest management was therefore an early theme on Uganda.

Nicholson considered that supplies of firewood, poles, and sawn timber for local consumption in the countryside could best be guaranteed by encouraging tree growing by farmers and by establishment of small plantations under the control of local administrations. The role of the Forest Department was to safeguard the environment and forest resources on a long-term basis, and among its duties were to be: the selection of reserves; the demarcation of their boundaries; the writing of legislation to permit forest conservation; research; preparation of working plans; exploitation; and afforestation. It was advocated at this time that the number of professional staff in the Forest Department be increased to eighteen, an establishment which was not attained until 1946 (Forest Department, 1951). This marked the beginning the daunting task of implementing the custodial forest management policy whose problems have persisted to the present time.

Many of Nicholson's suggestions regarding the aims of the Forest Department were incorporated in an official Policy Statement in 1948, in which two major objectives of the department were given as follows (Hamilton, 1984):

1. To reserve in perpetuity, for the benefit of the present inhabitants of Uganda and posterity, sufficient land, either forested or capable of afforestation; to maintain climatic conditions suitable for agriculture; to preserve water supplies; to provide forest produce for agricultural, industrial and domestic supplies; and to maintain soil stability in areas where the land is liable to deterioration if put to other uses.

2. To manage this forest estate so as to obtain the best returns on its capital value and the expenses of management, in so far as such returns are consistent with the primary aims set out above.

A significant change in the Forest Policy Statement of 1948 compared with the forest policy objectives advocated earlier by Nicholson was the down-grading of the value of protective forestry in recognition of the pressing immediate demands for agriculture (Hamilton, 1984). The Forest Policy statement clearly spelt out that because of Uganda's dependence on agriculture, the rapid development of the country, and the continuing increase of its population, it is necessary to limit the size of the forest estate to the "minimum area" which will achieve the primary aims of management.

Minimum areas for each administrative district were calculated using figures for wood consumption per head and the sizes of district populations, and there was also an initial aim to place 10 percent of the land area of Uganda under

forest. When the actual area of legally protected forest reached or exceeded this “minimum” amount, then the district was declared to be “adequately forested”, although the areas were adjusted between districts to compensate for low site productivity or high land pressure. This rather short-sighted planning underestimated future population growth and demand for forest resources in the country as attested to by later events that involved extensive deforestation and encroachment on forest reserves.

3.5.2 Establishment of Local Forest Reserves

Legislation establishing forest reserves under district administrations was enacted in 1939 and 1947. These new Local Forest Reserves were expected to be small but numerous and to cater for local demands. Their creation was not expected to detract from the value of Central Forest Reserves, which were larger and intended to serve regional needs (Hamilton, 1984).

In addition to the task of looking after Central Forest Reserves, the central government Forest Department was expected to continue with its educational, advisory, and research functions, though in practice the encouragement of tree growing by farmers came to be undertaken largely by the Department of Agriculture. The establishment of Local Forest Reserves was in line with the government's post-Second World War Development Plan, which laid particular emphasis on the provisions of small areas of natural forest or plantations to supply wood products to the rural community on a permanent basis (Forest Department, 1955).

3.5.3 Development of timber management

By the 1930s a policy had evolved which gave the government the task of regulating the volume and type of timber cut but left extraction and processing to private sector. British commercial firms were granted exclusive felling licenses over defined parts of the forest estate for prescribed periods, the licenses being given in return for fees payable to the Forest Department based on volume of sound timber cut (Forest Department 1934). Before 1930 very little information was collected on the distribution and other characteristics of tropical forests, with the exception of some studies by Dawe (1906) who discovered the rubber tree *Funtumia elastica* in Uganda, at first in Mabira forest in 1903, and also made some botanical surveys of forests in the south and western parts of the country.

Not long after establishing Local Forest Reserves, the Forest Department expressed concern, during the late 1940s and early 1950s, about the poor management of privately owned forests in the Buganda Kingdom. These forests were a major source of the country's timber, comprising 44% contribution in 1949 (Hamilton, 1984). The remedy prescribed by the Forest Department was to initiate the Buganda Dedication Scheme, which gave land owners the opportunity to lease their forests to the Buganda Kingdom government for a period of 99 years (Sangster, 1951).

Leased forests would be managed by the Local Forest Service to give maximum sustainable timber production, with the owner receiving 75% of the profits. This overly ambitious and rather suspicious scheme failed because of the highly emotive nature of land issues in Buganda, including a general

suspicion of government intentions (Hamilton, 1984). Another scheme also tried out at this time without success was a plan for establishment of communally owned village forests. It is not surprising that these schemes failed because of the manner in which the colonial government had previously taken over ownership of land from local people without any compensation and the fact that to get access to it the local people now needed a permit and had to pay a fee for its use!

3.5.4 Silvicultural practices

The period from 1930 to 1960 was one of considerable achievement in the evolution of methods of cropping the natural forests for timber, a field in which Uganda came to be recognized as a leader among tropical countries (Hamilton, 1984). Studies in forest ecology were initiated by Eggeling (1947) in the 1930s, forming the basis of management techniques later followed up by Dawkins (1958) and others. The first research plots for determining the growth characteristics of natural forests under different silvicultural treatments were established in 1933 and their number had risen to 267 by 1960 (Howard, 1991).

Tropical forests in Uganda tend to contain a rather large number of tree species of various timber values. In recognition of this, the Forest Department devised a system of grading species into classes according to current worth, species being occasionally shifted between classes in response to increase in knowledge, industrial developments, or changes in their demand (Hamilton, 1984). Royalties payable by sawmillers or pit-sawyers varied between timber

classes, and the department tried to devise methods of management which would increase the more desirable species. Large scale operations were, therefore, initiated in Budongo and the Mengo forests in the late 1930s with enrichment planting at first carried out by line planting of nursery-raised seedlings of valuable tree species, such as *Entandrophragma*, *Khaya*, and *Maesopsis*, after selective harvesting of an initial timber crop (Philip, 1962).

Following on from about 1945, this technique was replaced by one of compensatory planting to supplement natural regeneration. This method was adopted due to labor shortages and because it was felt that natural regeneration was inadequate to ensure a reasonable second crop over large parts of the forest. Another major problem of timber management at this time was that some of the commonest species of tall trees, such as *Cynometra alexandri* and *Parinari excelsa*, were of low commercial value. Arboricides were therefore introduced to kill these and other weed species starting in 1954 and soon were being used on a large scale to simulate heavy felling (Hughes and Lang Brown, 1962). One disadvantage which became apparent was that the crashing down of dead branches and whole trees could cause damage to young regeneration of desirable tree species growing beneath them (Dawkins, 1958).

Techniques for the management of the natural forest for timber production were eventually changed in the late 1950s with the general adoption of a monocyclic (uniform) felling system (Dawkins, 1958; Philip, 1962). This system called for the conversion of a forest into a mosaic of approximately even-aged crops, each part of the mosaic being harvested at regular intervals of the order of

60 to 100 years. The following procedure was followed in Budongo forest: (1) all trees of desirable species larger than a specified girth size were extracted by the sawmiller; (2) all individuals of the undesirable (weed) tree species above 10 cm diameter were marked by the Forest Department staff and the large trees frilled before an arboricide was applied to their stems to kill them; (3) nursery-raised seedlings of mahogany species, mainly *Khaya*, were planted in any gaps and sometimes in lines; (4) the planted seedlings were tended by weeding and climber cutting carried out by Forest Department workers until they were established.

In the South Mengo Forests adjacent to Lake Victoria and about 40 km from Kampala, the capital city, a different procedure was followed (Earl, 1968), thus: (1) all trees of desirable species larger than a specified size were extracted by the sawmiller; (2) desirable species too small to be harvested in the initial cycle were marked by Forest Department staff so that they would not be felled during Stage 3 (and if sufficiently grown, these trees would form part of the next crop); (3) Forest Department staff then carefully felled undesirable trees, minimizing damage to the young regeneration of desirable species; (4) charcoal makers and firewood merchants were then allowed to enter the forest in an orderly way to take the lop and top left by the sawmillers and to harvest felled weed trees; (5) Nursery raised seedlings of fast growing species, mainly *Maesopsis eminii*, were planted in gaps left by charcoal burners; (6) some climber cutting and weeding was then carried out to tend the new crop until it got established. The incorporation of a commercial charcoal production component into the harvesting

cycle in south Mengo forests was possible due to the high demand for fuelwood in the Kampala and neighboring Jinja urban areas and to date has not been adopted elsewhere.

3.5.5 Establishment of forest plantations

Planting of trees by the Forest Department had begun by 1908 when small plantations were widely established near government stations. *Acacia meansii* (Black Wattle) and *Eucalyptus* were introduced in 1912, for production of fuelwood and poles (Forest Department, 1951), but an indigenous tree *Markhamia platycalyx* had been the main species used in the earlier years.

Chlorophora excelsa, which was one of the most important timber species, was harvested mainly from cultivated areas and derived savanna in the eastern region, where its lack of regeneration was a cause for concern. Much effort was put into its culture on experimental plantations in 1930s, but these met with little success because of the incidence of the gallfly (*Phytolyma*) and other pests. Meanwhile *Eucalyptus* plantations have spread widely throughout the country and the genus has become the main source of poles and firewood in many areas. The first softwood plantations comprised of conifer species were established in the highlands of the western region in 1942, and their development was later enhanced by assistance from the Norwegian government (Hamilton, 1984).

3.6 Post-Colonial Era Forest Management: The First Two Decades (1962 -1985)

3.6.1 The end of the colonial era and maintenance of the *status quo*

Uganda attained independence in 1962 but little changed from the colonial forest resource management regime. The organization of the Forest Department bureaucracy remained unchanged; with an Administrative Division comprising a Headquarters, a Management Division responsible for field operations and a Development Division responsible for research, mapping, forest inventories and training. Under the general post-colonial manpower compensation scheme 15 expatriate professional foresters retired pre-maturely but only 8 local replacements were obtained and a number of expatriate staff stayed on (Ministry of Information, 1964).

Due to a lack of training facilities in the country a few people were sent to Britain for professional and lower cadre training. There was also no change in the forest policy of 1948 and responsibility for its implementation continued to be shared between the central government and local authorities (Hamilton, 1984). The former retained responsibility for the management of the major forest reserves and for the provision of technical training, research and advisory services, while the local authorities were responsible for the management of smaller reserves and for the provision of extension services.

The only major change in regard to the organizational set up of the forestry sector after independence was that ownership of Crown land was transferred to District Land Boards or to the Land Commission of the central government,

although this did not affect the status of forest reserves which continued to be administered under the Forest Ordinance. At this time the forest reserve estate covered about 14,500 km², of which approximately three fifths were managed primarily for protective purposes and two fifths for production. Encroachment was considered the most serious threat to the forests in the central region and also damage by elephants in the western region. Elephants have since that time been gradually eliminated from forest reserves by government control shooting measures (Ministry of Information, 1964).

Development of the forest estate to increase its productivity continued and a record acreage of high forest (10,300 hectares) received silvicultural treatment and 730 hectares of plantations were established from 1962 to 1963. A five year development expansion program covering natural forest silvicultural treatment and softwood timber plantation establishment was drawn up but could not be started owing to lack of funds. It is worth noting here that local governments were doing quite well with expenditure on forestry of British Pounds 172,000 and revenue of British Pounds 163,000, while the central government expenditure on forestry was British Pounds 503,000 and revenue only British Pounds 166,000 (Ministry of Information, 1964).

For all the past years of colonial forest management, it was reported that in spite of efforts by the Publicity Section to educate the public about forestry, there was considerable "ignorance" amongst the population about the value of the forest estate and efforts were intensified on publicizing the aims and activities of the Forest Department (Ministry of Information, 1964). The basis for this

assumption is not indicated but it shows how the Forest Department was also ignorant about indigenous knowledge of the use and management of forests. This conflict of "understanding" still persists between forestry professionals and local people.

3.6.2 The 1966 Crisis

Since independence in 1962, there had been some political conflicts concerning power sharing between the central and the local governments which had retained Kingdom status under the colonial indirect rule policy and this status had been retained in the post-independence federal political system constitution (Were and Wilson, 1970). These conflicts developed into a major political crisis in 1966 with far reaching consequences for the management of forest resources. The central government used the military to overthrow the Kingdom governments and in 1967 unilaterally re-wrote the constitution to abolish the Kingdoms and declared Uganda a Republic with an Executive President.

Thus in 1967, the forest services run by former Kingdoms and local district governments were taken over by the centrally organized Forest Department. According to the Forest Department Report for 1964-1968, abolition of local forestry services was welcomed by many professional foresters on ground that it would ensure efficiency and rationality in the development of forest resources. Although the amalgamation of the forest reserves was almost a recipe for disaster, many foresters still support it and have so far succeeded in resisting all

efforts to decentralize forest reserve control. Even by the time of taking over local government control of forest resources, it should have been clear that the action would only aggravate existing problems such as encroachment, given the lack of an adequate number of forestry staff and limited financial resources. Consequently, control by the central government has become increasingly problematic ever since.

Nevertheless, the period from 1962 to 1970 can be considered to have been of considerable progress in research and development of timber management techniques in natural forest and also in the establishment of plantations, although it was characterized by shortages of professional staff. During the late 1960s the Norwegian Agency for International Development (NORAD) became actively involved in forestry activities in Uganda, especially with the implementation of the softwood plantation expansion scheme and with development of forestry education at Nyabyeya Forestry College near Budongo Forest and at Makerere University (Hamilton, 1984).

A sizable body of information on the growing of softwoods was already available from the many experimental plots which had been established earlier and NORAD was able to move straight into large-scale planting with *Pinus caribaea* and *Pinus patula* being the main species used. A Forestry Department was opened at Makerere University in 1970 to take care of professional training under a five year inter-governmental agreement; with NORAD contributing staff salaries, equipment, and transportation.

3.6.3 Forest policy review of the early 1970s

Forest policy came under review in the early 1970s and the Forest Policy Statement of 1948 was replaced by the one issued in 1971 and the informal adoption by senior foresters in 1974 of some supplementary policy proposals contained in the Lockwood Consultants Report (1973). The 1971 Forest Policy statement states that the objectives of the Forest Department were:

1. To reserve adequate land as forest estate so as to ensure: a sustained production of timber and other forest products for the needs of the country, and where feasible for export also; protection of water catchments, soils, wildlife and amenity of land.
2. To develop that estate so as to obtain maximum economic return to the country.
3. To ensure efficient conversion of wood products, so as to reduce waste.
4. To carry out extension services aimed at: helping farmers, organizations and other people to grow and protect their own trees; educating the public about the role of forestry and forest industries for their welfare; and advising industries and users of wood on suitability of various uses.

Lockwood Consultants (1973) made a survey of demand and supply of forest resources in Uganda and recommended further changes to the forest policy with the following main objectives:

1. To ensure the supply of raw material for direct use, or for processing by industry, both in the present and with provisions for the future.

2. To provide employment opportunities in those areas where unemployment was at unacceptable levels.

3. To capture the returns to the nation from the natural forest resource resulting from the utilization of the remaining natural high forest areas.

4. To recover all costs, interest charges and returns for risks associated with the planning and development of afforestation and enrichment planting programs.

Senior foresters agreed to adopt these proposals in 1974 after adding their earlier objective concerning extension services (Hamilton, 1984). In the words of the Lockwood Consultants report, forest policy was defined as "the sum total of all government actions and policies which affect forests," adding that what goes by the name of "forest policy" is really forest management policy. Going by this definition of forest policy, very little was actually achieved by the Forest Department in its implementation.

When compared to the 1948 Forest Policy Statement the new policy objectives showed an increase in emphasis on the direct monetary value of the forest products and a downgrading of protective forestry. This is particularly true of the objectives recommended by Lockwood Consultants in which environmental values such as protection of watersheds, soils, biodiversity and amenity of land were barely considered important.

3.6.4 Military *coup d'etats* and wars of liberation years: 1971- 1986

Political crises in Uganda and their far reaching consequences for forest resources management did not end with the 1966 crisis. In January 1971 the military under the leadership of Idi Amin overthrew the government of President Milton Obote. The military government did not wait long before issuing a string of decrees with very serious consequences for practically all aspects of resource management in Uganda. In 1972 Amin accused Asian entrepreneurs, who had taken over British business enterprises after independence, of corruption and expelled them *en masse* from Uganda after which he turned their expropriated enterprises into government corporations. Most of these corporations were placed under the "management" of some of his military colleagues and it was not long before they run bankrupt.

A major development in the forestry sector at this time was the return of government to direct involvement in extractive forest industries. At the beginning of 1972 nearly all the major sawmills were owned by people originating from the Indian subcontinent and when all Asians were expelled from the country that year, the mills were abandoned. Urgent action was needed to keep the mills running and so a new section of the Forest Department known as the Uganda Government Sawmills Project was created to act as the managing organization. Many foresters moved into this section but in 1974 this section was itself dissolved and its assets were acquired by a new parastatal organization outside the Forest Department, the Wood Industries Corporation (WICO) (Hamilton, 1984).

Twenty one sawmills were originally acquired by WICO and in general they were in a reasonable state of repair at the time they were taken over. But within a short time the mills fell out of production one after the other, and by 1980 only two were operating at anything near full capacity. Although considered when founded to become a major generator of income, WICO proved to be a financial burden rather than an asset. The organization had defaulted on royalty payments for trees felled and bank loans before it wound up (Hamilton, 1984). The woes of WICO have contributed substantially to the massive increase in largely illegal pitsawing to meet increasing demand for timber in the country. Other reasons for the failure of WICO included a lack of spare parts for machinery and shortages of technical and management expertise.

Around this period, because of disputes concerning alleged government human rights abuses, the Norwegian government decided to withdraw aid from the country in 1973 and the entire forestry sector was adversely affected. The Norwegian staff at Makerere University, together with all continuing students, moved to Kenya where the students completed their forestry degree programs. The softwood afforestation program also was severely affected due to the withdrawal of funding and its operations had ceased by 1975.

3.6.5 Encroachment and other illegal activities in forest reserves

Encroachment and other illegal activities in forest reserves are not new in Uganda but since about 1972, there was considerable degradation of the Forest Department estate (Hamilton, 1984). It is clear from Forest Department reports

that illegal activities were not a serious problem before the 1960s (e.g. Forest Department, 1951; Forest Department, 1955). Prior to the early 1970s, illegality of any kind was minimal outside the central districts around Kampala city. In these areas some theft of poles from plantations was reported and some minor encroachment from people who were left in enclaves within the reserves at the time of their establishment. Annual government reports indicate increasing illegal activities since the 1960s and by 1974, fuelwood and pole theft and encroachment were mentioned as major problems.

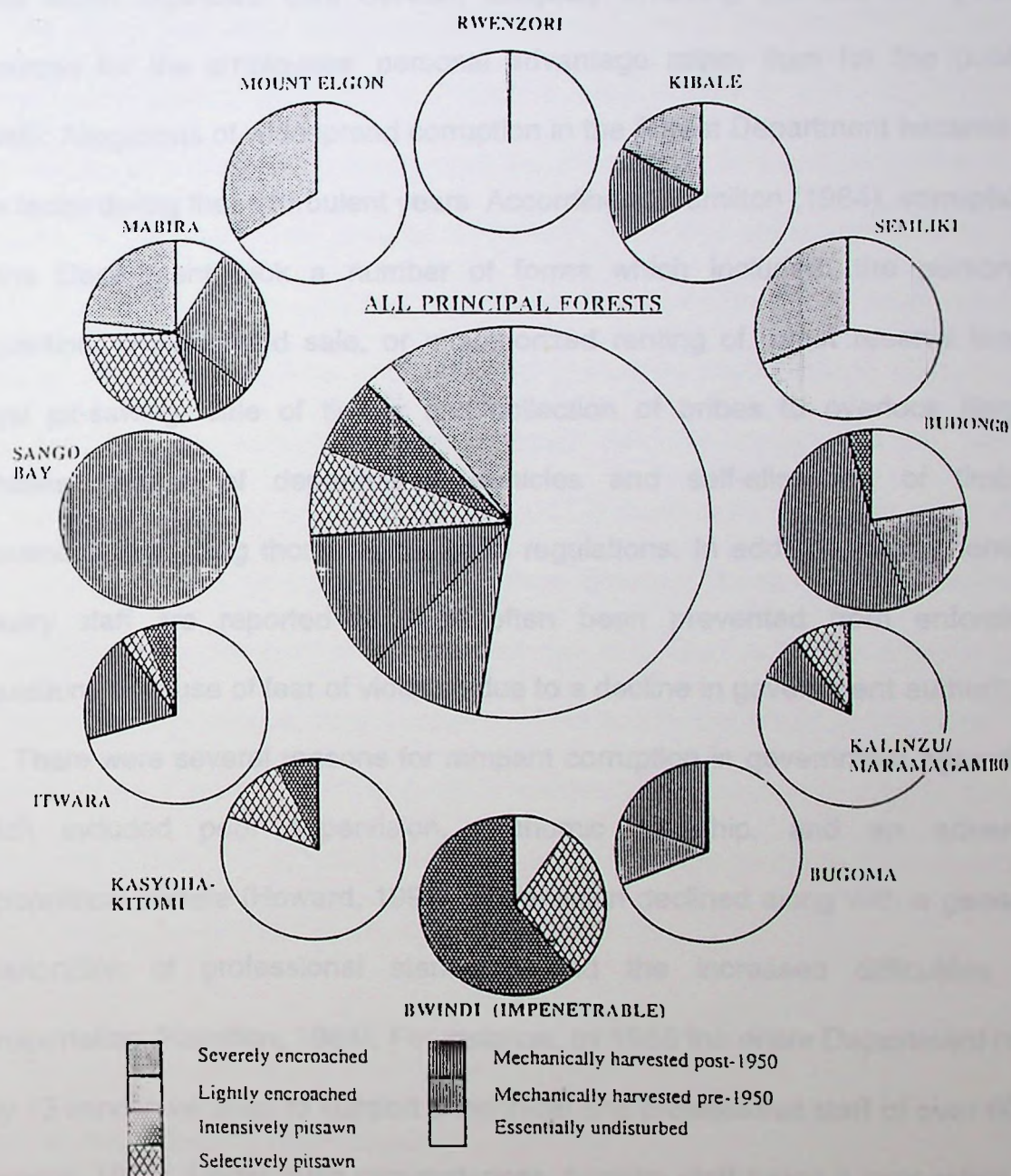
The increase in illegal activities was exacerbated by the 1975 Land Reform Decree, issued by the military government, by which all land in the country was declared public land and vested in the Uganda Land Commission (Kamugisha, 1993). At around the same time, Amin declared an "economic war" to double agricultural production and announced that every Ugandan was free to settle in any part of the country, a statement which was interpreted by many people to mean permission to clear forest land for agricultural production. Most of the recent extensive destruction of forests that occurred between 1971 and 1986, was due both to agricultural encroachment and to increased demand for timber and fuelwood, especially charcoal (Struhsaker, 1987).

An increase in demand for forest products and agricultural land can also be attributed to an increase in population. Immigrants from overcrowded districts in the south-western part of the country have had to move to less populated regions, often forested areas on public land and forest reserves (Struhsaker, 1987). Howard (1991) made a detailed study of 12 major forest reserves which

cover approximately 4,000 km² of tropical high forest and 1,500 km² of montane forest. The degree of encroachment, the level of illegal pitsawing activity, and the extent of mechanical harvesting in each of these reserves is shown in Fig. 3.3.

In his study, Howard estimated that 12% of the forested land within the country's major tropical forest reserves had been affected by agricultural encroachment, with four reserves, namely Kibale, Semliki, Mabira and Mt. Elgon badly affected while eight had suffered little encroachment. About half of the reserves were also affected by illegal pitsawing, especially Bwindi and Mabira. Estimates of deforestation were put at 100 km² (2%) of Uganda's tropical high forest lost annually between 1981 and 1985 (FAO, 1988), while more recent figures indicate 500 km² lost per annum (NEAP, 1992) which implies that the remaining forest are shrinking very fast. By mid 1980s the Forest Department had lost much of its control over forest reserves for a number of reasons. The organization had a severe shortage of funds since about 1974 as part of the government move to cut expenditure on services and increased expenditure on defense and security measures (Jorgensen, 1981).

Apart from being a financial victim of political instability, forestry sector was faced with other related problems. During the 1979 Liberation War that removed Idi Amin from power, the Forest Department Headquarters then at Entebbe were looted, the herbarium vandalized and other valuable items and records stolen. Even after the removal of Idi Amin from power, the military strategy in the early 1980s led to forest clearance in some areas; the forests having gained a reputation as likely hiding places of anti-government insurgents.



Notes:

1. Much of the undisturbed forest occupies steep, 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.

Fig. 3.3 The status of Uganda's twelve major forest reserves (After Howard, 1991)

3.5.6 Corruption in government institutions

Since the early 1970s, there have been persistent reports of corruption at all levels within Uganda's Civil Service, allegedly involving the use of public resources for the employees' personal advantage rather than for the public benefit. Allegations of widespread corruption in the Forest Department became a new factor during these turbulent years. According to Hamilton (1984), corruption in the Department took a number of forms which included: the personal acquisition, unauthorized sale, or unauthorized renting of forest reserve land; illegal pit-sawing, sale of timber and collection of bribes to overlook illegal activities; misuse of departmental vehicles and self-allocation of timber allowances exceeding those laid down in regulations. In addition, some honest forestry staff are reported to have often been prevented from enforcing regulations because of fear of violence due to a decline in government authority.

There were several reasons for rampant corruption in government agencies which included poor supervision, economic hardship, and an adverse sociopolitical climate (Howard, 1991). Supervision declined along with a general deterioration of professional standards and the increased difficulties of transportation (Hamilton, 1984). For instance, by 1986 the entire Department had only 13 service vehicles to support a technical and professional staff of over 600! (Howard, 1991). Under such circumstances, forestry staff found it impossible to remain committed fully to their jobs, and most were obliged to spend most of their time earning a real living elsewhere. It was also evident that government organizations were vulnerable during periods of political upheaval; although they

appeared to retain their institutions relatively intact, but without achieving much in the execution of their intended functions.

The period from early 1970s to mid 1980s was one of the most difficult times in the Forest Department's history. Financial support was at a record low and staff morale diminished. All working plans became out of date and partly due to a shortage of stationary, few records of forestry activities were kept (Hamilton, 1984). Forest reserve boundaries became overgrown with bush, while natural forest silvicultural operations and softwood plantation maintenance ceased by 1974 and 1975, respectively. Forestry research came to a stand still and little if any survey or inventory work was carried out for more than a decade since this time (Howard, 1991). One other serious development in these difficult years was the adoption by politicians of the populist line that land is for the people and should not be alienated as forest reserves. This notion undermined the custodial authority of the Forest Department which had always depended to a large extent on the rule of law. The debasement of the law by politicians made it increasingly difficult for the Department to implement its mandate.

3.7 Forest Management in Recent Years: 1986 - 1996

3.7.1 Forestry sector rehabilitation

Through yet another civil war between the government and rebels from 1980 to 1986, Uganda got a new government led by former rebel leader Yoweri Museveni. One of the major priorities of the new government has been to rehabilitate the country's economy and infrastructure which had been devastated

by the protracted wars fought since the early 1970s and the forestry sector got to be a major beneficiary of this initiative.

Due to government concern that the demand for forest products is rapidly outstripping their supply, several important programs involving external aid have been initiated since 1986. The largest of these being the six year World Bank financed Forestry Rehabilitation Project (FRP) with a budget of US\$ 38.3 million, including a government contribution of US\$ 3.4 million, launched in 1988. The project was aimed at improving the management of Uganda's natural forests and plantations to meet the needs for forest products and services on a sustainable basis (Howard, 1991). The project started off with a Forest policy revision to re-emphasize the importance of sustainable multiple-use forest management. The major objectives of the new Forest Policy are (Forest Department, 1990):

1. To maintain and safeguard enough forest land so as to ensure that sufficient supplies of forest products are available in the long term for the needs of the country and where feasible for export.

2. To manage the forest estate so as to optimize economic and environmental benefits to the country by efficient conversion and use of forest products; protection of the forests against illegal activities, diseases and fire; application of appropriate silvicultural methods which ensure sustainable yields and preserves environmental services and biotic diversity; research in improving seed sources, silviculture, protection, forest products, and conservation of environmental values.

3. To promote an understanding of forests by: establishing extension and research services to encourage agro-forestry practices; publicize availability and suitability of forest products and importance of environmental services provided by forests; and to hold regular open days to demonstrate appropriate forest technology and to bring attention to the positive benefits of forestry.

The multiple-use approach to forest management advocated by the new policy poses several challenges. Objectives for extractive forestry often conflict with conservation initiatives which makes implementation of such policy quite difficult. A formidable task, therefore, lies with the Forest Department in reconciling the diversity of forest resource uses in the country.

3.7.2 Recent major achievements and future plans

The Forestry Rehabilitation Project has progressed quite well with the European Economic Commission (EEC) supporting the natural forest management and conservation component that has overseen forest boundary re-opening, construction of staff housing units, provision of staff transport and a reserve biodiversity survey carried out. A timber inventory in all forest reserves was also completed in 1993.

The Forest Department has also embarked on a reforestation program since the late 1980s under which so far 43 km² of degraded forest land has been reforested after eviction of illegal encroaches. In addition, the value of each forest reserve for nature conservation is currently being documented and further plans exist to set aside 20% of the tropical forest reserves as strictly protected

nature reserves, and a further 30% as buffer areas where only limited timber exploitation will be allowed, leaving 50% for intensive timber management (Forest Department, 1990).

A number of smaller forestry projects are being undertaken with the technical assistance of international agencies like CARE, WWF, NORAD, USAID and others to establish peri-urban and village tree nurseries and help in the integration of rural development with forest conservation. A number of NGOs are involved with several projects outside the forest reserves involving the local people to create awareness about the importance of nature conservation and tree planting (Sayer et al., 1993). Forestry research has also been re-activated to develop methods for natural and plantation forest management, as well as development of appropriate wood technology and agro-forestry practices, as part of the National Agricultural Research Organization (NARO) with more funding from the World Bank.

Due to local and international concerns about tropical forest deforestation there have been numerous recommendations that large areas of forest be set aside as protected areas. This has prompted a government decision to re-designate 300,000 ha of natural forest from forest reserves to the National Parks Service and recommendations for the already mentioned partitioning the remaining forest reserves into protected nature reserves, buffer zones and intensive timber management areas.

Because of the complexity of multiple-use forest management, there is currently a general consensus that no simple solutions can be used to solving the problems of deforestation in Uganda and that wide-ranging integrated programs are needed to foster effective and sustainable forest management (Sayer et al., 1993, Tabor et al., 1990). A number of such programs have now been initiated and the current decade will be crucial in deciding the fate of the entire forest ecosystem in the country.

3.7.3 Current challenges and constraints

In spite of the largely successful implementation of the recently wound up Forestry Rehabilitation Project (FRP) the project had several technical and bureaucratic problems (Kamugisha and Cornelia, 1996). There were persistent bottlenecks with disbursement of government financial contributions which held up several project activities.

This resulted in some of the project components which required government contributions not meet their intended targets on time and the project has wound up leaving many of these components, such as infrastructure rehabilitation, stranded half-way to completion.

The Forest Department prepared a proposal for a follow-up project entitled "The National Forestry Development Program (NAFDEP: 1995-2002)". The program was based on a strong conviction that unless there is immediate follow-up to the FRP, the costly investments already made will be lost and the costs of starting all over again much later prohibitively expensive (Kamugisha and

Cornelia, 1996). The central idea was to harness and re-align any positive achievements of FRP into mutually reinforcing activities and use the experience gained to complete unfinished work and develop capacity for better subsequent performance.

Unfortunately no financial support is forthcoming so far probably due to apparent donor bias to biodiversity/wildlife preservation programs channeled through other government institutions and the myriad of NGOs; the fact that the Forest Department has been the custodian and singularly borne the responsibility for environmental and biodiversity conservation for almost a century notwithstanding. The production aspects of the forestry sector are presently shunned by donors to the extent of being ridiculed as environmentally unsound (Kamugisha and Cornelia, 1996).

The amount of money received from government is far less than the actual financial requirements of the Forest Department and the agency has been heavily dependent on external donor financing for most of its recurrent and development budget. Domestic financing for the forestry sector has declined in real terms and disbursement of the little funds that get through is very intermittent and does not rhyme with the unique natural rhythm and operational cycles of forest activities in the field.

All revenue collected by the Forest Department has to be returned to the government treasury from which funding has to be requested. Financial budgeting, disbursement and accounting follow lengthy bureaucratic procedures and forest management operations usually grind to a halt while some season-

sensitive operations cannot be done in time due to delayed funding. From the financial point of view, the forestry sector seems to rank very low among national budgetary priorities and there is limited appreciation of the contribution of the sector to the national economy and environmental well-being. This is probably because of the long gestation period of investments in forestry and many forest products are intangible and/or consumed at the subsistence level.

Other problems in the forestry sector are related to planning and administration of the Forest Department as well as lack of adequate mutually beneficial collaborative linkages with related sectors. The administrative structure of the Forest Department is a rigid salary bureaucracy that does not separate the productive and service roles of the Department and hence does not attend to either adequately (Kamugisha and Cornelia, 1996). Below the central government level, forest administration is structured along political administrative structures regardless of the significance of the forest resources distribution, leading to spreading thin the already limited resources and hence inadequate attention being focused on forest management units such as reserves. National development plans are also made oblivious of their implications to the forestry sector, often leading to excessive demand for certain forest products and degradation of forests.

With the recent decision by government to decentralize state administrative functions, the old centralized planning procedures are now out of date but at the same time new planning procedures for local governments are not yet established due to lack of resources and planning capacity at the local level.

While the structural and functional arrangements between the local district and national level planning will expedite a bottom-up approach, involvement of the people at sub-district level is not yet obvious and may remain top-down for the foreseeable future.

For some forestry themes the objectives of management are not clearly defined and there is little commitment to them (Kamugisha and Cornelia, 1996). Forest extension has for instance been officially marginalized for a long time although it is a professed major Forestry Department objective that ranks high in the forest policy statement. The Forest Department has for a long time been pre-occupied with forest reserves and its extension section has no formal linkages with the agricultural extension service which has a closer rapport with local farmers and better chances for successful program implementation.

The Forest Department currently employs 128 professional Forest Officers (Degree level), a number of whom have post-graduate qualifications in various specialized fields, 99 Assistant Forest Officers (Diploma level), 218 Forest Rangers (Certificate level) and 384 Forest Guards (trained on job). Although these form the core of the forestry planning and management personnel almost none of them is considered adequately qualified and/or experienced in program/project formulation and management (Kamugisha and Cornelia, 1996).

This pessimistic stance has resulted in the over-reliance of public resource management agencies, including the Forest Department, on mainly foreign expatriates for project management and hence denying local professionals the necessary experience to carry on at the end of projects. Typically project staff

are preferentially remunerated and this has caused alienation of those that are left out and problems of continuation after projects have ended when those who were lucky to participate have to revert to the "old life" of low salaries. These problems have left the Forest Department and other related institutions with problems of effective functioning without donor financed project frameworks as a result of some form of a systemic and chronic "project syndrome".

3.7.4 Current strengths and opportunities

In spite of the numerous problems currently facing the Forest Department, the agency has an old forest management tradition dating back to almost a century and can draw on substantial experiences gained to enhance the development of sustainable forest resource management. The forestry professional cadre has also grown through training programs in Uganda and abroad and the hands-on experience gained from the current forestry projects and activities of the National Environmental Action Plan (NEAP) should help to build adequate capacity to efficiently plan and implement a coherent forestry sector development policy. The increasing environmental awareness and existence of many forestry sector NGOs within the local communities provides a good opportunity for involving local people in forestry activities for improving their livelihoods and the national economy as a whole. There now also suitable training facilities for forestry professionals and technicians and a well organized Forestry Research Institute is operational.

The recent democratically adopted national constitution and the forthcoming Decentralization Planning Guidelines (DPGs) provide a good environment for inter-sectoral and participatory planning that will benefit the forestry sector. A National Forest Action Plan has also been finalized with a frame-work established to formulate sectoral priorities and projects. The re-establishment of the two-tier system of local and central forest reserves and the proposed joint forest management schemes, in which forest reserve revenue will be shared with local communities, should enlist more local support and participation in forestry for development. The Forest Department has also recently been allowed to retain some of the revenue (up to 40%) from sale of forest products for its immediate use (Kamugisha and Cornelia, 1996). This will help in easing the chronic cash-flow difficulties and in promoting the potential for sustainable self-financing.

The existence of many NGOs involved with forestry development activities provides the Forest Department with an opportunity for a mutually beneficial partnership that can expedite access to a broader base for financing and establishment of a rapport with local communities. There is also some political good will both locally and internationally that can be used for budgetary leverage and acquisition of other needed resources. The recent involvement of the private sector in raising wood-lots and industrial plantations in forest reserves has also attracted capital investment and eased the Forest Department's burden of singularly managing most of the forest resources in the country.

kilometer grid line blocks into 25 m x 50 m plots (i.e. 8 plots per ha) from which sample plots were randomly selected using a table of random numbers as paired coordinates. The number of sample plots per compartment ranged from 12 (totaling 1.5 ha) to 24 (totaling 3 ha) depending on their (compartment) size, which ranged from 300 ha to 600 ha.

Table 4.1 Case study compartment descriptions

Forest Reserve	Compartment Number	Number of sample plots	Management/Silvicultural Prescriptions
Budongo			
	N1	14	- Semi-mechanized logging in 1945, post-logging refining with arboricide, and enrichment planting in late 1950s.
	N2	20	- Pre-logging refining with arboricide, semi-mechanized logging in 1945-47, and post-logging refining with arboricide.
	N15	18	- Reference: Unlogged nature reserve.
Mabira			
	E176	12	- Selective logging (pitsawing) since 1960s, no ameliorative treatment.
	E187	12	- Semi-mechanized logging in 1960, post-logging refining with charcoal burning, and enrichment planting.
	W 224	20	- Semi-mechanized logging in 1969, no ameliorative treatment.
	W216	24	- Reference: Unlogged nature reserve.

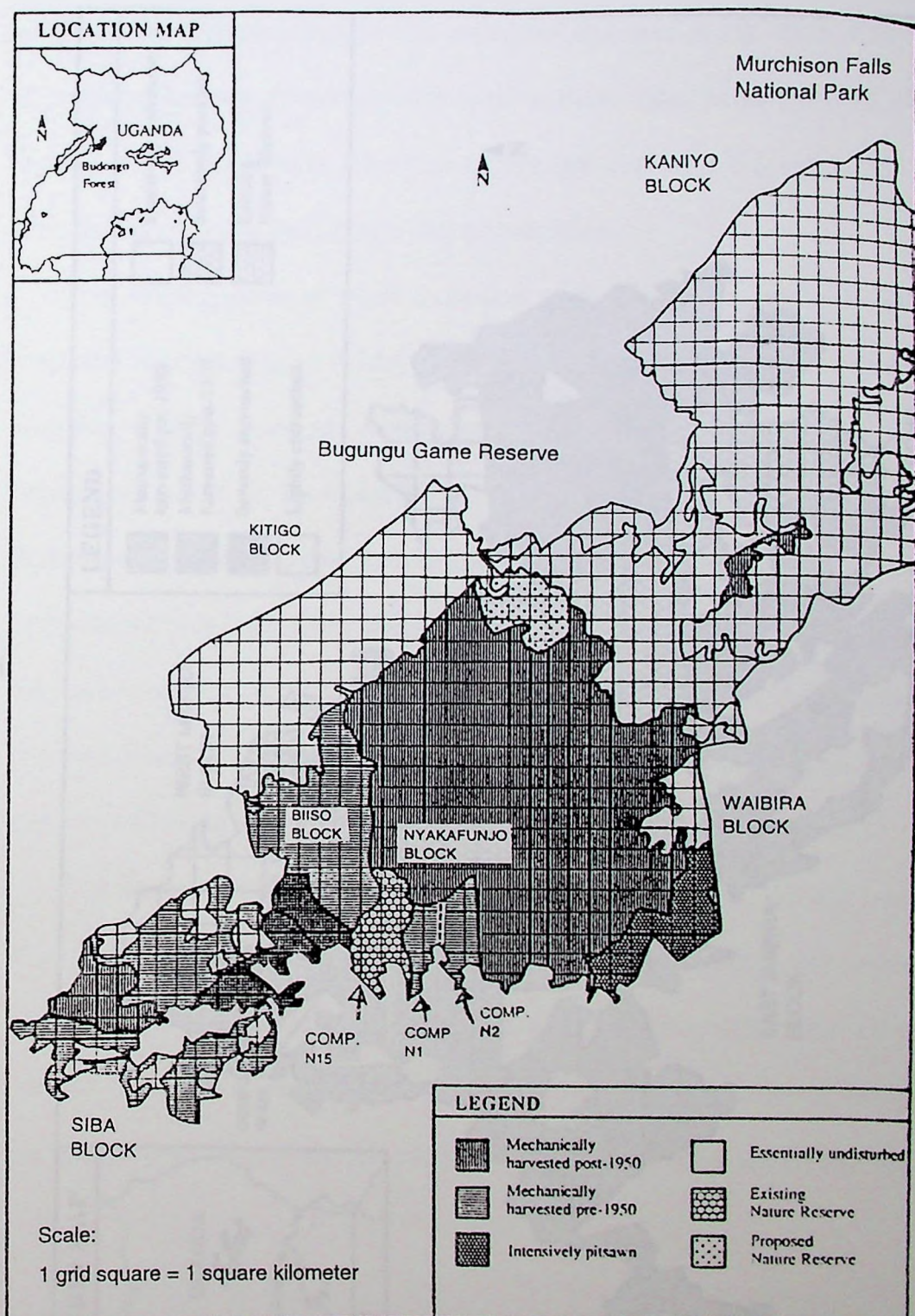


Fig. 4.1. Map of Budongo Forest showing the three case study compartments (After Howard, 1991).

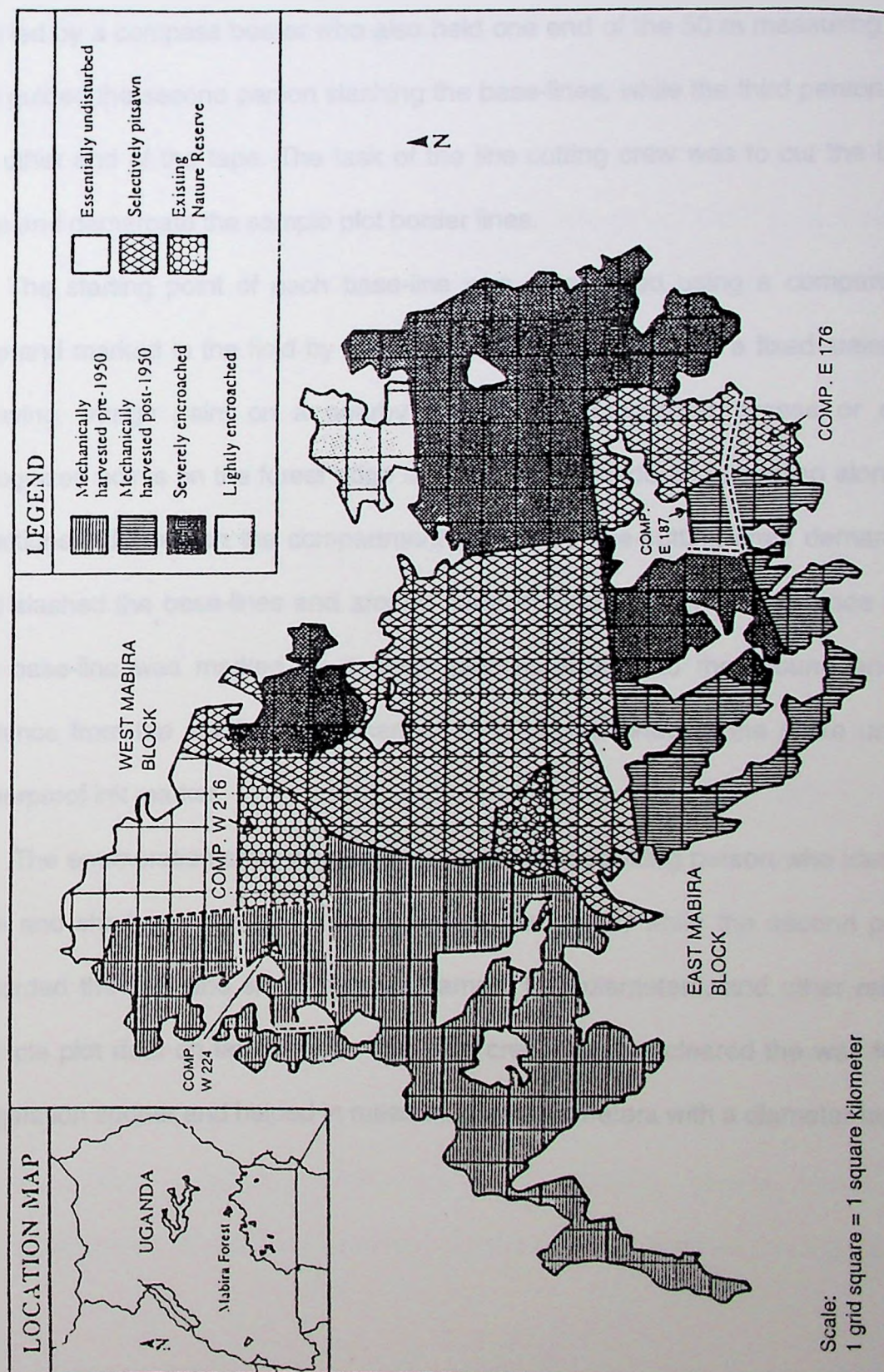


Figure 4.2 Map of Mabira Forest showing the four case study compartments (After Howard, 1991)

Two field teams, the line cutting crew and enumeration crew, each consisting of three people were hired during the field data collection. The line cutting crew was led by a compass bearer who also held one end of the 50 m measuring tape and guided the second person slashing the base-lines, while the third person held the other end of the tape. The task of the line cutting crew was to cut the base-lines and demarcate the sample plot border lines.

The starting point of each base-line was determined using a compartment map and marked in the field by tying a colored flagging tag on a fixed stake and spraying orange paint on a nearby tree. From established access or easily recognized points on the forest edge or along forest roads and traveling along the directions indicated on the compartment maps, the line-cutting crew demarcated and slashed the base-lines and around sample plots. Each 50 m distance along the base-line was marked by a stake planted firmly into the ground and the distance from the starting point marked on a tag attached to the stake using a waterproof ink marker.

The enumeration crew was led by a vegetation spotting person who identified tree and shrub species and measured tree diameters, while the second person recorded the tree and shrub species names, tree diameters, and other relevant sample plot data on tally sheets. The third crew member cleared the way for the vegetation spotter and helped in measuring tree diameters with a diameter tape.

4.2.3 Measurements of standing timber and tree species diversity

Within each of the 25 m x 50 m sample plots, all trees with DBH (diameter at breast height or just above buttress) of at least 10 cm were tallied by species and DBH, while for trees with DBH of 30 cm and above were also tallied by merchantable height (visually estimated by number of 3 m saw log sections), crown position, stem form and visible defects on Field Data Form I (see Appendix A1). This data was used for determining some of the multiple-use forest values and other important stand parameters such as tree genera richness, dominance and regeneration in the case study compartments.

4.2.4 Measurement of shrub species diversity

In order to determine shrub species diversity, a nested sub-plot measuring 3 m x 3 m was randomly located in one of the four corners of each 25 m x 50 m sample plot and identification of all shrub species carried out and the data recorded on Field Data Form II (See Appendix A2). The use of smaller nested sub-plots for shrub species identification was to facilitate ease of data collection.

4.2.5 Biophysical site description and local community forest activities

Other data describing of the sample plot biophysical environment and activities of the local community in the forest was recorded on Field Form III (See appendix A3). It included information on topography, general forest stand characteristics, and evidence of recent human activities such as grazing, hunting,

charcoal burning, timber and pole harvesting, and foot-path counts (See Appendix A3).

4.3 Field Data Analysis Procedure

4.3.1 Formulation of a weighted summation valuation decision matrix

A weighted summation valuation decision matrix (Canham, 1990) was used to appraise and compare major multiple-use values of Budongo and Mabira Forests in form of outputs, or valuation criteria as they will be referred to hereafter, as represented in constituent case study compartments. The multiple-use valuation criteria consisted of (1) timber (and charcoal fuel-wood commercially produced in Mabira Forest only) production; (2) local jobs creation; (3) non-timber/charcoal-wood products for local community; (4) wildlife habitat maintenance; (5) biodiversity conservation; and (6) forest road construction. The procedure for derivation of the valuation criteria magnitudes is given in Appendix C of this study.

The criteria represented the items of value (benefits as positive values and costs as negative values) that are relevant to current forest management policy. The magnitudes of each of the valuation criteria were arranged in rows across the valuation matrix for all case study compartments in each of the two forests to allow a comparison to be made between them.

4.3.2 Determination of relative criteria weights

While a comparison could be made between the case study compartments by use of an implicit set of values to compare the magnitudes of the valuation criteria basing on professional judgment, it is usually considered more useful to state explicitly the weights given to each of the valuation criteria. Due to market imperfections, capturing the values of interested parties (stake holders) and measurement of magnitudes of all valuation criteria requires the use of non-market valuation which has long been a subject of theoretical and applied research in which different scales have been used (Canham, 1990; Walsh, 1986; Sinden and Worrel, 1979).

In this study, each of the valuation criteria was assigned a numerical weight on a scale ranging from -10 to +10, reflecting its relative value or importance to all the other criteria in the matrix. This was achieved by use of a group dynamics technique whereby each member of three groups forestry professionals (who were present at the time of data collection) assigned weights to the criteria for each of the two case study forests. The three groups comprised of (1) central (Headquarter) Forest Department administrators; (2) field-based staff in charge of Budongo and Mabira Forests; and (3) forestry research and training staff at Makerere University, the Forestry Research Institute in Kampala, and Nyabyeya Forestry College (located at the edge of Budongo Forest) who were present at the time of field data collection. The three groups were identified as major stake holders in forest resource management and also because of their important consultative role in forest policy formulation.

the highest total score reflected the compartment with the greatest combined multiple-use forest values.

4.3.5 Silvicultural stand diagnosis

In order to determine the silvicultural impacts of timber management, silviculturally important stand parameters were evaluated in order to compare the composition, structure, and regeneration in the timber management and nature reserve case study compartments (used as reference areas) in Budongo and Mabira Forests. The silvicultural stand parameters consisted of:

(i) **Tree genera abundance (richness):** the average number of stems per given tree genus in a sample plot in absolute terms and also expressed by genera-area curves and calculation of Shannon-Wiener genera diversity index [H] (See No. 5 of Appendix C).

(ii) **Tree genera frequency (evenness):** the presence of a given tree genus in individual sample plots, expressed in absolute terms: genera presence expressed as a percentage, whereby 100% = presence in all sample plots; and in relative terms: calculated as the percent contribution to the sum of absolute frequencies and also by calculation of the Shannon-Wiener equitability (evenness) index [E] which gave an approximation of floristic homo/heterogeneity;

(iii) **Tree genera dominance:** the degree of coverage of tree genera determined from stem basal area, in absolute and relative terms: calculated as a percentage of the total basal stem area a genus occupies in a given compartment, with the dominance of a given genus representing its "ruling position" or bio-

coenotic importance in the constituent forest stands and dominance-genera sequence curves (Whittaker, 1965) used to analyze the forest structure.

(iv) **The distribution of tree genera stem diameters:** graphically presented for timber fee group I (most valuable), II, and III genera; and understory, uncommon, and all tree genera grouped together with the shape of the curves giving an indication of tree genera regeneration and development.

4.4 Results and Discussion

4.4.1 Multiple-use values of case study forest compartments

A weighted summation valuation decision matrix method (Canham, 1990) was used to appraise and compare the combined multiple-use values of Budongo and Mabira case study forests as represented in 2 timber management compartments (N1 and N2) and 1 nature reserve compartment (N15) in Budongo Forest; and 3 timber management compartments (E176, E187, & W224) and one nature reserve compartment (W216) in Mabira Forest. The appraisal involved use of 6 multiple-use valuation criteria representing major forest outputs, taking into consideration their relative importance to 3 groups of forestry professionals.

Fifty questionnaires with a cover letter (See Appendix D) were sent to the forestry professionals requesting them to assign each of the 6 multiple-use valuation criteria a numerical weight, ranging from -10 to +10, indicating its relative value or importance to the other criteria for the two case study forests. Only 31 questionnaires were responded to (returned with criteria weights assignments). A profile and response pattern of all the questionnaire recipients according to their 1995 job categories and professional attributes (education level and current job experience) is given in Table 4.2.

Table 4.2 Profile and response pattern of 50 forestry professionals, who were sent multiple-use forest values appraisal survey questionnaires (Qn.), according to current job category and professional attributes (education and work experience). The 50 questionnaire recipients consisted of: 18 central (Headquarter) administrators, 9 field-based staff; and 23 research and training staff from whom 12, 9, and 10 responses were received, respectively. Percent response numbers are printed in bold print to facilitate their comparison.

PROFESSIONAL ATTRIBUTES	CURRENT PROFESSIONAL JOB CATEGORY									
	Central (Headquarter) forestry administrators			Field-based staff			Research and training staff			
	No. of Qn. recipients	No. of respondents	Percent response	No. of recipients	No. of respondents	Percent response	No. of recipients	No. of respondents	Percent response	
Education:										
(i) M.sc. to Ph.D. degree level	13	8	62	0	0	0	16	7	44	
(ii) B.sc. degree level	5	4	80	4	4	100	7	3	43	
(iii) Certificate to Diploma level	0	0	0	5	5	100	0	0	0	
Current work experience:										
(i) < 10 years	11	6	55	5	5	100	11	2	18	
(ii) 10 to 15 years	4	4	100	4	4	100	8	5	63	
(iii) > 15 years	3	2	67	0	0	0	4	3	75	

The results indicate that while all the 9 field-based staff (all of whom had below M.Sc. education and less than 15 years experience at their jobs) responded to the questionnaires, only 12 out of 18 (67%) of the central forestry administrators, and 10 out of 23 (44%) of the forestry research and teaching staff responded. For the latter two job categories, most of the responses came from people with a B.Sc. forestry degree and with more than 10 years experience at their jobs. Fewer responses came from professionals with at least an M.Sc. degree and of less than 10 years experience at their jobs.

Discussion

A possible reason for the very high questionnaire response pattern among field-based staff could be that forest management policy changes recommended by studies of this nature affect the jobs of field-based staff (who happen to be mostly of lower education status) than the highly educated central (Headquarter-based) forestry administrators and research and training staff based at training and research institutions.

Forest management policy changes in Uganda have traditionally been associated with new projects (such as the recently completed Forestry Rehabilitation Project) which usually involve creation of new jobs with better remuneration, especially for low to medium education field-based forestry professionals. This could be the reason why staff in this category showed much enthusiasm for participating in this study which is about current forest management policy issues. Another reason for higher field staff participation is

that some also stand to gain academic and financial benefit from studies based on field data collection (such as happened this study) in which they are recruited to work as research assistants.

The higher response pattern exhibited by central administrators and research and training professionals with high-level education but with little work experience (less than 10 years at current job) than those with lower-level education but longer experience could be because the former were more in need for forest management planning information so as to cope with the currently very dynamic resource policies. The more experienced staff could have been contented with knowledge accumulated over the years and therefore had less need for new information in conducting their duties.

4.4.1.1 Multiple-use valuation criteria weights

As mentioned in the previous section, three groups of forestry professional staff assigned weights to major multiple-use valuation criteria, considered to be of major concern to current forest management policy, expressing their relative importance in regard to the two case study forests (Budongo and Mabira). Table 4.3 shows the mean and standard deviation values for the relative multiple-use criteria weights assigned by the three groups of forestry professionals.

Table 4.3 Means (averages) and standard deviations (S.DEV.) of relative multiple-use valuation criteria weights assigned for Budongo and Mabira Forests by 3 groups of forestry profession respondents. The respondents consisted of 12 central (headquarter) administrators (Cent. admin.); 9 field-based staff; and 10 research and training staff. Mean weights assigned by the three groups of respondents are in bold print to facilitate their comparison.

MULTIPLE-USE VALUATION CRITERIA	BUDONGO FOREST				MABIRA FOREST							
	Cent. admin.		Field staff		R/T staff		Field staff		R/T staff			
	Mean weight	S.DEV.	Mean weight	S.DEV.	Mean weight	S.DEV.	Mean weight	S.DEV.	Mean weight	S.DEV.		
Timber and charcoal-wood production	6.33	2.15	8.77	1.72	4.00	5.52	3.42	3.99	7.44	1.94	2.30	4.00
Provision of local jobs	4.92	2.23	6.00	1.94	2.50	5.36	5.58	2.94	5.56	2.88	3.10	2.69
Non-timber/charcoal-wood products for local community	4.92	2.57	7.11	1.90	4.70	2.06	5.42	2.15	7.89	1.54	5.30	3.02
Wildlife habitat maintenance	7.83	1.53	7.56	2.30	6.40	2.95	6.92	2.11	6.89	1.90	3.60	5.08
Biodiversity conservation	7.92	1.68	7.56	2.70	7.00	2.31	6.67	2.15	7.00	2.78	6.20	3.08
Forest road construction	1.67	3.60	3.78	1.48	-2.60	4.22	1.92	4.10	3.78	0.67	-0.50	3.78

(i) Budongo Forest

The mean (averages) of weights assigned for Budongo Forest indicate that central forestry administrators and research and training staff considered biodiversity conservation (with mean assigned weight [MAW] = 7.92) and wildlife habitat maintenance (MAW = 7.83) to be the most important forest values. Field staff, on the other hand, consider timber production to be of even greater importance (MAW = 8.77) than the former two criteria, although they assigned weights similar to those of central administrators and research and training for biodiversity conservation and wild-life habitat maintenance criteria.

Central forestry administrators placed timber production (MAW = 6.33) in second place, followed by provision of local jobs (MAW = 4.92), production of non-timber/charcoal-wood products for local communities (MAW = 4.92) and forest road construction (MAW = 1.69). Research and training staff, on the other hand, assigned almost similar weights to timber production (MAW = 4.0) and non-timber products for local community (MAW = 4.7), with provision of local jobs (MAW = 2.5) in fourth place followed by forest road construction which was considered a cost (negative weights) hence assigned the least weight (MAW = -2.60).

Field staff also considered non-timber products for the local community (MAW = 7.11) to be of almost similar importance to wildlife habitat maintenance (MAW = 7.56) and biodiversity conservation (MAW = 7.56) but assigned higher weights to provision of local jobs (MAW = 6.00) and forest road construction

(MAW = 3.78) than the other two professional groups, although they considered forest road construction to be of least value just like the other two groups.

(ii) Mabira Forest

Multiple-use criteria mean weights assigned by central administrators for Mabira Forest indicate that, like in the Budongo forest case, wildlife habitat maintenance (MAW = 6.92) and biodiversity conservation (MAW = 6.67) had the highest value, followed by provision of local jobs (MAW = 5.58) and non-timber/charcoal products for the local community (MAW = 5.42). The timber/charcoal-wood products criterion was put in fifth place (MAW = 3.42) followed by road construction with the least weight (MAW = 1.92). Field staff weight assignments for Mabira were almost similar to those for Budongo although they assigned comparatively lower weights for timber/charcoal-wood production (MAW = 7.44) and wildlife habitat maintenance (MAW = 6.89).

Research and training staff mean weight assignments for Mabira Forest also followed a more or less similar pattern as those assigned for Budongo Forest, with biodiversity conservation valued highest (MAW = 6.20), although non-timber products for local community took second place (MAW = 5.30) followed by wildlife habitat maintenance (MAW = 3.60), provision of local jobs (MAW = 3.10) and timber/charcoal-wood production (MAW = 2.30). Like for Budongo Forest, they considered road construction to be a cost (negative value) in Mabira Forest and assigned it the lowest weight (MAW = -0.5).

Discussion

In general, multiple-use criteria mean weights for Budongo Forest were higher than those assigned for Mabira Forest, except for field staff whose weight assignments for the two forests were mostly similar. This suggested that Budongo Forest was generally considered to be of higher overall multiple-use value than Mabira Forest. Also, weights assigned by central administrators and field staff for most criteria were closer and higher than those of research and teaching staff whose weight assignments were the lowest for all criteria. This was probably due to differences in professional work, whereby unlike the other two groups, the jobs of research and training staff are not directly dependent on forest production operations such as timber management.

Field staff assigned the highest weights for most criteria and seemed to have general agreement on multiple-use criteria values (lowest assigned weights standard deviations), while research and training staff seemed to lack consensus on most criteria (highest assigned weight standard deviations). Criteria weights and their standard deviations for central administrators were intermediate between those of the other two groups of forestry professionals.

All the three groups of foresters considered biodiversity conservation to be a very important forest value, although field staff considered timber/charcoal-wood production (and non-timber products in Mabira) to be of even higher importance. Research and training staff, on the other hand, considered timber/charcoal-wood production to be of much lower value, only higher than road construction which (unlike the other groups) they considered to be a cost

(negative weight). This stance by research and teaching staff about road construction could be because they are least involved with forest management activities; and their lack of consensus on multiple-use criteria probably being due to their involvement with more academic and less administrative or practical aspects of forestry than the other two groups.

4.4.1.2 Weighted summation valuation scores

Table 4.4 shows multiple-use unscaled and scaled criteria magnitudes for all case study compartments in Budongo and Mabira Forests. The scaled criteria magnitudes were multiplied by mean weights sets assigned by the three forestry profession groups to produce the final multiple-use weighted summation valuation criteria decision matrix for each of the two case study forests in which the scores (average weights x scaled magnitudes) were summed and ranked according to constituent compartments.

(i) Budongo Forest

The weighted summation multiple-use criteria valuation decision matrix for Budongo Forest (Table 4.5) indicates that compartment N1 which was logged, treated with arboricide to kill weed tree species, and planted with seedlings of mahogany species, had the highest sum of scores for all the three mean weights sets assigned by the forestry profession groups, followed by compartment N2 which was logged at about the same time (1945-1947) as compartment N1, treated with arboricide, but was not planted at all. The nature reserve

compartment (N15) had the lowest sum of scores because it had the lowest magnitudes for all criteria resulting in negative scores (See Table 4.4).

The nature reserve compartment had no merchantable timber inventory, and also lower wildlife habitat maintenance and biodiversity conservation criteria magnitudes, and was less used by local people (absence of foot-paths) than the timber management compartments. Compartment N2 had a lower summed score rank than compartment N1 because the former had less merchantable standing timber inventory and offered less job opportunities (due to lack of planting and less labor requirements for logging and sawmilling activities) as well as a lower tree and shrub species diversity index (See Table 4.4).

Table 4.5 Valuation matrix for Budongo Forest compartments (CPT) with multiple-use criteria mean weights assigned by central administrators (weights set # 1), field-based staff (weights set # 2), and research/training staff (weights set # 3), and scores (weights x scaled magnitudes).

Multiple-use valuation criteria	Weights set #1	Weight x scaled magnitude		Weights set #2	Weight x scaled magnitude		Weights set #3	Weight x scaled magnitude			
		CPT. N1	CPT. N2		CPT. N1	CPT. N2		CPT. N1	CPT. N2		
Timber volume (m ³ /ha)	6.33	6.20	0.26	-6.46	8.77	8.59	0.36	-8.94	3.92	0.16	-4.08
Local jobs (mandays/ha)	4.92	5.45	-1.30	-4.12	6.00	5.64	-1.62	-5.03	2.77	-0.70	-2.09
Non-timber products: (foot-path density,m/ha)	4.92	1.35	4.11	-5.45	7.11	1.94	5.94	-7.88	1.29	3.92	-5.21
Wildlife habitat: Structural diversity (DBH Standard dev.)	7.83	3.55	5.42	-8.98	7.56	3.43	5.24	-8.67	2.91	4.43	-7.34
Biodiversity conservation: (Sum of tree spp. diversity, equitability, and shrub spp. abundance indices)	7.92	9.14	-4.40	-4.79	7.56	8.73	-4.16	-4.57	8.08	-3.80	-4.23
Forest roads (m/ha)	1.67	0.96	0.96	-1.93	3.78	2.18	2.18	-4.37	-1.50	-1.50	3.00

Summed scores:
(sum of weights x scaled magnitudes) 26.65 5.05 -31.73 31.51 7.94 -39.46 17.47 2.51 -19.95

Summed score rank 1 2 3 1 2 3 1 2 3

(ii) Mabira Forest

The weighted summation multiple-use valuation decision matrix for Mabira Forest is shown in Table 4.6 which indicates that compartment E187 which was last logged in late 1960s, treated by charcoal refining, and planted with seedlings of mahogany species, has the highest sum of scores (weights x scaled magnitudes) for sample mean weights of all the three forestry professional groups, followed by compartment E176 which had been selectively logged (manually by pitsawyers) since the early 1960s but received no ameliorative treatment, followed by compartment W224 (last logged by semi-mechanized methods in late 1960s) and adjacent to the nature reserve (compartment W216) which had the lowest summed score rank.

The unlogged nature reserve had the lowest score for similar reasons as for the one in Budongo Forest except that in this case it had the highest magnitude for the wildlife habitat maintenance criterion. Compartment E176 had a lower summed score rank than compartment E187 because it had lower magnitudes for all criteria except for wildlife habitat maintenance, while compartment W224 had lower summed score than compartment E176 mainly because it had lower foot-path density (indicator of use by local people), structural diversity (indicator of wildlife habitat maintenance) and biodiversity conservation indices.

Table 4.6 Valuation matrix for Mabira Forest compartments (CPT) with multiple-use criteria mean weights assigned by central administrators (weights set # 1), field-based staff (weights set # 2) and research and training staff (weights set # 3), and scores (weights x scaled magnitudes).

Multiple-use valuation criteria	Weights set #1			Weights set #2			Weights set #3		
	E 176	E 187	W 216	E 176	E 187	W 216	E 176	E 187	W 216
Timber and charcoal-wood volume (m ³ /ha)	3.42	-0.68	3.77	-4.34	1.26	7.44	-1.48	8.20	-9.44
Local jobs (mandays/ha)	5.58	-2.20	7.91	-5.10	-0.66	5.56	-2.19	7.88	-5.04
Non-timber/charcoal-wood prod. (foot-path density, m/ha)	5.42	6.49	2.26	-5.51	-3.24	7.89	9.45	3.29	-8.02
Wildlife habitat: Structural diversity (DBH Standard dev.)	6.92	1.04	-8.25	8.53	-1.32	6.89	1.04	-8.22	8.49
Biodiversity conservation: (Sum of tree spp. diversity, equitability, and shrub spp. abundance indices)	6.67	3.47	6.77	-8.52	-1.71	7.00	3.64	7.11	-8.95
Forest roads (m/ha)	1.92	-1.66	1.66	-1.66	1.66	3.78	-3.27	3.27	-3.27

Summed scores:
(sum of weights x scaled magnitudes) 6.46 14.12 -16.60 -4.01 7.19 21.53 -26.23 -2.49 8.86 10.73 -14.17 -5.41

Summed score rank 2 1 4 3 2 1 4 3 2 1 4 3

Discussion

Although there were generally considerable differences in the mean weights assigned by the three groups of forestry professionals, their application to the valuation decision matrices did not change the compartment summed score ranks in both case study forests. This was because the differences in the mean weights assigned by the three groups were not big enough to offset the even bigger differences in criteria magnitudes for the various compartments. However, the importance of the differences in how different interest groups value multiple-uses of forests is apparent in the Mabira case where summed scores for compartments E176 and E187 are almost the same for weights set #3 assigned by research and training staff who attached comparatively much lower value to timber/charcoal-wood production, local jobs creation and forest road construction than the other two groups of forestry professionals.

The higher overall multiple-use valuation criteria scores for the timber management compartments than for the nature reserve ones underscore the importance of timber management to multiple-use forest management in both case study forests, although differences between compartments in regard to valuation criteria such as non-timber products for local people and tree species diversity indices could be due to more causal factors than the effects of timber management alone. Three such important factors are local site variations between compartments, constituent forest stand successional stage and relative proximity to local community settlements.

Literature on tropical forest ecology has many accounts of the relationship between vegetation and site factors such as soil chemistry and physical characteristics. Several researchers have found that on stable landscapes where weathering is in advanced stages, nutrient status is very low and tree species may be responding more to soil physical factors, particularly soil aeration and moisture (e.g. Richards, 1952; Schuz, 1960; Lescure and Boulet, 1985). Patterns of forest diversity in some tropical forests have also been interpreted as showing that increased soil moisture promotes species richness (Hall and Swine, 1981). For instance, Budongo Forest data in Howard (1991) indicates that the number of tree species per hectare is greatest in swamp forest (67 species) and least in *Cynometra* climax forest (16 species) with mixed and colonizing forest types intermediate with 50 and 31 tree species per hectare, respectively.

The progressive decrease in foot-path density from Budongo's compartment N2 (which is adjacent to settlements) through compartment N1 (in middle) to compartment N15 (nature reserve at forest core, although a small portion of it is also at the edge of the forest), and also a comparatively lower foot-path density in the Mabira nature reserve (compartment W216 which is relatively inaccessible) implies different levels utilization intensity by local people. This could have also been a contributing factor to biodiversity diversity index differences due to different levels of vegetation disturbance. The low species diversity index magnitudes for the nature reserve compartments may therefore be due to less interaction with local people than for having not benefited from timber management.

4.4.2 Silvicultural impacts of timber management

Due to considerable current concerns about tropical forest management for timber production and its presumed adverse effects on forest composition and structure (NARO, 1991; Struhsaker, 1997), a silvicultural stand diagnosis was carried out in order to determine and compare major silvicultural stand parameters in timber management and relatively undisturbed nature reserve compartments in Budongo and Mabira case study forests. The silvicultural parameters consisted of tree genera abundance (richness), evenness (frequency), dominance (expressed by stem basal area coverage), and regeneration and development (expressed by the distribution of DBH) for stems with a minimum DBH of 10 cm.

4.4.2.1 Tree genera richness (abundance) and evenness (frequency)

(i) Budongo Forest

A one-way analysis of variance (ANOVA) procedure was used to test the hypothesis (H_0) that timber management compartments (N1 and N2) and the nature reserve compartment (N15) had similar tree genera richness (average number of tree genera per 25 m x 50 m sample plot). The ANOVA test results (See Appendix E1) revealed that this was not the case ($F = 10.90$, $df = 2, 49$, $p < 0.01$). Independent multiple comparison t -tests were then carried out for a similar hypothesis as above between all compartment pairs (See Appendix E1). The t -tests showed significant differences in tree genera richness between all compartment pairs except compartments N2 and N15 ($t = 1.54$, $df=36$, $p = 0.13$).

Average number of tree genera per 25 m x 50 m sample plot for compartments N1, N2, and N15 was 19, 12, and 14, respectively.

Tree genera richness was further analyzed by plotting genera-area curves and calculation of the Shannon-Wiener genera richness index [H] and evenness discerned from relative frequency-tree genera charts (See Figs. 4.3 and 4.4.) and calculation of the Shannon-Wiener tree genera evenness (equitability) indices [E] for all the case study compartments. By this evaluation, compartment N1 had the highest genera richness, followed by compartments N2 and N15 which had similar genera richness (curves closer together), while there were only minor differences in tree genera evenness among all case study compartment, with 13, 14, and 10 out of 31 genera groups in compartments N1, N2 and N15, having at least average (3.2%) relative frequency (a measure of evenness), respectively. The Shannon-Wiener tree genera richness [H] and evenness [E] (equitability) indices followed a similar compartment rank pattern with compartments N1, N2, and N15 having H and E values of 5.12, 4.98, and 4.53; and 0.82, 0.75, and 0.73, respectively.

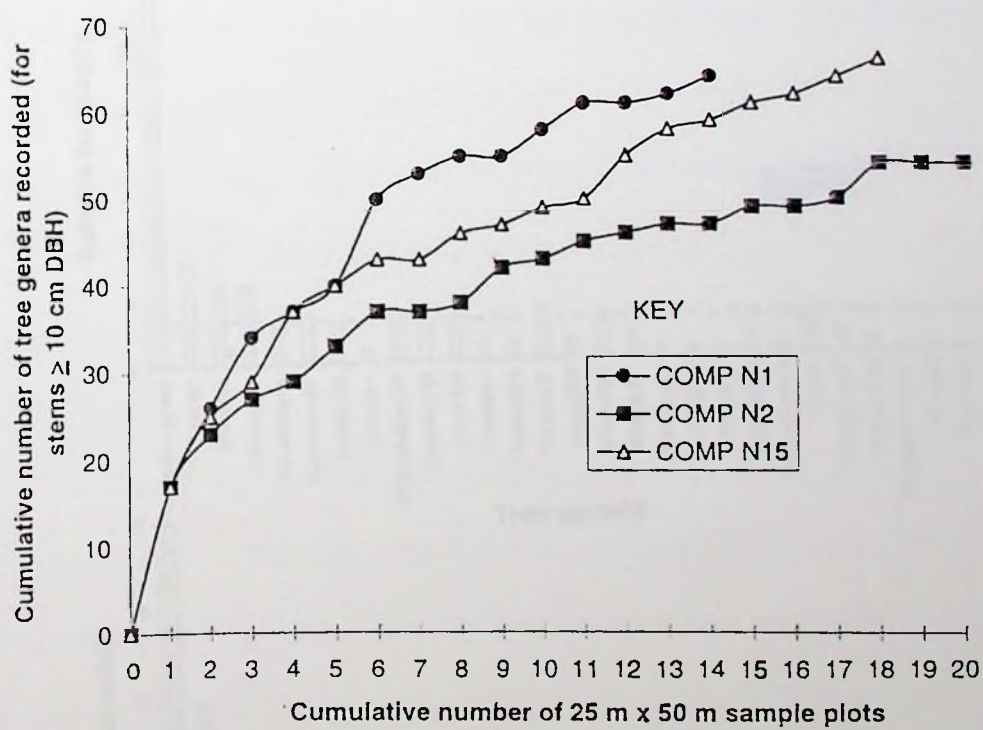


Fig. 4.3 Tree genera-area curves for Budongo Forest case study compartments.

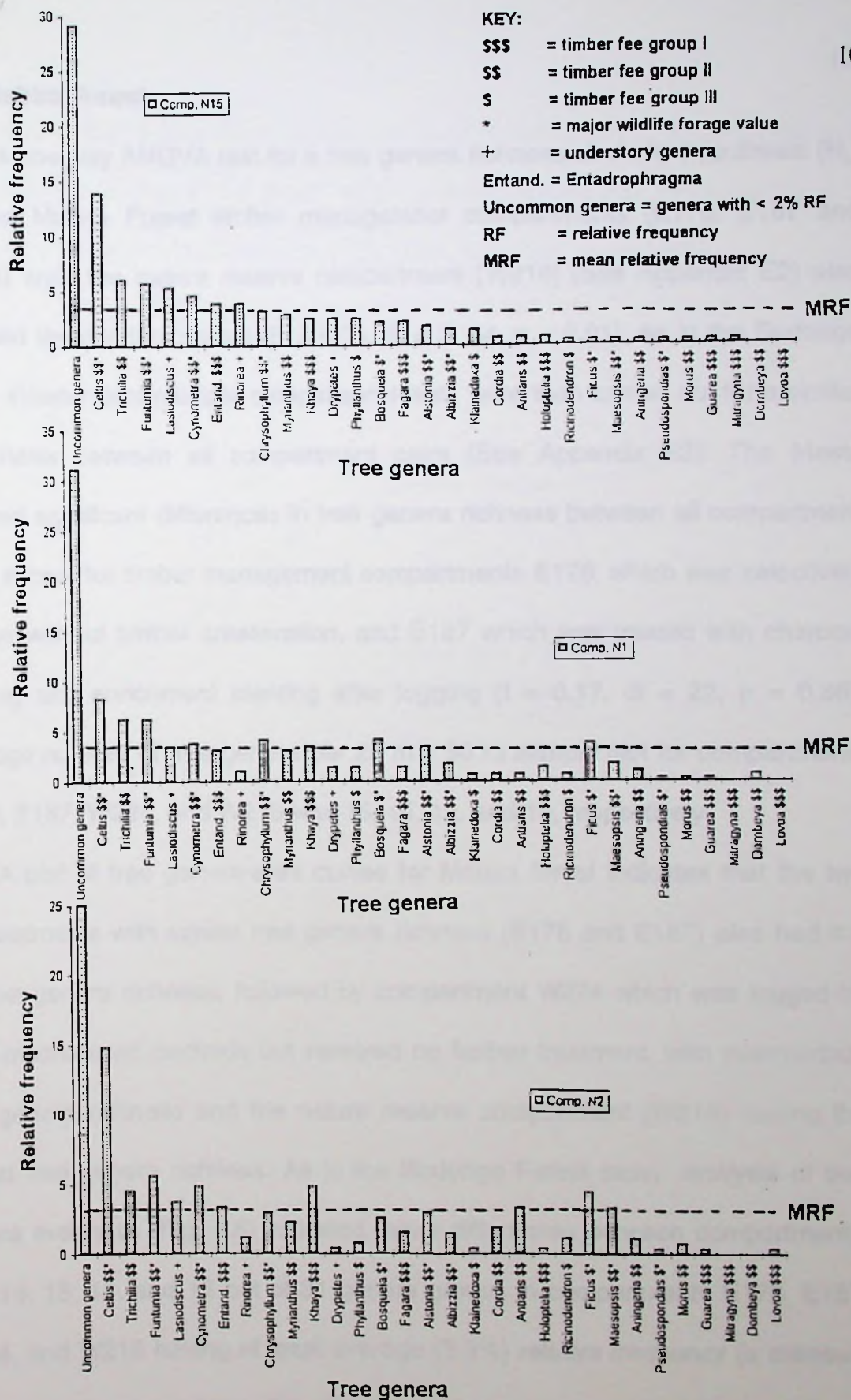


Fig. 4.4 Relative frequency (expressed as percent presence of stems ≥ 10 cm DBH) of 30 major tree genera and 37 uncommon tree genera (combined) recorded in Budongo Forest case study compartments. Data is sorted by nature reserve compartment (N15) tree genera sequence.

(ii) Mabira Forest

A one-way ANOVA test for a tree genera richness similarity hypothesis (H_0) for the Mabira Forest timber management compartments (E176, E187 and W224) and the nature reserve compartment [W216] (See Appendix E2) also rejected the null hypothesis ($F = 8.06$, $df = 3, 64$, $p < 0.01$). As in the Budongo case, independent multiple comparison t -tests were then carried out for a similar hypothesis between all compartment pairs (See Appendix E2). The t -tests showed significant differences in tree genera richness between all compartment pairs except for timber management compartments E176, which was selectively logged without further amelioration, and E187 which was treated with charcoal refining and enrichment planting after logging ($t = 0.17$, $df = 22$, $p = 0.86$). Average number of tree genera per 25 m x 50 m sample plot for compartments E176, E187, W224, and W216 was 15, 15, 12, and 10, respectively.

A plot of tree genera-area curves for Mabira forest indicates that the two compartments with similar tree genera richness (E176 and E187) also had the highest genera richness, followed by compartment W224 which was logged by semi-mechanized methods but received no further treatment, with intermediate tree genera richness and the nature reserve compartment (W216) having the lowest tree genera richness. As in the Budongo Forest case, analysis of tree genera evenness (Fig. 4.6) indicated minor differences between compartments, with 14, 15, 14, and 13 out of 31 genera groups in compartments E176, E187, W224, and W216 having at least average (3.3%) relative frequency (a measure of evenness), respectively. The Shannon-Wiener tree genera richness [H] and

evenness [E] (equitability) indices followed a similar compartment rank pattern with compartments E176, E187, W224 and W216 having H and E values of 4.83, 4.54, 3.94, and 3.60; and 0.79, 0.76, 0.64, and 0.60, respectively.

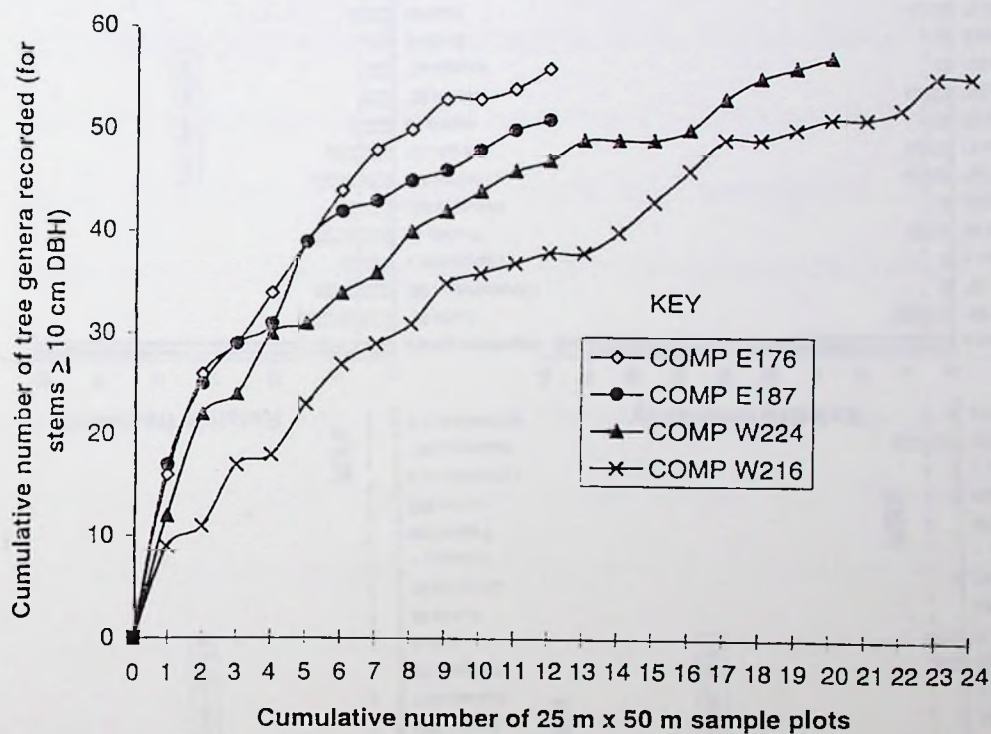


Fig. 4.5 Tree genera-area curves for Mabira Forest case study compartments.

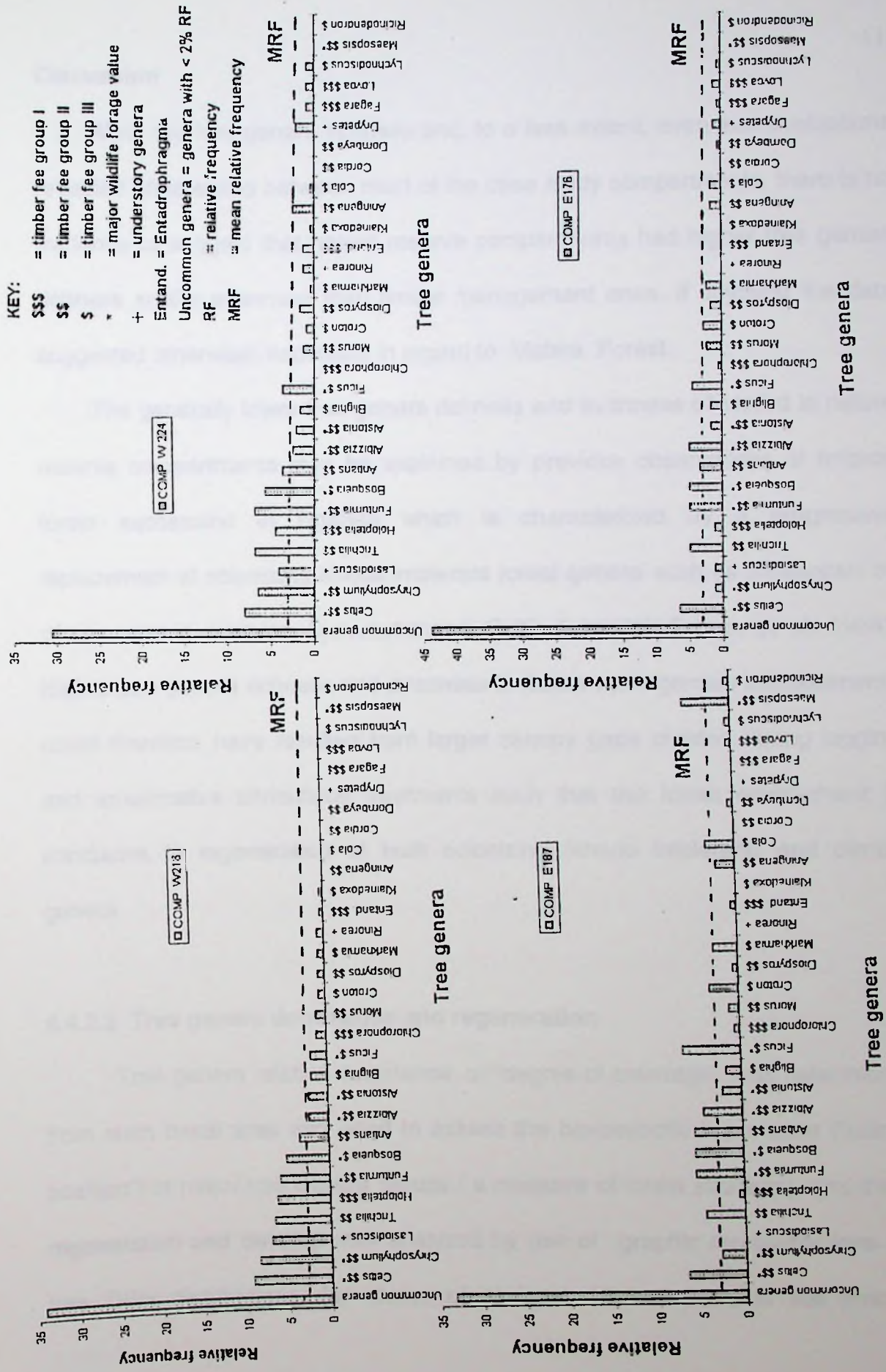


Fig. 4.6 Relative frequency (expressed as percent presence of stems ≥ 10 cm DBH) of 30 major tree genera and 25 uncommon tree genera (combined) recorded in Mabira Forest case study compartments. Data is sorted by nature reserve compartment (W216) tree genera sequence.

Discussion

While the tree genera richness and, to a less extent, evenness evaluations revealed differences between most of the case study compartments, there is no evidence to suggest that nature reserve compartments had higher tree genera richness and/or evenness than timber management ones. If anything the data suggested otherwise, especially in regard to Mabira Forest.

The generally lower tree genera richness and evenness observed in nature reserve compartments may be explained by previous observations of tropical forest succession in Uganda which is characterized by a progressive replacement of colonizing shade intolerant forest genera such as *Maesopsis* by climax genera such as *Cynometra* and *Celtis* (Langdale-Brown, et al. 1964). Higher tree genera richness and evenness in timber management compartments could therefore have resulted from larger canopy gaps created during logging and ameliorative silvicultural treatments such that the forest environment is conducive to regeneration of both colonizing (shade intolerant) and climax genera.

4.4.2.2 Tree genera dominance and regeneration

Tree genera relative dominance, or “degree of coverage”, was determined from stem basal area and used to assess the bio-coenotic importance (“ruling position”) of major tree genera groups (a measure of forest structure), and their regeneration and development analyzed by use of graphic representations of tree DBH distributions, for stems of at least 10 cm DBH, in the timber

management and nature reserve case study compartments of Budongo and Mabira Forests.

(i) Budongo Forest

Dominance-genera sequence curves (Whittaker, 1965) were graphed for Budongo Forest case study compartments (Fig. 4.7). The shape of the curves is similar (stable, sigmoid log-normal) for all the three compartments, indicating similar forest structure. Also the high relative dominance by *Cynometra* and *Celtis* is apparent, although there is genera relative dominance rank substitution between compartments, such as *Alstonia* and *Funtumia* having higher relative dominance than *Celtis* and *Cynometra* in compartments N1 and N2 than in the nature reserve, respectively. Nevertheless, *Cynometra* and *Celtis* appear in the top five genera with highest relative dominance in all compartments. Average tree genera basal area was highest in the nature reserve compartment (N15) with 40.21 m²/ha, followed by N1 with 37 m²/ha, and N2 with 27 m²/ha.

Fig. 4.8 shows the diameter distributions for timber fee groups I (most valuable), II and III in Budongo case study compartments. The data indicates that regeneration of all timber fee groups is generally better in timber management compartments than in the nature reserve, especially timber fee groups I and III. Regeneration of mahogany genera is best in compartment N1 where enrichment planting was done, although its regeneration in N2 is almost as good which brings into question the justification for costly enrichment planting operations.

Diameter (DBH) distributions for understory genera, uncommon genera, and all genera combined are shown in Figure 4.9. The graphs for all the three genera groupings follow the same pattern, whereby the nature reserve compartment (N15) has the highest stem numbers per hectare for most DBH classes, followed by compartment N1 and N2, respectively. The reason for this trend is that understory genera such as *Lasiodiscus* and *Rinorea* have very numerous stems in the nature reserve compartment where they regenerate best under a closed canopy, although they do not attain high diameters, while more stems in the higher diameter classes in the nature reserve are evident due to the absence of logging and other silvicultural treatments that reduced large diameter stems in compartments N1 and N2. Tree genera regeneration (DBH class 10 - 20 cm) for all genera combined was highest in the nature reserve compartment (N15) with 272 stems/ha, followed by N1 with 216 stems/ha, and N2 with 107 stems/ha. The reason for compartment N2 having much lower regeneration is not clear although more intensive utilization by adjacent local communities is a possible reason.

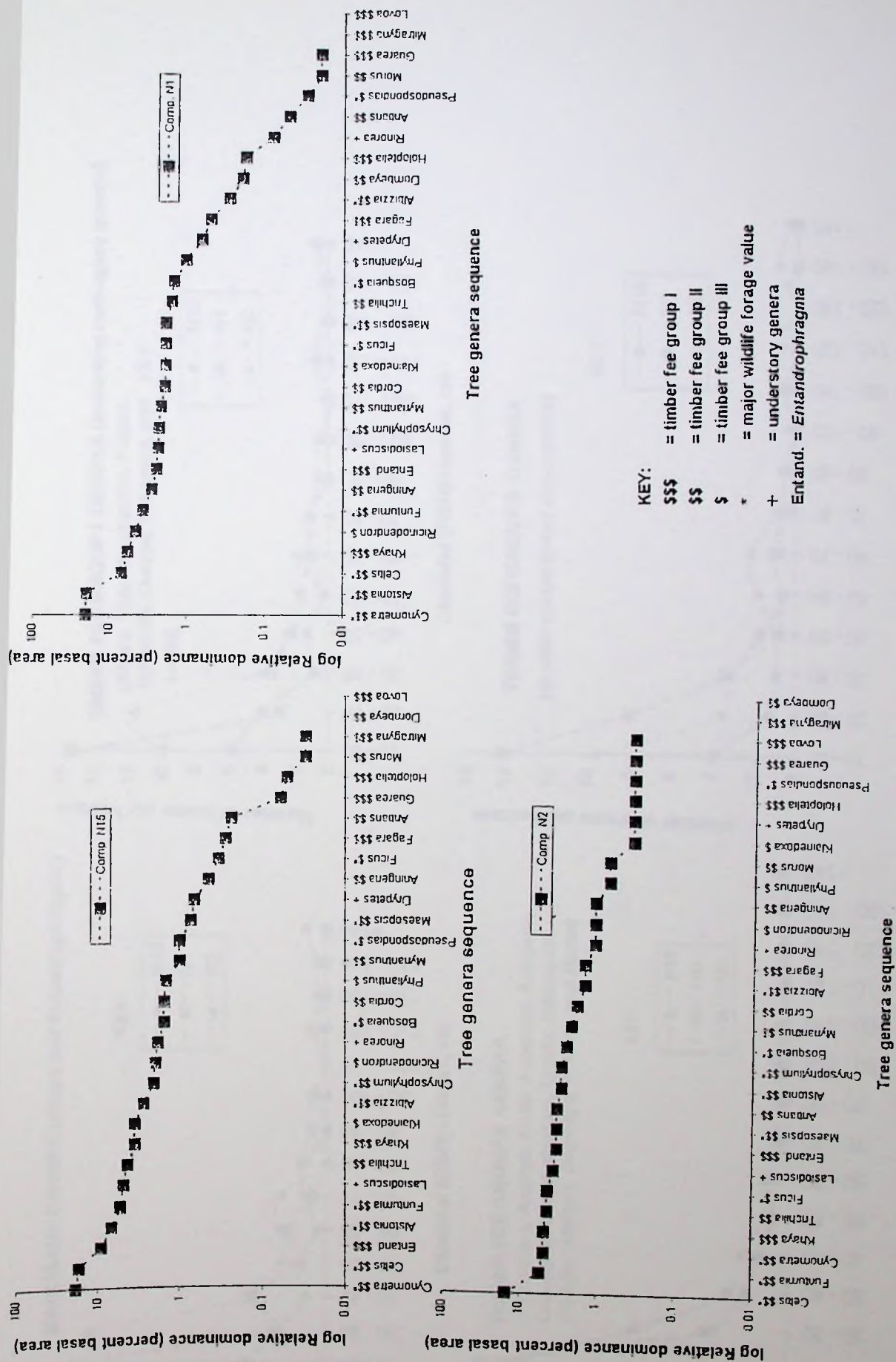


Fig. 4.7 Dominance-diversity curves (Whittaker, 1965) for Budongo Forest case study compartments. Data is for 30 most economically and ecologically important tree genera with stems ≥ 10 cm DBH.

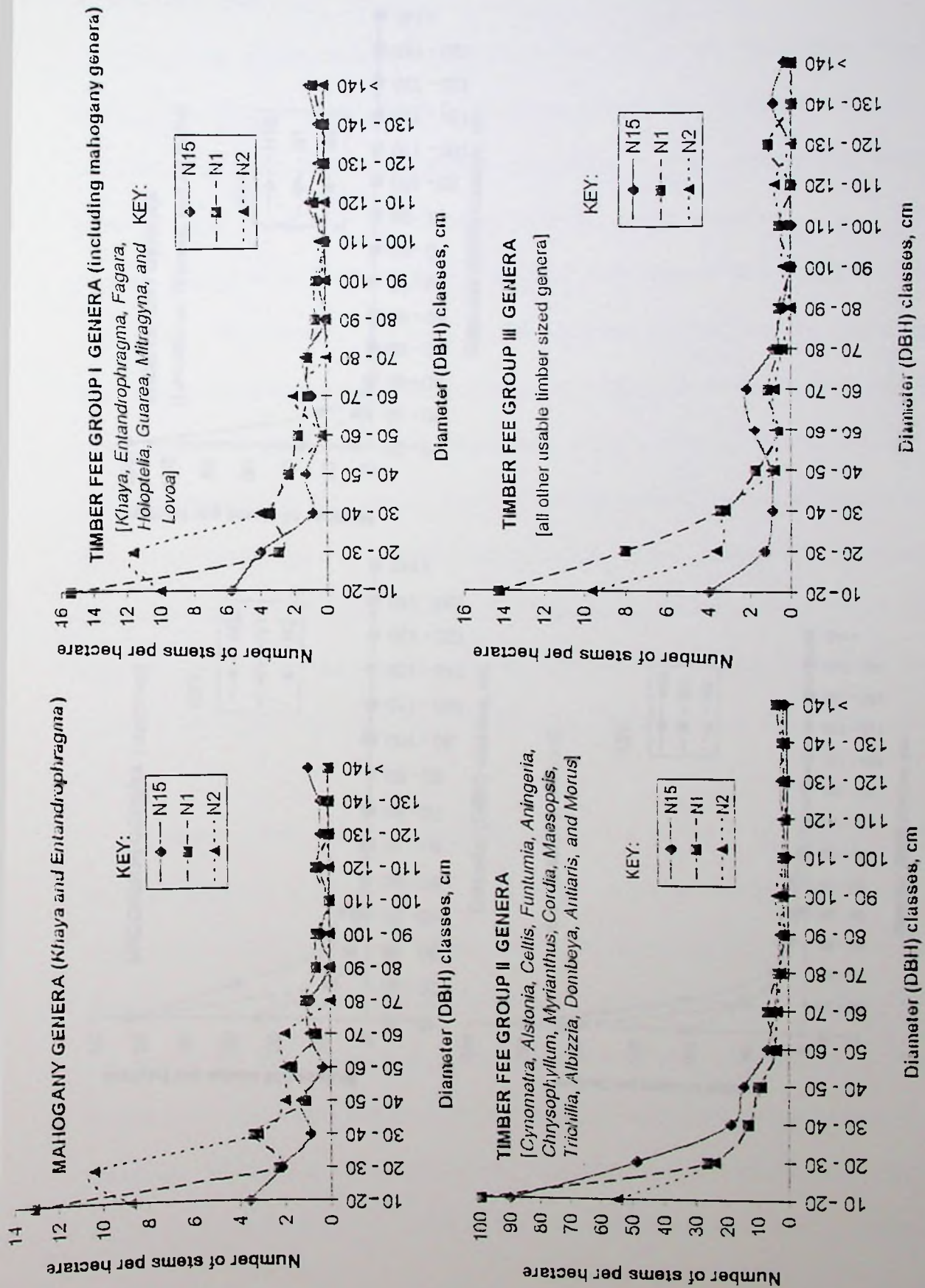


Fig 4.8 Diameter distributions of important timber genera recorded in Budongo

Forest case study compartments. Data is for stems with ≥ 10 cm DBH.

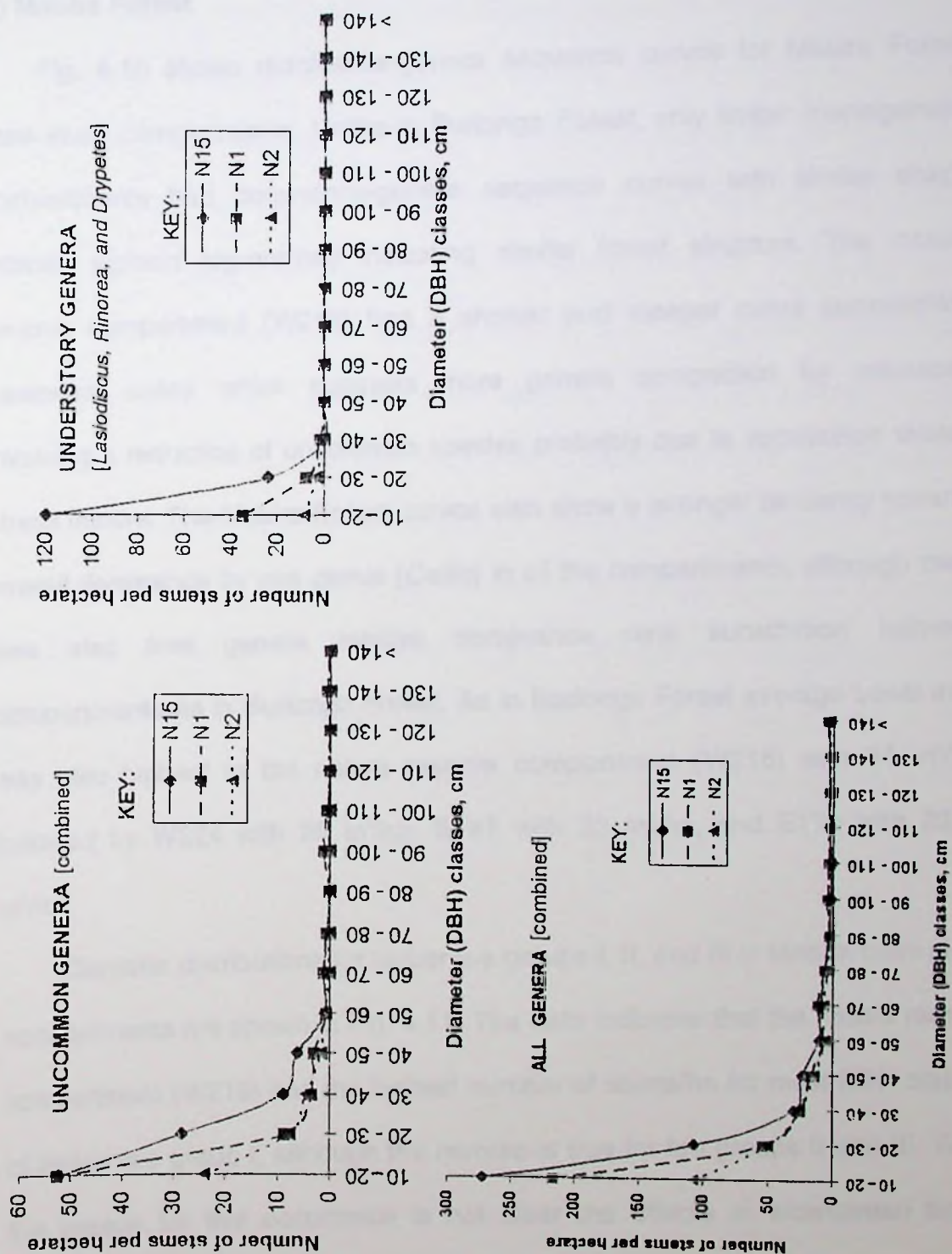


Fig. 4.9 Diameter distributions of understory genera, uncommon genera, and all genera combined, recorded in Budongo Forest case study compartments. Data is for stems with ≥ 10 cm DBH.

(ii) Mabira Forest

Fig. 4.10 shows dominance-genera sequence curves for Mabira Forest case study compartments. Unlike in Budongo Forest, only timber management compartments had dominance-genera sequence curves with similar shape (stable, sigmoid log-normal) indicating similar forest structure. The nature reserve compartment (W216) had a shorter and steeper curve approaching geometric series which suggests more genera competition for resources involving a reduction of uncommon species probably due to succession related stress factors. The Mabira Forest curves also show a stronger tendency towards overall dominance by one genus (*Celtis*) in all the compartments, although there was also tree genera relative dominance rank substitution between compartments as in Budongo Forest. As in Budongo Forest average basal area was also highest in the nature reserve compartment (W216) with 34 m²/ha, followed by W224 with 29 m²/ha, E187 with 23 m²/ha, and E176 with 22.07 m²/ha.

Diameter distributions for timber fee groups I, II, and III in Mabira case study compartments are shown in Fig. 4.11. The data indicates that the nature reserve compartment (W216) had the highest number of stems/ha for most DBH classes of timber fee group I, although the reverse is true for fee groups II and III. While the reason for this occurrence is not clear the effects of widespread timber poaching of high value timber in timber management compartments cannot be ruled out. *Maesopsis eminii* which was planted during the charcoal production phase during silvicultural treatment of the forest appears only in the compartment

(E187) where it was planted. Maintenance of this shade intolerant (colonizing) species in Mabira therefore seems to be dependent on enrichment planting.

Diameter distributions for understory genera, uncommon genera, and all genera combined for the Mabira case study compartments are shown in Fig. 4.12. Unlike in Budongo Forest, understory genera such as *Lasiodiscus*, *Rinorea* and *Drypetes* are missing from compartment E187 where the open canopy created by logging and charcoal burning operations probably prevented their regeneration. Also, while the nature reserve compartment (W216) has the largest number of trees per hectare with DBH above 40 cm for all compartments, (most likely due to absence of logging), it shows poorer regeneration (fewer stems per hectare in the small DBH classes) than compartment E176 for both uncommon and all genera groups combined. Tree genera regeneration (DBH class 10 - 20 cm) for all genera combined was highest in compartment E 187 with 291 stems/ha, followed by the nature reserve (W216) with 256 stems/ha, then E187 with 235 stems/ha and E176 with 177 stems /ha.

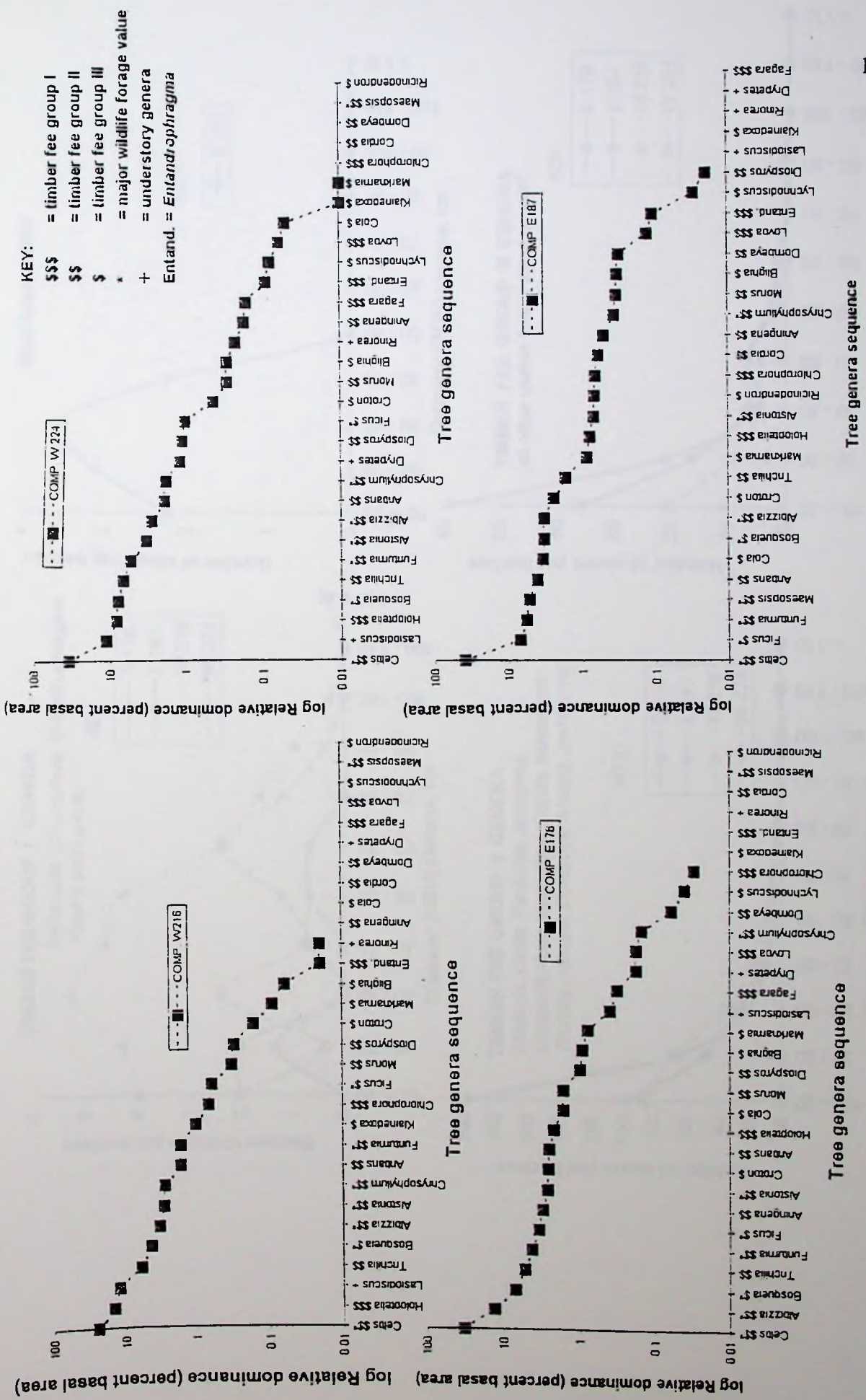


Fig. 4.10 Dominance-diversity curves (Whittaker, 1965) for Mabira Forest case study compartments. Data is for 30 most economically and ecologically important tree genera with stems ≥ 10 cm DBH.

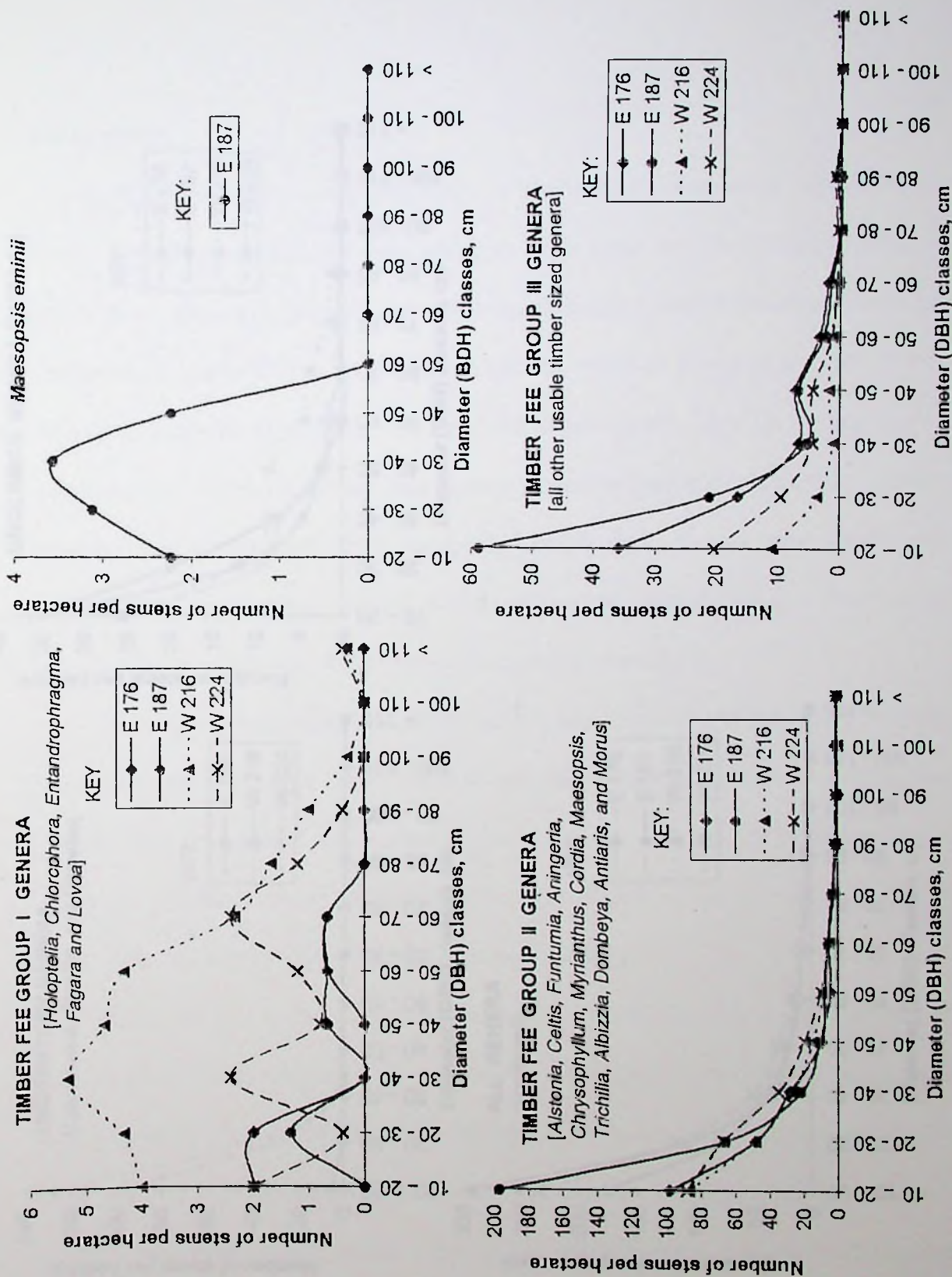


Fig 4.11 Diameter distributions of important timber genera recorded in Mabira Forest case study compartments. Data is for stems with ≥ 10 cm DBH.

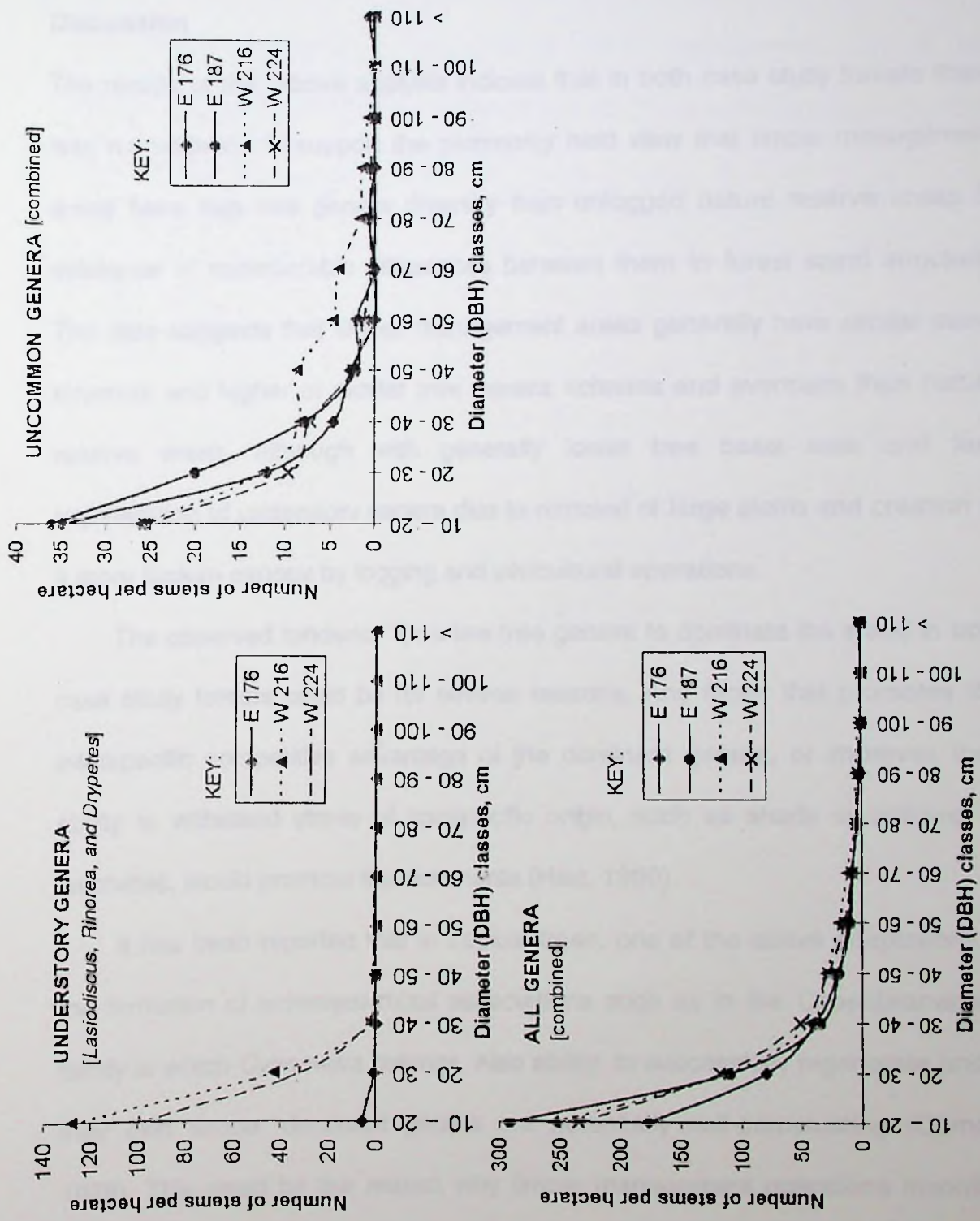


Fig. 4.12 Diameter distributions of understory genera, uncommon genera, and all genera combined, recorded in Budongo Forest case study compartments. Data is for stems with ≥ 10 cm DBH.

Discussion

The results of the above analysis indicate that in both case study forests there was no evidence to support the commonly held view that timber management areas have less tree genera diversity than unlogged nature reserve areas or existence of considerable differences between them in forest stand structure. The data suggests that timber management areas generally have similar stand structure and higher or similar tree genera richness and evenness than nature reserve areas, although with generally lower tree basal area and less regeneration of understory genera due to removal of large stems and creation of a more broken canopy by logging and silvicultural operations.

The observed tendency for a few tree genera to dominate the stand in both case study forests could be for several reasons. Any factor that promotes the interspecific competitive advantage of the dominant genera, or improves their ability to withstand stress of conspecific origin, such as shade or build-up of leachates, would promote the dominants (Hart, 1990).

It has been reported that in tropical trees, one of the above adaptations is the formation of ectomycorrhizal associations such as in the *Caesalpinaceae* family to which *Cynometra* belongs. Also ability to successfully regenerate under their own shade, dominant genera are potentially self-perpetuating (Cornell, 1978). This could be the reason why timber management operations involving only partial canopy opening did not prevent the forest structure in the case study timber management compartments to recover a few decades after logging and silvicultural treatments. However, it is worth mentioning here that any differences

between timber management and nature reserve areas may not be solely attributed to presence or absence of timber management due to other biophysical factors such as variations in site quality, forest succession stage and utilization history.

as partially demarcated British Crown Forest Reserves (Philip, 1964). This was followed by the gazetting of Kitigo Block as an undemarcated reserve in 1939.

The Nyakafunjo, Waibira, and Siba forests were described as being reserved mainly for timber production, and their designation with that of Kitigo forest were changed from Crown to Central Forest Reserves to be managed by the Forest Department in 1948. This was done following enactment of the Forest Ordinance of 1947 by which gazetted forests were classified into three categories; Central Forest Reserves (CFR) under the control of the Forest Department; Local Forest Reserves (LFR) under the local government authorities but with supervision by the Forest Department; and Village Forests (VF) to be designated by local authorities for the benefit of local communities (Philip, 1964).

Under the Public Lands Ordinance of 1962, ownership of all land in Bunyoro, including all forest reserves, was vested in the Bunyoro Kingdom Land Board which was empowered to make bye-laws relating to local land use. However, the forest reserves were to be administered by the Uganda Government in accordance with the Uganda Independence Order in Council of 1962 and were to be so administered until such a time when the Bunyoro Kingdom had adequate staff and resources to administer them.

The only privileges to local people then were, and still are, those common to all forest reserves, which permit the harvesting of forest products for their own domestic use but not for sale (Philip, 1964). The 1962 Ordinance was revoked with the abolition of traditional Kingdoms in 1967. Although traditional Kingdoms have been re-instated since the late 1980s, they only have a cultural role and no control

over public resources such as forest reserves. The forest blocks comprising Budongo Forest Reserve, previously gazzeted as separate reserves were amalgamated by Legal Notice No.11 of 1963 into a single forest reserve, more or less the way it exists today.

(ii) Mabira Forest

Mabira Forest Reserve covers an area of 303 km² consisting of 2 blocks of forest (See Fig. 3.2 in chapter 3); West Mabira (112 km²) and East Mabira (191 km²) located in Mukono District, within the Kingdom of Buganda, in central Uganda (See Fig. 2.4 in chapter 2). Established in 1900 by an agreement between the British government and the Kingdom of Buganda, it was officially gazetted as a Crown forest reserve in 1932 under Legal Notice No. 8 for timber and wild rubber production. A re-gazetting of Mabira and other forest reserves in the Buganda Kingdom was done under Legal Notice No. 79 of 1962 after exchanges of land in the forest with private estates which had encroached on the reserve so as to consolidate forest boundaries.

Unlike in Budongo Forest, the re-gazetting left 10 enclaves totalling 56 km² of public and private land completely surrounded by the reserve boundary in addition to numerous villages around the very irregular forest boundary in a "peninsula-lagoon-like" pattern (See Fig. 4.2 in chapter 4). Some of these enclaves were a result of various leases granted in the past over parts of the forest for rubber and coffee production, but in view of the extended lengths of time before expiring it was decided by the Forest Department that these should not be included in the forest

re-gazetting of 1962 and were excised from the reserve. The Forest Department must now be regretting this and similar other decisions made later because of the extensive encroachment emanating from these enclaves.

Local people have no forest rights except for some limited privileges to collect water, medicinal plants, palms, and firewood and poles of non-timber tree species in reasonable quantities for their domestic consumption but not for sale, just as in other forest reserves in the country. Mabira forest Working Plans have also always prescribed that domestic animals shall be allowed to water and have access to salt licks in the reserve. Grazing is allowed only at the discretion of the District Forest Officer who issues a permit for it. Any kind of hunting is legally not allowed although it has always been done almost unhindered.

Discussion

Presently, the reserves are managed by the Forest Department with the responsibility of implementing government forest policy of sustainable multiple-use management and enforcement of legislative provisions governing forest management and use. Current legislation regulating the use of forests is stipulated in the Forest Act of 1964 which is largely another version of the British colonial legislation drafted early this century. There are local variations in the rules governing different areas of Uganda but the following legal provisions are widely applicable to forest reserves (Howard, 1991):

- cultivation, residence and livestock grazing in the forest reserve requires a permit issued by a Senior Forest Officer;

- certain species of trees are designated as reserved forest produce, and may only be cut with Forest Department permission;
- local people can make use of unreserved forest produce, which they may take from reserved or public forest land in reasonable quantities for their domestic use without a permit or payment of fees; and
- 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 a fee.

It is very clear from the foregoing, that timber management objectives were instrumental in the establishment of legal protection for Budongo and Mabira Forest Reserves. The forestry law is generally enabling in providing a framework for sustainable management and control of the forest reserve which is implemented through the use of detailed Working Plans, Departmental Standing Orders, the Forest Manual, and Guidelines for Forest Guards which prescribe the administrative and technical procedures of forest resources protection, regulation, and conservation. There are some other land use laws that reinforce the Forest Act. These include laws on wildlife, land ownership, mining, population settlement, and fire control. Also all local governments had bye-laws on forestry until 1968 when local governments were abolished.

Nevertheless, some parts of the Forest Act are outdated and do not adequately address the more recent developments relating to forest reserve management. For instance, the penalties and cash fines stipulated in the law have completely lost their deterrent effect with the passage of time due to inflation and

the local government bye-laws are in limbo. Law enforcement by the Forest Department staff in Budongo and Mabira forests, like in all the other reserves, has also been a big problem especially in recent decades due to civil strife, socioeconomic hardships and the resultant low staff motivation. Also because a large portion of the local population is illiterate, ignorance about the legal provisions relating to forest resources abounds. Laws and regulations therefore need to be communicated to the public in an easily understandable form, where necessary, in local vernaculars so as to reach all interested parties.

The Forest Act is presently being reviewed (Kamugisha and Cornelia, 1996) at a time when other relevant laws and a new national constitution are in place. This should provide a good opportunity for rectifying the shortcomings of the current legal provisions relating to forests. At the same time local governments are being re-established through a national decentralization program. This process should also be an opportunity to enlist local participation in the legal review process and the re-introduction of necessary local government bye-laws relating to forest management and utilization.

5.3.1.2 Forest management plans

(i) Budongo Forest

The management and control of Budongo, as in other forest reserves in the country, is facilitated by the use of Working Plans which describe the ecological conditions of the forests and set out the objectives of management and

prescriptions for achieving those objectives for a given period of time, usually ten years. The first working plan for Budongo Forest Reserve was prepared in 1934, followed by subsequent revisions for ten year periods, 1944-1954, 1954-1964 and 1964-1974 (Philip, 1964).

During this 40 year period a great deal was achieved in the evolution of methods used in natural forest timber management, which included assessment and mapping of timber resources, yield control, silvicultural treatments, and forest boundary demarcation and maintenance. However, since 1974 there were no new Working Plans for Budongo Forest reserve until 1992 when a 2 year period Interim Management Plan was prepared during the course of the Forestry Rehabilitation Project.

(ii) Mabira Forest

Although Mabira forest has been used by indigenous tribes longer than its recorded history, it came into national prominence early this century at a time when the exploitation of wild rubber in Africa became a lucrative business. The wild rubber extraction in Mabira, however, did not last long and ceased shortly after World War II. Large scale timber exploitation in the reserve began in 1906 when the first sawmill operations were initiated, but the operations were haphazard and it was not until 1944 that systematic timber management was embarked on.

Due to serious shortages of staff, no silvicultural operations could be carried out until the end of World War II when the first Working Plan was prepared in 1948 for all the central Uganda forest reserves (south Mengo forests), of which Mabira

is a part. This plan expired in 1957 but as revision could not be undertaken, its validity was extended from year to year until 1961 when the latest Working Plan for the period up to 1971 was prepared.

As in the case of Budongo and other forest reserves in the country, this latter plan was not replaced until 1994 when a 2 year period Interim Management Plan was prepared for Mabira forest as a separate management entity. All the three plans spell out prescriptions for implementation of multiple-use policy objectives of wood production, watershed protection, and biodiversity conservation, with sustained yield production of timber as the dominant commercial forest use. The plans were prepared basing on forest sample enumerations and other related research work, and management prescriptions adjusted as more experience in management was gained (Webster, 1961; Mugumya and Shabomwe, 1994).

Discussion

Because Budongo and Mabira Forest Reserve have always been mainly managed for timber production, the various management plans have almost no prescriptions for sustainable management of non-timber resources such as wildlife, apart from the rather passive protection of the reserve from encroachment (Philip, 1964; Webster, 1961). Even for timber management, there haven't been any new or revised Working Plans for Budongo and Mabira, except for the rather sketchy Interim Management Plans prepared in 1992 and 1994, respectively, to cover a period of two years only (Mpangire et al., 1993; Mugumya and Shabomwe, 1994).

The purpose of the interim plans was to develop short-term management prescriptions aimed at protecting and rehabilitating the reserves for a two year period during which more detailed and long term Working Plans would be prepared basing on the 1992 forest inventory. It is now almost three years since the first interim management plan expired but the expected Working Plans have not been prepared due to apparent lack of technical know-how and experience (Kamugisha and Cornelia, 1996). The Working Plan Section of the Forest Department is no longer in existence and the expatriate staff who prepared the now expired Working Plans have left the country, including the tropical forest ecology expert whose work was to ensure that all management decisions were ecologically sound.

Without up-to-date management plans, management at the reserve level has faltered, is reactive and considerable uncertainty looms over its future direction, especially in regard to silvicultural treatments (Kamugisha and Cornelia, 1996). There is therefore an urgent need to prepare new management plans to take care of prescriptions for recent developments such as forest reserve zoning and re-designation. It is also necessary to rebuild capacity to re-establish formal management plan implementation procedures; otherwise current forest reserve management planning is unsustainable.

5.3.1.3 Forest reserve demarcation and boundaries

(i) Budongo Forest

Budongo Forest Reserve is located on the eastern edge of the western Rift Valley, east of Lake Albert. The reserve straddles the counties of Bughaya (in Hoima District), Buliisa, Bujenje, and Bururi (in Masindi District), $1^{\circ}37'-2^{\circ}03'N$, $31^{\circ}22'-31^{\circ}46'E$; and is covered by the Department of Lands and Surveys map sheets: 30/III, 30/IV, 38/II, 38/IV, 39/I, 39/II, 39/III (Series Y732) at 1:50,000 scale, and several forest management maps (at 1:10,000 scale), as well as aerial photographs taken in 1952, 1961 and 1985 by private air survey firms.

Establishment of Budongo Forest Reserve boundaries dates back to 1955 after conclusion of negotiations between the Bunyoro Kingdom and the British colonial government (Philip, 1964). The boundaries of Siba, Nyakafunjo and Waibira forest blocks were chosen wherever possible to follow natural features, mainly streams or the summits of prominent hills. Elsewhere, the reserve boundary was kept as short as possible (using straight lines), except where this would include existing human habitation or large areas of grassland better left for cultivation.

Re-demarcation of the reserve boundary began in 1956 and continued intermittently until early 1961 when it was completed. Where the boundaries do not follow natural features such as rivers, they have been marked with numbered concrete posts at all corners, as well as direction trenches and cairns. Budongo forest reserve is contiguous with the Murchison Falls National Park (3,840 km²)

and Bugungu (748 km²) and Karuma (713 km²) Game Reserves on the northern and western boundaries, respectively (Philip, 1964). The length of the external boundary of the reserve is 280 km, of which 110 km is natural features such as river courses, leaving 170 km of boundary requiring regular maintenance (Mpangire et al., 1993).

Due to gradual increasing pressure from the neighboring population, it was decided in 1963 to maintain the southern section of the reserve boundary as a patrolled footpath (Philip, 1964). Boundary line-cutting, however, lapsed during the late 1970s and most of the 1980s, only to be resumed with the launching of the World Bank financed Forestry Rehabilitation Project in 1988 (Howard, 1991). Presently, boundary maintenance activities include brush slashing, planting of live tree markers and foot patrols (Mpangire et al., 1993). Forest Rangers, Guards, and Patrolmen are in charge of each of the eight blocks, with each Patrolman maintaining 10 km of boundary per month. The Patrolmen are recruited from the local communities around the respective Ranger posts.

(ii) Mabira Forest

Mabira Forest Reserve is located 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 of Mukono District, 32°52'-33°07'E, 0°24'-0°35'N; and is covered by the Department of Lands and Surveys map sheets 61/IV, 62/III, 71/II and 72/I (Series Y732) at 1:50,000 scale, and several forest management maps (at 1:10,000 scale), as well as aerial photographs taken in 1948, 1955, and 1985.

The history of the demarcation of Mabira is described with that of other south Mengo forests in the 1948-1957 Working Plan (Sangster, 1948). Current reserve boundaries were revised in 1962 under Legal Notice No. 79, after some adjustments following exchanges of land with private estates in the area. Three small forests, Namawanyi, Namananga and Kalagala (with a waterfall) all totaling 360 ha were transferred from local government reserves to Mabira under Statutory Instrument No.176 of 1968 after the abolition of local governments in Uganda (Mugumya and Shabomwe, 1994). The Mabira Forest Reserve boundaries are marked by earth cairns built over serially numbered concrete boundary markers at each corner, and hoed footpaths between the cairns. There are also direction trenches at the corners and on each cairn a fig tree, *Ficus natalensis* or *F. brachypoda*, or a *Dracaena* shrub has been planted.

When the boundaries were being re-opened after World War II, seed of *Cassia spectabilis* was sown near the cairns and at regular intervals along the boundary lines. Where they survived, these distinctive *Cassia* are now over 30 feet tall and the boundaries are well established, especially where local people use them as footpaths. The length of Mabira reserve boundary is 398 km, which is 118 km longer than that of Budongo Forest Reserve (which is more than twice the size of Mabira) due to its extremely irregular "peninsula-lagoon-like" shape. As in other forest reserves in Uganda, boundary maintenance of Mabira lapsed since the early 1970s only to be resumed in 1988 (Howard, 1991). Currently, patrolmen are stationed at 10 km intervals along the boundary to keep guard of the reserve and

local labor hired to maintain the boundary by slashing around cairns and direction trenches (Mugumya and Shabomwe, 1994).

Discussion

Budongo and Mabira Forest Reserve boundaries are presently clearly marked and well maintained. As long as the Forest Department can continue to maintain them, the boundaries should remain secure for a long time to come. However, with the drying up of financing from the World Bank financed Forestry Rehabilitation Project (FRP), failure by the Forest Department to maintain the reserve boundaries cannot be ruled out entirely. Boundary maintenance has proved to be a very expensive operation. In Mabira forest reserve, for instance, the operations cost about US\$ 3,000 to 4,000 per year (Mugumya and Shabomwe, 1994) and during the period 1948 to 1960 they cost half of the total expenditure on the reserve (Webster, 1961).

The financial and human resources available to the Forest Department are inadequate to carry out the task of policing the reserves effectively and forestry staff and workers are poorly paid and hence have little motivation to carry out their duties. As a result, forest users who choose not to comply with the forest law can easily escape detection (Banana and Gombya, 1996). Hopefully, the government decision to allow the department to retain part of the revenue from forest product sales (Kamugisha and Comelia, 1996) and the general improvement of the national economy will give a financially enabling environment for the department to continue maintaining forest reserve boundaries.

5.3.1.4 Illegal exploitation and encroachment

(i) Budongo Forest

Budongo Forest Reserve does not have a history of serious encroachment by farmers mainly due to a low population density in the adjacent areas (Philip, 1964). Population densities in the surrounding 5 sub-counties had at the time of the 1980 population census an average of 106 persons per km² which is less than half of that of Mabira Forest Reserve with an average of 228 persons per km² and where encroachment is a more serious threat to the forest (Howard, 1991). Nevertheless, aerial photographs of Budongo taken in 1985 revealed a few small areas of agricultural encroachment in the southern Siba forest block. This small scale encroachment on the reserve is very likely to be a result of laxity of forest management staff and lack of boundary maintenance prior to 1988.

(ii) Mabira Forest

Unlike Budongo and other forest reserves in the country, Mabira forest has quite a long history of illegal activities. According to the 1961 Working Plan records, from 1948 to 1953 illegal felling by licensed sawmillers and pitsawyers was serious due to inefficient supervision (Webster, 1961). If the culprits were caught, the offenses would be compounded but many pitsawyers are reported to have escaped without penalty.

However, apart from the loss of revenue and seed trees, illegal felling was not regarded as a serious threat to the productivity of the forest at this time; and after introduction of the "footpath" system of boundary maintenance and patrolling, there was a marked decrease in the number of offenses (Webster, 1961). A considerable increase was reported in 1959/60 and attributed to the exhaustion of private forests and this trend was rightly predicted to continue. It is important to note that unlike other tropical forest soils in Uganda the bright red clay soils derived from amphibolite rock characteristic of Mabira is richer in bases than granites and schists and correspondingly more fertile (Webster, 1961).

In 1948, encroachment by peasant farmers was reported as being on a comparatively small scale but during the following years it was regarded as a major problem and it has continued until the early 1990s when all of them were evicted *en masse*. The Forest Department unwittingly contributed to the severity of the problem to some extent. After realizing that some encroachers had established perennial crops and had been cultivating undetected in the reserve for a considerable number of years with temporary licenses erroneously issued by the local chiefs, the department legalized their occupancy by the creation of a new residence license No. H.1. under the Forests Ordinance of 1950 (Webster, 1961).

The new license allowed the Forest Department to plant mahogany and *Chlorophora excelsa* trees within the encroached areas at close spacing in the hope that as the trees grew up and competed with food and other crops, the encroachers would leave the area. This apparently short-sighted expectation was dashed by considerable obstruction from encroachers when the department

attempted to plant the trees in 1952 and 1953. The program flopped as there was no way of protecting the seedlings in the widely scattered encroachment plots. In spite of putting increased pressure on the unlicensed encroachers by serving eviction notices, there was little decrease in their numbers. The problem became so serious that in 1961, an Assistant Forest Officer was appointed to assist the District Forest Officer with encroachment cases on a full-time basis. During that year the total area of encroachment was 1.5 square miles in Mabira forest (Webster, 1961).

As mentioned earlier in this chapter, there were several cases of encroachment even by estate owners which were regularized in 1962 by exchange of land or by leasing the encroached areas to the companies concerned. Since the 1950s, there has also been a steadily growing pressure on the Forest Department to give up land for the growing of plantation crops such as sugar, tea and cocoa due to the fact that the forest estate is now the largest area of unsettled land left in the country's central region. Despite some resistance to these pressures the Forest Department has had to occasionally give in like in 1983 when a 40 year license was issued to Uganda Tea Corporation to establish a 200 ha fuelwood plantation and shortly after another license issued to a private company to plant a Cardamon spice crop on 30 ha in 1986 (Mugumya and Shabomwe, 1994).

A census of encroachers in Mabira was carried out in by the Forest Department in 1988 (Howard, 1991). During the census, 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 the reserve) was found to be under cultivation. All the cultivation permits issued previously by the Forest Department to 917 (27%) of the encroachers had expired between 1982 and 1986 and this was the basis of having all of them evicted *en masse* during the early 1990s as part of the Forestry Rehabilitation Project (FRP) activities initiated in 1988. Nevertheless, illegal activities have become so much part and parcel of Mabira that the 1994 Interim Management Plan projected a revenue of Uganda Shillings 4 million (US\$ 4,000) from seized forest contraband, which was 11% of total revenue expected from the reserve for the two year period of the plan.

Discussion

Apart from agricultural encroachment which is relatively easy to monitor, a more serious threat to the two reserves is illegal selective timber harvesting (high grading) by pitsawyers. During the field data collection phase of this study pitsawing sites were evident in all the areas visited, especially in the part of the reserve adjacent to local settlements. As if to dramatize the problem, one tree was even felled in the vicinity of one research site in Budongo forest as data for this study was being collected, although the pitsawyers fled when they were approached.

The Forest Department field staff are regularly preoccupied with reserve patrols which often result in impounding large amounts of timber in the forest and sometimes in big truck loads on the road to the market. On the edges of the two

forest reserves are small trading centers teeming with unemployed youth whom the forestry staff told us were the ones mostly engaged in illegal pitsawing, sometimes even at night to evade staff patrols. There was also evidence of hunting and trapping activity in the reserve although no reliable information was available on its scale and impacts on wildlife populations in the forest reserve.

If the high level of illegal pitsawing in Budongo and Mabira forest reserves continues unchecked, it will most certainly compromise sustainable timber management even in the short term and eventually erode the genetic integrity of the reserves because of the extensive high grading practices characteristic of the illegal practice. Pitsawing was initially allowed and meant for salvage operations, provision of employment and timber to the local people and for harvesting in difficult terrain; however it has now become very controversial issue and a big threat to sustainable tropical forest management. The Forest Department currently allows pitsawing only in private forests and public forest land outside gazetted forest reserves (where it has been banned but continues illegally).

Licenses for pitsawing are applied for and obtained from the Forest Department Headquarters through the political administrative system and the District Forest office. Only 4 hand saws per license are allowed although there is no way of ensuring that this provision can be adhered to since land outside forest reserves is out of Forest Department control. The hand saws licensed by the Forest Department for pitsawing outside reserves therefore easily find their way into forest reserves. Besides, from the utilization point of view pitsawing is a very wasteful technology although it has been lauded by conservationists on grounds

that it is more “environmentally friendly” and more compatible with forest conservation than mechanical logging and sawmilling technologies.

Control of illegal activities has not been easy for the Forest Department and this is not expected to change soon. The previous reverence of Working Plans as effective tools that ensured strict adherence to scientific and moral ethics in the Department has almost vanished and there is little control and transparency in the way timber harvesting is conducted (Kamugisha and Comelia, 1996). For instance, the Forest Department has always granted the so-called *free issue* of timber trees to individuals and organizations for special reasons.

The practice was initially a public relations gesture intended to help development initiatives in the local areas such as schools or disaster areas with timber for local construction. This provision has however, been grossly abused and decisions to issue trees are largely based on political grounds. The trees allocated are even converted by pitsawing which is supposed to be banned in reserves. This policy is therefore contradictory and contravenes current forest control regulations. The implementation is also flawed as the pitsawyers end up harvesting more trees than those allocated under *free issue*.

Because control of illegal activities has so far failed, involvement of local people in a joint-management scheme is being considered in the hope that it would create a conservation ethic in the local population and help curb illegal activities. In implementing such a policy however, the Forest Department will have to consider issues concerning forest resources ownership and access. Such tenure issues determine whether local people will be willing to participate in the

management and protection of the forest (Bromley, 1991). Lowry (1990) argues that where forests have little economic value to local people because of restrictive access rules, sustainable local management institutions are unlikely to emerge.

Incentives for conservation by local people can be improved by increasing the value of the resource to local people by, for instance, granting more access rights or by granting them a share of forest concession revenue. None of these measures have been adopted by the Forest Department so far. Insecurity of land tenure and restricted access for the local communities is a possible reason for the observed widespread degradation of forest reserves in Uganda (Banana and Gombya, 1996). A centralized regulatory state policy that is not backed by adequate resources to enforce its rules has led to the condition where most forest reserves in Uganda are *de facto* open-access resources.

Uganda's Forestry Research Institute is currently conducting studies to find out how a joint management scheme can be effectively implemented (Kahembwe, 1996). Local NGOs are also increasingly getting involved with forest conservation under the Integrated Conservation and Development Projects. These have so far concentrated on extension, non-consumptive use of forests and amelioration of the forest-people interface, with their activities supported by technical backstopping from relevant government departments. Involvement of local people seems to be one of the best ways to curb illegal activities in forest reserves, although the Forest Department has traditionally had a very uneasy relationship with local people who are considered as potential encroachers and a permanent threat to the reserves.

5.3.1.5 Timber harvesting concession agreements

(i) Budongo Forest

Budongo forest reserve is Uganda's most important tropical timber forest, which once supported 28% of the country's standing timber resources on only 65 % of its forest land (Langdale-Brown et al., 1964). Lockwood Consultants (1973) estimated an average of 192 m³ of standing timber exceeding 50 cm DBH per hectare in the unexploited parts of the reserve, more than twice the stocking in Kalinzu forest, Uganda's second best stocked natural forest reserve. The most recent inventory carried out in 1992 has estimated a post-exploitation average stocking of 86.9 m³ of standing timber exceeding 50 cm DBH per hectare (Tindyebwa, 1992).

Timber harvesting concession licenses have been issued to sawmillers since 1934 for a an initial period of 10 years with a possibility of two further 5 year period renewals. At present, there are four sawmills operating in Budongo Forest Reserve and their licenses have recently been renewed.

(ii) Mabira Forest

Large scale commercial timber exploitation began in Mabira forest in 1906 with a sawmill run by the Forest Department, but it was not until 1944 that any form of systematic timber management was embarked on (Forest Department, 1955). Timber harvesting concession licenses have been issued to private companies since 1953 and an area 3,430 ha of forest was harvested in the first 8 years to mid

1960 (Webster, 1961). Exploitation has been more or less continuous since that time although timber stocks are relatively low compared to Budongo and some other forest reserves in the country. Lockwood Cosultants, 1973) estimated 37 m³ of standing timber exceeding 50 cm DBH per hectare. The 1992 Forest Department inventory has put the current average stocking at 60 m³ of standing timber exceeding 50 cm DBH (Tindyebwa, 1993), an increase of about 60% since 1973 probably due to silvicultural treatments applied in Mabira since the 1960s.

Mabira Forest reserve has several unique features relating to timber harvesting. All the timber harvesting licensees operate sawmills in the two cities of Kampala and Jinja, outside the reserve, and one sawmill company in Jinja also operates a plywood factory based on Mabira. Over the last decade or so, uncontrolled timber exploitation by pitsawyers has become such a serious problem that the forest reserve has assumed a major economic importance as a source of illegal timber. Unlike in Budongo forest, illegal timber harvesting operations in Mabira involve use of power saws for felling trees and some times even for ripping.

Discussion

Timber harvesting concession licenses are issued by the Commissioner for Forestry with the approval of the Minister for Natural resources. The licenses authorize the sawmillers to fell and take timber of species and quantities specified in a designated concession, usually comprised of several compartments. The licensees can only fell trees above a specified minimum diameter and the trees are

marked by the Forest Department staff under the supervision of the District Forest officer.

The District Forest Officer may, at his discretion, allow the harvesting of trees below the minimum diameter or restrict felling of some trees above the minimum diameter that are important for silvicultural purposes (e.g. seed trees). Felled trees are measured and marked by the Forest Department staff before they are removed from the felling site by the sawmiller. All felled trees must be removed within a period of one month after which they may be disposed of by the Forest Department without compensation. The sawmiller takes and pays for all usable logs of felled trees at stipulated fee rates. The licensee is obliged to keep proper books of accounts and of mill output which are open for inspection by Forest Department senior staff.

The concession license agreement has numerous terms and conditions which are subject to periodic revision but the following terms generally apply (Philip, 1964):

- The sawmillers may construct roads only on such alignment as approved by the District Forest Officer. The roads are spaced so that logs are not hauled directly on the ground from the felling site to the point of loading on to trucks or to the mill log yard for more than 400 yards or 800 yards if logs are hauled by arches or sulkies. The District Forest Officer may allow wider spacing of extraction roads at his discretion. Main extraction and tracks are maintained by the sawmillers while in their use although the Forest Department has the right

to use them at any time. On termination of the concession licenses, the roads are relinquished to the Forest Department without compensation.

- The licensees are liable to pay compensation to the Forest Department for any damage caused to the forest during the logging operations. All unused lop and top remain the property of the Forest Department although the licensee may use some for sawmill fuel at no extra charge.
- The licensees agree to erect, maintain, and operate an efficient sawmill plant and associated structures for which plans are approved by the Forest Department which allocates the licensees rent free sites for the buildings.
- The concession licenses may be suspended or terminated if the licensees contravene or fails to comply with any terms and conditions of the license or if the sawmill enterprise goes into liquidation. In the event of termination a license, the licensee has the right to appeal to the Minister of Natural resources whose decision is final. The licensee may at any time terminate the license by giving a six months notice to the Forest Department. Three months after the termination of the license, all logs and sawntimber lying within the concession area become the property of the Uganda government and nine months after such termination, all buildings, sawmill machinery and logging equipment likewise become the property of the Uganda government.
- Provided that the licensees satisfactorily comply with the conditions of the licenses, they may have the licenses renewed for two further periods of five years each.

■ A more recent requirement is that sawmillers establish nurseries to raise seedlings for use by the Forest Department to carry out enrichment planting after the logging operations.

The license agreements are a potentially good regulatory tool for forest resource conservation. But as mentioned earlier, adherence to them has mostly not been effected due to limited resources available to the Forest Department for ensuring adequate supervision of timber harvesting operations.

5.3.2 Continuity of Timber Production

5.3.2.1 Timber harvesting rules

(i) Budongo Forest

Timber harvesting rules in Budongo Forest Reserve are stipulated in the concession license agreement as already mentioned earlier in this chapter. The felling and removal of timber are carried out by the licensee who is responsible for the quality of the work of the felling crew. The crews are expected to take care in preventing damage caused to the felled trees and the neighboring trees. The licensee is liable to pay compensation for any damage caused to the forest. The quality of the felling operations is monitored by Forest Department staff. To make sure that minimum felling diameter limits are adhered to, trees to be felled are marked by Forest Department staff prior to being felled.

(ii) Mabira Forest

Timber harvesting rules for Mabira are similar to those of Budongo and other forest reserves in the country. The only difference is in the timber fee structure which varies between the reserves due to differences in timber species and proximity to the urban markets and hence varying transport costs.

Discussion

The regulations governing felling operations have however been difficult to enforce. Felling is done with cross-cut saws but they are used and poorly maintained with very little skill. Power saws are not used in Budongo forest and only by illegal pitsawyers in Mabira forest. The lack of skill in felling is compounded by the presence of butt rot in many of the big trees which makes it difficult to predict the time and direction of their fall. Felling damage to the residual stock is therefore extensive and could seriously compromise the possibility for sustainable timber production if enough time is not allowed for the forest to recover or ameliorative silvicultural techniques applied.

The practice of charging very low royalty fees paid for sound logs and not standing trees does not encourage efficient harvesting practices, degrades a valuable and scarce resource, and does not encourage investment in secondary down-the-line processing beyond sawntimber production. Timber harvesting is also characterized by excessive illegal activities due to problems with law enforcement and there is inadequate control and transparency in harvesting operation (Kamugisha and Cornelia, 1996). As already mentioned earlier in this chapter,

illegal timber harvesting currently poses the biggest threat to sustainable forest management in the two reserves and others in the country.

5.3.2.2 Long-term soil conservation

(i) Budongo Forest

Adverse impacts on forest soils in Budongo forest is mainly due to timber harvesting operations, especially forest road construction. Nevertheless, timber harvesting rules have some provisions for minimizing soil disturbance and erosion. Extraction roads must be constructed on such alignment as the District Forest Officer approves. The roads are also spaced such that logs are not hauled on the ground from the felling site to the point of loading on trucks or to the mill log yard for more than 400 yards, and not more than 800 yards if logs are hauled by arches or sulkies.

Road construction is carried out by both the sawmillers and the Forest Department. The roads constructed by the sawmillers have to stand up to the heavy loads moving in all weather. They have to be of high standard, made of compacted murrum (laterite). The roads are constructed about a year ahead of felling operations and on alignments approved by the Forest Department.

(ii) Mabira Forest

The rules governing soil conservation as it relates to road construction and logging operations in Mabira are similar to those of Budongo and other Forest

Reserves in the country. However, Mabira forest is traversed by a very dense network of logging and 14 public roads, including a major highway between the cities of Kampala and Jinja. Besides, silvicultural treatments in Mabira have mostly involved charcoal burning before enrichment planting is done which exposes the soil and makes it more susceptible to erosion in the short term. Fortunately, the terrain of Mabira forest area is characterized by numerous flat topped hills of moderate height sloping gently into broad valleys with an undulating pattern which minimizes any chances for very serious soil erosion.

Discussion

Regulations governing the construction and maintenance of forest roads have, however been difficult to enforce. Like in the felling operations, extraction is done brutally by hauling the logs along the ground with D7 and D8 Caterpillar tractors which churn-up the skidding trails and log landing stations (Aluma, 1976; Ndemere, 1991). Attempts to persuade the sawmillers to use arches have failed due to their reluctance make the extra investments involved (Philip, 1964). There is considerable soil disturbance and compaction during the logging operations and long-term soil conservation can only be guaranteed by improving logging methods and/or adoption of long rotation periods to allow the soil to recover.

After the licensees have finished using the roads, they are handed over to the Forest Department for its own use and maintenance. However, very little road maintenance is done by both the sawmillers and the Forest Department and most of them are in very poor condition and almost impassable in wet weather. The

roads built by the Forest Department are low grade tracks not suitable to heavy traffic or use in wet weather. Improvements in forest road maintenance are therefore also needed for the long-term soil conservation and sustainability of forest management.

5.3.2.3 Pre-logging timber inventory

(i) Budongo Forest

Exploratory timber sampling started in 1952 and was carried out throughout the forest reserve. The sampling consisted of low percent enumerations using systematic paired samples of chain-wide transects in which booking was made at 2 chain intervals. The results were considered acceptable if sampling errors were less than 20 % and reliable minimum estimates (R.M.E) used to estimate volumes (where R.M.E = sample mean-standard error), (Philip, 1964). Current pre-logging inventory practice consists mainly of stock mapping in which all commercial-size trees are located is also carried out and harvesting schedule maps prepared.

(ii) Mabira Forest

Exploratory timber sampling (enumeration) was first carried out in Mabira in 1947 by the Forest Department ecologist, and stand tables prepared (Webster, 1961). However, pre-logging commercial stock mapping in which all commercial-size trees are located, began in Mabira in 1958. The main objectives of pre-

exploitation enumerations are to define forest types and to provide data required for timber yield control and formulation of silvicultural prescriptions.

Discussion

Pre-logging timber inventory is a good safeguard for sustainable management because the annual allowable cut can be determined. The data obtained is also useful for formulating appropriate management prescriptions. However, timber inventories are very expensive operations which the Forest Department has only been able to carry out with donor funding. If the financial situation of the Forest Department does not improve it will be difficult to conduct the inventories in future. The inventories are also undermined by rampant illegal timber harvesting which should be curtailed in order to maintain sustainable management of the reserve.

5.3.2.4 Records of timber volume harvested

(i) Budongo Forest

After trees are felled by the sawmillers, they are scaled by the Forest Department staff and royalty charged basing merchantable volume of sound logs. Rebates on timber fees are granted on defective logs but not for logs damaged by poor felling techniques. Records of timber volume and areas harvested are compiled by the field staff and submitted to the District Forest Office in the nearby Masindi town every month, from where quarterly and annual reports are prepared.

(ii) Mabira Forest

A procedure similar to the one used in Budongo Forest Reserve for royalty payment and compilation of monthly timber volumes harvested is used in Mabira. Records of timber harvests are compiled by the field based Forest Officer who submits them to the District Forest office in Mukono town for preparation of quarterly and annual reports.

Discussion

The records only reflect timber harvested by sawmillers and are incomplete without the quantities harvested illegally. There is a need to quantify how much timber is illegally harvested such that the annual allowable cut reflects correct timber stocking. If this is not done, the sustainability of timber production cannot be guaranteed.

5.3.2.5 Post-harvest timber stock monitoring

(i) Budongo Forest

Between 1933 and 1944 eleven research plots were established and have been used to study natural regeneration, to develop timber management silvicultural techniques, and to provide crop performance data (Philip, 1964). Since 1958 all areas being treated after timber harvesting have been sampled by permanent inventory sample plots. The period between measurements of these plots was initially fixed at five years, and later at two year intervals after

establishing when most of the damage to the canopy caused by felling has taken place. A comprehensive inventory covering the whole forest reserve was also carried out in 1992 and has provided the basis for current and future timber management prescriptions and harvesting schedules (Tindyebwa, 1992).

(ii) Mabira Forest

In 1947, three research plots were established in Mabira for studying timber crop performance under closed and partially open canopy conditions and also to study forest composition and succession. Since 1961, areas being silviculturally treated after timber harvesting have been sampled by permanent inventory plots to study forest regeneration and growth of the timber crop. The 1992 natural forest inventory also covered the whole of Mabira Forest Reserve and the data obtained is being currently used for formulating future management prescriptions.

Discussion

The 1992 timber inventory reflects the current timber stocking, however, illegal timber harvesting will in the long run undermine the usefulness of the inventory data. It is therefore important to closely monitor both legal and illegal timber harvesting so as to ensure sustainable timber production.

5.3.3 Continuity of non-timber products

(i) Budongo Forest

The continuity of non-timber products is currently difficult to determine due to lack of reliable up-to-date information. There used to be a big demand for building poles from Budongo forest during the 1950s and 1960s (Philip, 1964). At this time there was little difficulty in supplying poles of species that were not good for timber such as, *Celtis*, *Teclea*, *Lasiodiscus* and *Rinorea* species. This has declined due to the development plantations of *Eucalyptus*, *Cupressus* and *Pinus* species. There is little demand for fuelwood cut in the forest due to a low population density and the large quantities of wastewood from the sawmills which can be collected free of charge.

Prior to late 1940s, production of wild rubber was a lucrative enterprise, although its importance has dwindled (Philip, 1964). There has been no tapping of wild rubber since the end of World War II and even much of the crop established on nearby estates is derelict. There is a local demand for rattan cane, but its sparse occurrence makes it uneconomic to work except for a small local industry centered around carpenters employed by the sawmills who occasionally make furniture outside their regular employment jobs. There also used to be a demand for *Cordia mellenii* trees for making dug-out canoes to use for fishing and transport on the nearby Lake Albert (Philip, 1964). Nowadays most of the canoes are constructed from sawntimber and powered by outboard motors. Local people also

harvest other products like rattan canes, medicinal plants and palms for making mats and crafts on a small scale.

(ii) Mabira Forest

As mentioned earlier, Mabira forest gained national prominence at the beginning of the present century as a source of wild rubber. Rubber has been produced since 1906 when the first concession was granted until after World War II when the business in Uganda ceased. At one time 500,000 trees of *Funtumia elastica* were being tapped, but the high costs of clearing dense forest to get to trees and low yields favored the establishment of rubber plantations in the forest using exotic species (Pitman, 1954). Most of these plantations were replaced by coffee estates which still exist as enclaves within the reserve.

Silvicultural practices of the 1960s and 1970s in Mabira involved post-harvest treatment of the forest by converting un-merchantable tree species and logging residue into charcoal before enrichment planting was carried out. In 1968 there were 120 local people licensed to produce charcoal in the reserve and a Forest Department operated Missouri produced 1,729 bags of charcoal in 1973. In 1969 the combined total production was 60,000 bags (1,500 tons) (Earl, 1971). By 1975 when silvicultural operations ceased, charcoal production by the Forest Department had reached 10,000 bags (250 tons) per year (Mugumya and Shabomwe, 1994). During this period, the Uganda Sugar Corporation which runs a sugar estate next to Mabira forest and has a license for collecting firewood from

the reserve, cut 59,792 m³ (stacked) of firewood in 1975 (Mugumya and Shabomwe, 1994).

In 1986, a private company was given a license to plant a spice crop of Cardamon on 200 ha of forest in Mabira in a form of *taungya* system whereby valuable tree seedlings would be allowed to regenerate under the spice crop which would be phased out after tree canopy closure. In 1983, another license was issued to the Uganda Tea Corporation to establish a fuelwood plantation for a period of 40 years on 30 ha of Mabira forest (Mugumya and Shabomwe, 1994). Mabira Forest Reserve is therefore a major source of fuelwood production for Uganda's two largest cities and associated enterprises. The forest is also locally important as a source of building poles, firewood, fibers, wild fruits, medicinal plants and bushment although hunting is banned.

Discussion

Due to the small scale of non-timber forest product harvesting operations, their sustainable production should be guaranteed in the future without compromising the ecological functioning of the forest. However, as demand for forest products in the country, especially fuelwood, increases the capacity to produce them will diminish. In the long term, regulation of fuelwood harvesting in forest reserves will certainly be necessary alongside efforts to increase production from plantations and agro-forestry woodlots.

5.3.3.1 Harvesting rules for non-timber products

(i) Budongo Forest

There are no official harvesting rules for non-timber forest products but licenses are issued for commercial scale working. The licenses only specify the fees payable per month for products such as rattan canes, palm, wild coffee and also fees based on quantities harvested or traded for products like firewood, charcoal and poles. These licenses are also applicable to operations on public land outside the forest reserve. Access to the forest reserve for uses such as recreation and cultural activities is open to the local communities.

(ii) Mabira Forest

Like in Budongo and other forest reserves in Uganda, there are no official harvesting rules for non-timber forest products. Some level of control is only exercised through the issuance of monthly permits for commercial-scale operations.

Discussion

Due to the small scale of non-timber harvesting activities imposition of harvesting rules is not necessary for maintaining sustainable management of the reserve. However, harvesting rules will be needed to control harvesting non-timber products if an increase in the scale of harvesting is detected or stocks decline

considerably, although as with timber harvesting rule enforcement will certainly be a difficult undertaking.

5.3.3.2 Pre-harvest inventory of non-timber products

(i) Budongo Forest

There has not been any pre-harvest inventory of non-timber forest products in Budongo. However, a biodiversity survey which was conducted in the forest in 1993/94 has produced qualitative data on the flora and fauna composition of the reserve.

(ii) Mabira Forest

Like in Budongo and other forest reserves in the country, there hasn't been any official pre-harvest inventory of non-timber products in Mabira. The only data available is from a biomass survey of 1992 and some qualitative data on the fauna and floral composition of the forest obtained from the biodiversity survey of the forest in 1993. Local people also conduct informal surveys by traversing the forest looking for the location poles, firewood, fruits, palms, rattan canes and medicinal plants.

Discussion

The biodiversity surveys of Budongo and Mabira and the biomass survey of Mabira provide a good indication of the potential capacity of the forests to produce

non-timber products on a sustainable basis. This information will be very useful for the designation of the planned reserve zoning into Nature Reserve, buffer, and intensive timber production areas.

5.3.3.3 Records of production areas and quantities harvested

(i) Budongo Forest

There are some records of quantities and areas harvested for products such as charcoal, firewood and poles which are produced on a commercial scale but not for rattan canes, palms and other small scale products. These records are kept in compartment registers.

(ii) Mabira Forest

Like in Budongo, Mabira forest compartment registers have data on production areas and quantities of non-timber products harvested on a commercial scale. Subsistence level harvesting for domestic consumption is not recorded due to logistical problems of monitoring it.

Discussion

Although subsistence level harvesting is not recorded, because of the small scale of the non-timber harvesting activities the compartment register records of commercial scale level production should be adequate for long term monitoring of production of these products.

5.3.3.4 Post-harvest monitoring of non-timber products

(i) Budongo Forest

There is no official post-harvest monitoring for non-timber forest products in Budongo. An informal kind of monitoring is only carried out by local people who traverse the forest reserve to look for the location of rattan canes and palms and also to hunt or trap small mammals like bush pigs and antelopes for subsistence food.

(i) Mabira Forest

Like in Budongo, there is no post-harvest monitoring of non-timber products in Mabira forest reserve. Only local people traverse the reserve occasionally looking for forest products for their own domestic use or for sale.

(iii) Discussion

Because of the small scale of harvesting of operations of non-timber products, post harvest monitoring is currently economically unjustifiable, especially for Budongo forest reserve. However, if the scale of non-timber products harvesting increases considerably to warrant its regulatory measures, it may justify expenditure on post-harvest monitoring which could be carried out along with routine timber stock inventories.

5.3.4 Conservation of Flora and Fauna

5.3.4.1 Ecosystem protection in managed units

(i) Budongo Forest

More than three-quarters of Budongo forest reserve vegetation is believed to have been altered through timber exploitation, but the original cover is considered to have been of exceptional quality both in terms of community richness and commercial value (Howard, 1991). The ecology of Budongo forest is well known and has been described by Eggeling (1947). The number of tree species per hectare is greatest in swamp forest communities (67 species) and least in the successional climax *Cynometra* forest (16 species), with mixed and colonizing 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, with 240 species (56% of country's total) recorded, including trees that are not known from elsewhere in the country, such as: *Discoglyprena caloneura*, *Microdesmis puberula* and *Mammea africana*. Four tree species from the reserve are listed as endangered (FAO, 1986): *Chrolophora excelsa*, *Cordia millenii*, *Irvingia gabonensis*, and *Entandrophragma angolense*.

The fauna of Bodongo is reasonably well known, and includes 159 species of forest bird (48% of country's total), 5 species of diurnal forest primates (42% of country's total), and 42 species of forest swallowtail and Charaxes butterfly (62% of country's total). Of these, the Cassin's spinetail (*Neafrapus cassini*) and the yellow-footed flycatcher (*Muscicapa striata*) are not known from elsewhere in

Uganda (Howard, 1991). Threatened or near-threatened species that are known to occur in the reserve are: African elephant (*Loxodonta africana*), leopard (*Panthera pardus*), Chimpanzee (*Pan troglodytes*), Nahn's francolin (*Francolinus nahani*) and African giant swallowtail butterfly (*Papilio antimachus*) (Howard, 1991).

A nature reserve of about 3 square miles was established in the 1940s when systematic timber management started (Philip, 1964). The purpose of this area has been for botanical and ecological studies and to provide a relatively undisturbed area for the smaller mammals such as the rare potto and the dwalf forest antelope. Because the nature reserve by itself and surrounded by a man-induced environment was too small to support a normal population of large mammals such as elephants and bufaloes, it was included in the large mammal control schedule with the rest of the forest reserve areas.

The rich biodiversity of Budongo and its importance as a major timber source in the country has prompted the Forest Department to manage the forest for multiple-use to meet diverse and changing needs of society. At present there are plans to expand the Nature Reserve and to have a buffer zone around it where only limited timber harvesting will be allowed, so as to conserve the unique ecosystems of the forest.

A large portion (47%) of Budongo consists of savanna grassland ecosystems thought to be capable of supporting forest vegetation. These have been maintained by early burning to prevent intense late burns set by local hunters. However, because the savanna ecosystems cover large areas in adjacent protected areas outside the reserve (National Parks and Game Reserves), there

are plans to afforest some of the grassland patches within the forest reserve although the effect of such change on the ecology of the reserve has not been determined.

(ii) Mabira Forest

Mabira forest is considered to be a secondary forest, in which the distinctive vegetation types represent sub-climax communities, heavily influenced by man over a long period of time (Sangster, 1950). There are four forest types which make up the bulk of the forest. The youngest of these is dominated by the colonizing tree *Maesopsis eminii* which associates with *Albizzia* spp., *Markhamia platycalyx*, *Sapium ellipticum*, and *Celtis* spp. covering about 25% of the reserve area (Howard, 1991).

A later successional stage is represented by communities classified as young mixed forest and *Celtis-Holopterea* forest, which together cover 59% of the reserve. The only other important community is the poor mixed forest of wet valley bottoms dominated by *Baikiaea insignis* which, until recently covered 15% of the reserve (Howard, 1991). No area of the reserve is considered representative of a climax community, and given time, the succession could be expected to proceed towards some kind of single-tree species dominance (Sangster, 1950)

The fauna of Mabira is reasonably well known and includes 151 species of forest bird (46% of country's total), 2 species of diurnal forest primate (17% of country's total), and 39 species of forest swallowtail and *Charaxes* butterfly (59% of country's total) (Howard, 1991). The Tit Hylia (*Pholidornis rushiae*) is only found

in Mabira in the East African part of its range, but all other species are known from at least one other forest in Uganda (Howard, 1991). The depauperate primate fauna appears to be a rather recent phenomenon, since there are old records of black and white colobus (*Colobus troglodytes*) (Kingdon, 1971). The present status of large mammals is not known but the presence of buffalo (*Syncerus caffer*) were reported in 1980s and elephant (*Loxodonta africana*) were last recorded in Mabira in the 1950s. Threatened or near threatened species known from this forest are elephant (now extirpated), leopard (*Panthera pardus*). Nahan's francolin (*Francolinus nahani*), and blue swallow (*Hirundo atrocaerulea*) (Howard, 1991).

Since the 1950s, about 260 ha of Mabira forest immediately west of the Musamya River has been set aside as protected nature reserve. According to the Interim Management Plan of 1994 (Mugumya and Shabomwe, 1994), the nature reserve area has been expanded to 6,505 ha and includes an expansive swamp of about 600 ha along the Musamya River. The objectives of the nature reserve are: to conserve in perpetuity the forest gene pool and preserve its habitat in a viable and self-sustaining state; to secure a source of regeneration material capable of sustaining the productive capacity of Mabira and adjacent areas; and to study the development of the diverse biotic and edaphic ecosystems without human interference. The size of the planned buffer area around the nature reserve has not yet been decided but it will be located between the nature reserve and the remainder of the forest area meant for intensive timber management.

Discussion

Although timber management objectives considerably contributed to the legal protection of Budongo and Mabira forests, timber management has also contributed to cessation of the reserves as a habitat for large mammals which are mainly protected in National Parks and Game Reserves. The long term effects of exclusion of large mammals from the forests has not been studied and the effects of timber harvesting and silvicultural treatments on the forest ecosystems need to be determined to ensure that vital ecological functions of the forest are not impaired.

Current plans by the Forest Department to expand the areas to be designated as strictly protected nature reserves and the buffer zone areas around them should go a long way in ensuring protection of late successional forest ecosystems, while the intensive timber management areas will sustain early successional habitats for wildlife adapted to them. Given the current levels of forest reserve degradation, forest zoning appears to be one of the best ways to ensure sustainable multiple-use forest management in Budongo, Mabira, and other reserves in the country.

5.3.4.2 Extent of post-logging vegetation disturbance

(i) Budongo Forest

According to a recent survey by Howard in the late 1980s (Howard, 1991) and available Forest Department records and maps, more than three-quarters of Budongo forest reserve is considered to have been radically altered through

timber exploitation and silvicultural treatments (See Fig. 4.1 and Table 5.1), although little research has been done to evaluate the extent of post-logging vegetation disturbance. A preliminary study was carried out in the 1950s to assess natural and artificial regeneration of timber species after logging but the results were not conclusive (Dawkins, 1958).

Since 1990, the Budongo Forest Research Project (BFRP) has been established and housed at an old sawmill site in the reserve. The project which is a joint venture between the Uganda Forest Department and the Institute for Biological Anthropology at Oxford University, UK, has completed a study which assessed the effects of logging on forest composition and structure using the 1992 Forest Department inventory data (Plumptre et al., 1992). The study results indicate that logging has not affected forest composition in any predictable manner, but the show the effect on forest structure to be significant. A study to evaluate the success of enrichment planting in the reserve is to be carried by the project in the near future (Bakuneeta, 1996).

Table 5.1 Areas (km²) of different vegetation types and their condition in Budongo forest reserve (After Howard, 1991).

Vegetation condition	Vegetation types						TOTAL
	Grass land	<i>Celtis</i> forest	<i>Khaya</i> forest	<i>Cassia</i> forest	<i>Cynometra</i> forest	Undiff. forest	
Undisturbed	(381)	3	50	0	40	2	95
Logged (mechniszed) pre- 1950	-	13	27	0	50	0	90
Logged (mechniszed) post- 1950	-	111	52	34	30	0	223
Pitsawn	-	0	6	0	10	0	16
TOTAL	(381)	127	135	34	130	2	428

(ii) Mabira Forest

There is little available information available about the extent of post-logging vegetation disturbance in Mabira apart from the limited fieldwork conducted by Howard in the 1980s (Howard, 1991) and scanty Forest Department records on the subject. According to Howard's survey report and Forest Department records and maps, the portion of the reserve 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 (See Fig. 4.2 and Table 5.2). However, compartments in the northeast of this area have had so little disturbance by past timber exploitation as to warrant their description as undisturbed, and one of the compartments in the area is an old nature reserve. Compartments in the south of the West Mabira forest block have recently been exploited, to varying degrees, by pitsawyers.

To the east of the Musamya river, 28% of the reserve is described as lightly pitsawn, meaning that it has not been subjected to any large scale mechanised harvesting, although most of this area has been creamed of its most valuable timber by high-grading harvesting activities of pitsawyers. The remainder of the reserve (36% of the total area) has been severely degraded by recent mechanized timber harvesting operations, which have preceded the conversion of some 26% of the reserve to agricultural plots.

Table 5.1 Areas (km²) of different vegetation types and their condition in Mabira forest reserve (After Howard, 1991).

Vegetation condition	Vegetation types					TOTAL
	<i>Maesopsis</i> forest	<i>Celtis</i> forest	Young forest	Hill forest	Poor forest (wet)	
Undisturbed	5	0	16	0	5	26
Lightly pitsawn	24	24	24	0	12	88
Logged (mechniszed) pre- 1950	13	45	13	0	13	84
Logged (mechnized) 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

Discussion

The few studies that have been carried out in Budongo and other reserves in Uganda so far have indicated that logging has not affected forest composition in any predictable manner (Kasenene, 1987 Plumptre et al., 1994). However, it is clear that timber management at least maintains early successional stages of forest ecosystems through disturbance and creation of gaps.

By creation of gaps, timber management somewhat imitates nature as trees are bound to die as a result of aging or other natural agents like storm-throws or being struck by lightening even in the absence of timber management operations. As long as considerable forest areas are set aside as protected nature reserves representative of late successional forest communities, and logging practices and silviculture which ensure successful forest regeneration, timber management should not be a threat to sustainable conservation of natural forest ecosystems.

5.3.5 Level of Environmental Impact

5.3.5.1 Extent of soil disturbance and erosion

(i) Budongo Forest

As already mentioned earlier in this chapter, of all forest management activities, logging and road construction affect forest soils the most. Enforcement of regulations governing logging and road construction and maintenance in Budongo forest has proved to be difficult due to the high investment costs involved

(Philip, 1964). However the terrain of the area is gently undulating with easy slope and only a few isolated hills which limits the possibility for very serious soil erosion.

(ii) Mabira Forest

Regulations governing logging and road construction in Mabira are similar to those for Budongo and other reserves in the country, and their enforcement by the Forest Department equally difficult to enforce. Mabira also has a more dense road network, including major public ones. The level of soil erosion from road runoff water can be expected to be higher than in Budongo which has only one public road partially traversing the reserve and with much lighter traffic. Silvicultural treatments involving charcoal burning in Mabira also expose more soil surface to the sun and the ravages of runoff water. Fortunately the terrain of Mabira is also gentle which minimizes soil erosion.

Discussion

Although the effects of logging on forest soils has not been not well studied, any soil erosion resulting from vegetation removal is a temporary phenomenon as new growth comes up soon due to a well distributed rainfall pattern in the two reserves. Consequently, there is no substantial evidence of serious persistent soil erosion. Nevertheless, the effects of logging and road construction on soils needs to be determined in order to develop sustainable forest management practices. Long timber crop rotations and use of less mechanized logging technology would also be beneficial to forest soil conservation.

4.3.5.2 Extent and distribution of riparian and other watershed protection areas

(i) Budongo Forest

Budongo forest reserve and adjacent areas to the south and southeast comprise the watershed for two main rivers, the Sonso and Waisoke, which flow leisurely northwest through the reserve and then over the Rift Valley scarp into Lake Albert (Philip, 1964). Neither river is large, and are rarely deeper than three to four feet, while in the dry period their flow dwindles almost completely.

The southern part of the reserve is an amalgamation of riparian forest strips associated with the River Siba and several small streams. The Siba is itself a tributary of the Waki River which originates south of the forest reserve, traverses the southern end in a winding course and is joined by the Siba just before leaving the forest (Philip, 1964). Overall swamp forest covers 1,329 ha which is 2% of the entire reserve.

(ii) Mabira Forest

Mabira forest occupies gently undulating terrain characterized by numerous flat-topped hills and wide shallow swampy valleys which makes many parts of the forest subject to seasonal inundation. The topography is such that the land drains to the north, even though the reserve boundary lies only 13 km from the Lake Victoria shore.

Major water bodies consist of Rivers: Mugaba, Waluke, Wakanaga which drain into the Sezibwa River to the west, while Rivers Rwankima and Mubugwe traverse the reserve from the southeast to join the Musamya River at the northeastern boundary of the reserve. The Musamya in turn meets the Sezibwa (both associated with extensive papyrus swamps) at the northeastern tip of Mabira forest and onward into Lake Kyoga to the north. The wet valley bottoms are dominated by *Baikiaea insignis* and comprise about 15% of the total reserve area.

Discussion

Budongo and Mabira both have a considerable distribution of riparian and watershed protection areas. The two reserves therefore play an important role in the provision of environmental and economic benefits related to presence of water supplies and aquatic ecosystems. Maintenance of riparian and other watershed ecosystems are compatible with current timber management which only makes a partial forest canopy removal and leaves swampy areas almost intact even within the intensive timber management compartments.

The only major threat to these ecosystems has been encroachment by agriculture especially in Mabira whereby complete forest clearance and draining of swamps takes place. Conservation of riparian and other watershed ecosystems in Budongo and Mabira are sustainable as long as the Forest Department can keep encroachers out of the reserves. Sustainable multiple-use management of the two reserves is therefore linked to their effective protection against encroachment.

5.3.5.3 Protection of water bodies and wetlands

(i) Budongo Forest

There are no specific official regulatory provisions for the protection of water bodies and wetlands in the reserve. However, efforts have been made to ensure construction of wooden bridges and culverts across rivers and streams when building roads in the forest.

(ii) Mabira Forest

Like in Budongo and other forest reserves in the country there are no official regulatory provisions for water bodies and wetlands in Mabira. The only related regulations are those governing forest protection and the construction and maintenance of roads in order to minimize soil erosion and silting of water bodies.

Discussion

Although there are no official regulations governing the protection of water bodies and wetlands, the effects of timber management activities such as logging on wetlands is quite minimal as valuable timber stocking in swamp forest is low and there are no disruptive silvicultural prescriptions for these areas. Conservation of riparian ecosystems therefore does not pose a big problem to sustainable forest management although quite considerable soil erosion, compaction and silting takes place during logging and road construction. Sufficiently long timber rotations would certainly favor healthier riparian ecosystems. The effect of poisonous

chemical arboricides used in silvicultural treatments on aquatic flora and fauna also needs careful monitoring to ensure that no serious damage is caused.

5.3.6 Nature and Extent of Socio-economic Benefits

5.3.6.1 Employment opportunities

(i) Budongo Forest

Budongo Forest Reserve is administered by three Forest Officers, two of whom are field -based and under the supervision of the third officer based at the District headquarters in the nearby Masindi town. Under the Forest Officers, there are three Assistant Forest Officers, five Forest Rangers, and 6 Forest Guards. This staff is in charge of silviculture, stock mapping, reserve boundary and road maintenance, forest patrols, biodiversity conservation, research and routine administrative duties. About 50 people from the local area are also employed as laborers on temporary terms and are mainly engaged in nursery work, enrichment planting and maintenance of the forest reserve boundary and roads.

The four sawmills operating in the reserve also employ a total of about 150 local people. An unspecified number of people are legally self-employed in the reserve to harvest rattan canes and other products while others are in the lucrative but illegal pitsawing business in the reserve. Overall, Budongo Forest Reserve and associated services is one of the biggest employers in the area, only second to the nearby Kinyara sugarcane plantations and factory with which the Forest Department and sawmills compete for local labor supply. Overall, timber

management and sawmilling activities provide most of the employment for local communities living around the reserve.

(ii) Mabira Forest

Mabira forest reserve is administered by three Forest Officers, two of whom are field-based and under the supervision of the other officer based at the District Headquarters in Mukono town. The field-based officers in turn supervises a work force comprised of 2 Assistant Forest Officers, 5 Forest Rangers, 7 Forest Guards, and about 4 logistics support workers. About 20 people from the local area are also employed as laborers on temporary terms, depending on silvicultural, protection, and boundary maintenance work requirements. There are currently plans to employ a permanent labor force with on-job training but it will be difficult because of the alternative seasonal employment opportunities in the neighboring sugarcane and tea plantations which pays better wages than the Forest Department.

Because sawmills with logging concessions in Mabira process the logs in towns outside the reserve area, employment opportunities with them are only limited to logging operations which employ a combined total of only about 20 people. Most of the employment in the area is provided by sugarcane and tea plantations adjacent to Mabira forest. Nevertheless, during the 1960s and 1970s when charcoal production in Mabira was at its peak, over 100 local people were employed by the charcoal business and associated silvicultural activities like site clearing, nursery work and enrichment planting. If the Forest Department decides

to resume charcoal burning, it would offer a considerable amount of employment and income generation from the sale of charcoal. There are also some limited employment opportunities with the now developing ecotourism in the reserve for local people as tour guides and in selling crafts to visitors.

Discussion

From the foregoing, it is clear that the continuation of timber management and associated wood industries offer a considerable source of employment in the forest reserve areas and a ban on the timber industry would most certainly hurt the livelihoods of the local people. Besides, ecotourism and the possibilities for joint forest management schemes that are currently being considered by the Forest Department offer even more employment and other income generating activities for local communities both within and outside of the forest reserves on a sustainable basis.

5.3.6.2 Other benefits from forestry activities

(i) Budongo Forest

The reserve offers a great potential for ecotourism development as it comprises the only large forest area at altitudes of 750 -100 m with a rich biodiversity. Since the early 1990s, efforts have been made by the Forest Department to promote ecotourism in the reserve (Mpangire et al., 1993). Two camping sites have so far been established in the reserve and work on

chimpanzee habituation is in progress. Plans for establishing a tourist center with telephone, buildings and a water supply system are in advanced stages and number of local people are already employed as tour guides and others sell local produce like fruits and crafts to visitors.

At the southern edge of the reserve is located Nyabyeya Forestry College, the only institution in the country offering Forestry education to the diploma and certificate levels, apart from Makerere University which trains a few students (about 30 graduates/year) to the bachelors degree and even fewer (less than 5/year) graduate degree level forestry professionals. The Budongo Forestry Project located in the reserve also carries out some training for Makerere University students conducting research in the forest and project staff do some extension work in the local area.

Local people within the reserve neighborhood have also benefited from the electricity supply to the sawmills and the Forestry College. Small industries such as grain milling and carpentry and joinery get power from the lines supplying the forestry facilities with electricity. Although the roads to the sawmills and other forest reserve facilities are in a poor shape due to lack of adequate maintenance, they are better than nothing in such a remote area as rural Masindi District and local people use them heavily for ferrying agricultural produce to local and regional markets. One of the sawmills runs a school where children of mill workers and from the neighborhood get their primary education.

(ii) Mabira Forest

Mabira is the largest block of forest remaining in the central region of Uganda, and represents the best opportunity for maintaining a complete forest community characteristic of this important biogeographical region. By virtue of its location between two main urban centers, Mabira is likely to assume greater importance as a recreational area. The reserve also supports at least 3 animal species considered to be globally threatened with extinction (Howard, 1991).

The 1994 Interim Management Plan describes a proposal for a biodiversity conservation project in the reserve. The project is expected to establish a conservation and education center, set up an ecological research unit, and develop existing and new tourist camping facilities and scenic sites such as the Kalagala and Griffin waterfalls in the reserve. The project is expected to make a significant contribution to the socioeconomic development of the local area through provision of employment opportunities in the ecotourism industry and related activities.

Discussion

In addition to employment opportunities in timber management, sawmilling industry, and forest protection activities, local communities in and around Bodongo and Mabira have also benefited from the infrastructure associated with forest reserve enterprise. A more recent development with a good potential is ecotourism. Development of ecotourism is one of the best things that have

happened to Budongo and Mabira Forest Reserves and the surrounding areas in recent times.

The industry is compatible with timber management although considered more "environmentally friendly" and will boost the local in terms of employment and other income generating activities. The only major problems are that very little progress has so far been achieved in implementing planned activities due to lack of the necessary funding for the projects and the failure by the Forest Department to attract private investments in the industry. If these problems can be overcome, ecotourism development has promise for the most sustainable forest management and utilization so far.

5.3.7 Level of Planning and Adjustment to Experience

5.3.7.1 Local community consultation

(i) Budongo Forest

Management of Budongo Forest Reserve has been carried out with little, if any, local community consultation. Even at the time when there were some local government forest reserves, the Forest Department took an overall supervisory role with limited, if any, local input.

(ii) Mabira Forest

Management of Mabira, like Budongo and other reserves in Uganda has been the sole business of the Forest Department without involvement of local people.

This is however expected to change in the near future due to increased pressures on the reserve and limited resources available to the Forest Department to effectively police the reserve. The reserve is so closely associated with local communities that attempting to protect it without their consultation and active involvement is clearly a futile exercise.

Discussion

Forest management in Uganda has often been portrayed to be so technical and somewhat beyond the knowledge of local people. This stance is clearly manifested in the take over of local forest reserves by the Department in the mid 1960s and the current reluctance to decentralize forest reserve management. One of the reasons for this attitude by Ugandan foresters is retention of a colonial legacy of dismissing indigenous knowledge as unscientific and/or even primitive.

Current forest management challenges have however dictated changes in the stance of the Forest Department and the value of indigenous knowledge and local participation in forest management is getting increasingly recognition. The cash strapped Forest Department administration has realized that law enforcement and control of forest resources is an elusive undertaking without the co-operation of local people. The Forest Department has actually always had promotion of an understanding of forests and trees by local people as a major policy objective (Forest Department, 1955), but the approach by its extension service has always been to limit most of their activities to non-reserved public and private land which the department does not control and where agriculture and livestock production

competes with forest crops. This has prompted local people to view protected forest reserves as "idle" land only good for agricultural expansion.

There is also a conflict with the agricultural extension service which advises farmers on "bush clearing" to give way for agricultural crops and livestock while the forest extension service at the same time tells the same people to create forest "bush" on the same land. The fact that large parts of Uganda are well wooded also makes the tree planting campaigns by forest extension workers somewhat irrelevant. There is little wonder therefore that the extension service is the least funded section of the Forest Department and is not very popular among forestry professionals.

Nevertheless, there are current plans to involve local people in and around Budongo and Mabira in forest conservation efforts. Recent efforts have been focused on a conservation education program for local communities, emphasizing the importance of biodiversity conservation and ecotourism development (Mpangire et al., 1993; Mugumya and Shabomwe, 1994). The local communities are also to be sensitized so that they can assist in combating illegal pitsawing in the reserves. These programs however make no indication of local input in terms of indigenous knowledge about forests management.

The Forestry Research Institute (FORI) has recently initiated a study to address this problem by consulting local people around reserves about ways in which they can participate in management and how they hope to benefit from such a partnership (Kahembwe, 1996). However, the Forest Department is clearly skeptical about any success with joint forest management ventures with local

people, and without the department's initiative the study may end up like many others which have produced information that is not used in forest management planning and policy formulation.

5.3.7.2 Provisions for traditional forest utilization

(i) Budongo Forest

Local people have limited privileges (but no legal rights) to use the reserve for their cultural and domestic consumption needs but require a license to engage in commercial scale activities in the forest. They may also not reside or carry out farming activities in the forest. Apart from use of the forest for shifting agriculture and hunting, other forms of traditional forest utilization such as providing fuelwood, medicines, building poles, water and for cultural rituals can be practiced by the local community without interference from the Forest Department.

(ii) Mabira Forest

Although local communities in and around Mabira forest reserve have no legal rights over the forest, the very dense network of roads and footpaths that traverse the forest clearly indicate how the local people closely interact with the forest. The local people harvest firewood, poles, crafts materials, medicinal plants, water, sand, and fruits. Sale of wild passion fruits from Mabira is a big business on the roadsides and before encroachers were evicted Bananas grown in the reserve were sold also.

During the field data collection phase of this study some local people were distilling alcohol and others hunting in the forests even though hunting is banned. There are also close cultural ties with Mabira. For instance, there is a particular area close to the River Nile where local people and some Asian communities offer sacrifices to supernatural spirits, and some trees in the reserve are religiously revered, including one *Ficus* tree which the local Baganda tribe believe to have been planted by one of their Kings (Mugumya and Shabomwe, 1994).

Discussion

Traditional forest utilization allowed by the Forest Department is compatible with current forest multiple-use management policy objectives and can be expected to go on unhindered for a long time to come. However, the most serious problem related to local traditional forest utilization that has no immediate answers is the illegal pitsawing business. The business can actually be categorized as traditional forest utilization given its long history although it has been boosted by more recent retrogressive political and socioeconomic developments.

It will be very difficult for the Forest Department to control illegal pitsawing which is a source of instant cash income compared to other sources such as agricultural production which takes months or even years to yield income generating products. As the population expands there is also a likelihood for pressures of agricultural expansion on the forest reserves. There is therefore a need to develop the production potential of areas adjacent to reserves such that they complement rather than conflict with forest management objectives.

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Field Data Form 1

Tally Sheet for Standing Timber and Tree Species Diversity

SHEET NO

RECORDED BY

Stem Form:

Defect Types:

Defect Extent:

FOREST:

BOOKER:

0. No defect

2. Poor

1. Buttress

4. Broken top

1. Little

SPOッター

1. Minor defect

3. Not merchantable

2. Curve

5. Bulges

2. Medium

PLOT #

COORDINATES

3. Twist

6. Rot

3. Very Severe

7. Fork

ALL TREES			ONLY FOR TREES OVER 30 cm DBH					
No	SPECIES NAME	DIAMETER	CLEAR BOLE HEIGHT	CROWN POSITION	STEM FORM	DAMAGE/DEFECT		
		(CM) DBH	SAW LOGS	(E,C,I,O)*	(0-3)	TYPE (1-7)	EXTENT (1-3)	REMARKS
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
36								
37								
38								
39								
40								

* Crown position scores: E = Emergent; C = Codominant; I = Intermediate; O = Overtopped

APPENDIX A2

Field Data Form II

Tally Sheet for Shrub Species Diversity

SHEET #: _____

RECORDED BY: BOOKER _____

FOREST: _____

SPOTTER _____

COMP: _____

PLOT #: (3 m X 3 m sub-plot) _____

DATE: _____

COORDINATES: _____

SHRUB SPECIES DIVERSITY	
No.	SPECIES NAME
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
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21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
36	
37	
38	
39	
40	

Field Data Form III:

Tally Sheet for Biophysical Site Conditions and Local Community Forest Activities

FOREST:

PLOT #:

DATE:

COMPARTMENT #:

BOOKER:

A. TOPOGRAPHIC POSITION ☐ 1) Flat valley floor ☐ 2) Steep lower slope ☐ 3) Gentle lower slope ☐ 4) Mid-slope ☐ 5) Steep upper slope ☐ 6) Gentle upper slope ☐ 7) Ridge/hill top ☐ 8) Upland plateau ☐ 9) Flat	B. ASPECT ☐ 1) North ☐ 2) Northeast ☐ 3) East ☐ 4) Southeast ☐ 5) South ☐ 6) Southwest ☐ 7) West ☐ 8) Northwest	C. CLIMBER TANGLE ☐ 1) 0-5% ☐ 2) 6-30% ☐ 3) >30% SLOPE _____ (measured in degrees) Year exploitation _____ Year treatment _____
FOREST STRUCTURE		
D. DENSE FOREST ☐ 1) Mature mixed, without dominance ☐ 2) Mature mixed, with dominance of: _____ ☐ 3) Colonizing forest ☐ 4) Dry valley forest ☐ 5) Wet valley forest with dense understorey ☐ 6) Swamp forest ☐ 7) Seasonal swamp forest	E. OPEN FOREST ☐ 8) Low canopy, poor mixed ☐ 9) Bushland, thicket ☐ 10) Former encroachment, little tree regeneration	F. CANOPY HEIGHT ☐ 1) up to 10m ☐ 2) 10 to 20m ☐ 3) 20 to 30m ☐ 4) more than 30m HARVESTING ☐ 1) the forest has been harvested/logged ☐ 2) no signs of harvesting/logging
SUBPLOT (3m x 3m)		
G. REGENERATION COVER (% of the subplot cover when viewed from directly above - Total=100%) ☐ % herbaceous vegetation ☐ % bare soil ☐ % litter ☐ % rocks	H. DOMINANT SPECIES (give percentage of composition within regeneration subplot total=100%) ☐ 1) grasses ☐ 2) herbs ☐ 3) ferns ☐ 4) mosses ☐ 5) shrubs	I. HEIGHT (height of herb layer cover excl. emergents) ☐ 0) absent ☐ 1) <30cm ☐ 2) 31-60cm ☐ 3) 61-90cm ☐ 4) 91-120cm
J. SOIL COLOUR ☐ 1) black ☐ 2) dark gray ☐ 3) light gray ☐ 4) chocolate brown ☐ 5) red brown ☐ 6) yellowish brown ☐ 7) brown TYPE ☐ 1) Poorly developed ☐ 2) Sandy ☐ 3) Sandy clay ☐ 4) Clay ☐ 5) Peat ☐ 6) Loam	K. SAMPLE PLOT (25m x 50m) ☐ 1) number of footpaths present ☐ 2) number of trees cut for poles ☐ 3) number of trees damaged for fuelwood ☐ 4) number of trees cut for sawing timber during past 3 years ☐ 5) number of large tree stumps, more than 3 years old	☐ 6) number of animal traps/snare ☐ 7) number of campsites/fireplaces ☐ 8) hunting parties met/heard in vicinity ☐ 9) (signs of) cattle grazing ☐ 10) number of mining sites ☐ 11) other human activities (describe)

TROPICAL FOREST MANAGEMENT/SILVICULTURAL PRESCRIPTIONS (Philip et al., 1964):**I. Pre-Logging Refining:**

- (1) Objective: To create conditions in the forest, at the time of felling, in which the regeneration of desirable tree species can get established and to minimize felling damage.
- (2) Method: Climber cutting and poisoning all weeds (non-merchantable species) and defective or over-mature stems of desirable trees using a mixture of 3 percent Finopal in heavy diesel is done from 6 to 18 months prior to felling. The arboricide is sprayed onto the bole in a band 30 cm wide, except on tree species that are known to be resistant which are frilled before applying the poison in a band 15 cm wide. Trees which need frilling are: *Dombeya* spp., *Melanodiscus* spp., *Alstonia boonei*, *Bosqueia phoberos*, *Celtis* spp., *Croton macrostachus*, *Ricinodendron heudelitti*, *Sapium ellipticum*, *Trichilia* spp., and *Cynometra alexandri*. *C. alexandri* is frilled but the sprayed band is retained at 30 cm wide to ensure a good percentage kill. Each forest compartment is subdivided by cut lines into a grid of square plots of 4 ha each, with each plot treated in two sweeps on a 100 m front.

II. Post-Logging Refining with Arboricide (in Budongo Forest Reserve):

- (1) Objective: To remove weed tree species, defective stems, and over-mature trees that are impeding the growth of established regeneration.
- (2) Method: The operation is very similar to pre-logging refining, except that it is done in areas which have been recently harvested and that treatment units may be enlarged to 6 ha. The minimum size of tree stems treated is 8 cm DBH. In some forest compartments nursery raised seedlings of desirable tree species such as mahogany are planted in gaps and sometimes in lines. The planted seedlings are tended by weeding and climber cutting until they are established.

APPENDIX B (continued)

**III. Post-Logging Refining with Charcoal Production and Enrichment
Planting (Mabira Forest Reserve):**

- (1) Objective: To remove weed tree species, defective stems, and over-mature trees that are impeding the growth of established regeneration.
- (2) Method: After logging, stems of desirable tree species too small to be harvested during the felling cycle are marked and the rest of the undesirable trees felled carefully to minimize damage to desirable regeneration. Charcoal makers and firewood merchants are then allowed to enter the forest in an orderly way to take the lop and top left by sawmillers and to harvest the felled undesirable trees.

Nursery raised seedling of fast growing species, mainly *Maesopsis emini*, are then planted in gaps (charcoal burning sites) left by the charcoal makers. Some climber cutting and weeding follows to tend the new planted crop until it is established.

APPENDIX C

DERIVATION OF FOREST MULTIPLE-USE VALUATION CRITERIA MAGNITUDES:

- (1a) Standing timber volumes: These were determined for each case study compartment from field data of diameters (DBH) and visually estimated number of merchantable logs (3 m long) per tree of 30 cm (DBH) and above.

Sample plot timber volumes for each compartment were summed and divided by total plot area to get average timber volume in m^3 per hectare. Individual merchantable tree volume was calculated using *Smalian's* formula:

$$V = (A_1 + A_2) L/2$$

where

V = volume of solid log wood in m^3

A_1 and A_2 are the cross-sectional areas under-bark on the two ends of a log in m^2

L = merchantable tree stem length in m

A_1 was the merchantable tree stem DBH while A_2 was estimated by assuming a 1.27 cm (0.5 inch) decrease in log diameter for each 1.22 m (4 ft) section due to taper (*International log scaling rule* developed by Judson Clark in 1906).

In Uganda's tropical forests trees are considered to be of merchantable size when they have attained minimum DBH of 30 cm, although forest regulations usually set minimum felling diameters above 30 cm especially for high value timber species. A hypsometer was used to practice estimating merchantable tree bole length which in most cases is limited by the first branch or fork on a tree.

- (1b) Charcoal fuelwood volumes: These were estimated for Mabira forest reserve only, where charcoal production has been incorporated into timber management silvicultural treatments. The wood volume for charcoal production estimates were based on research by Earl (1968) who determined that 4 m^3 of round wood produces 360 kg of charcoal and that charcoal production per 0.4ha (1 acre) of exploited forest is 5000 kg.

APPENDIX C (Continued)

- (2) Number of jobs created in local area: These were estimated from data recorded in Budongo and Mabira forest management plans (Philip et al., 1964; Webster, 1961) for pre- and post-logging treatments (10 mandays/ha), post-logging treatment (11 mandays/ha) and enrichment planting and tending (125 mandays/ha). Jobs created by felling and cross-cutting (2 mandays/14 m³), were estimated from a timber harvesting productivity study by Ndemere (1991) and the same figure assumed for log transport and sawmilling. These labor requirements per m³ were converted to man-day/ha by multiplying them by volume figures per hectare for case study compartments and added to those for stand treatment to arrive at a total number of potential jobs that can be created from timber management activities per hectare for each case study compartment.
- (3) Non-timber/charcoal fuel-wood products: Due to a lack of reliable quantitative data on the use of the case study forest reserves by the local community, foot-path density was used to express the intensity of forest use. Foot-path density was estimated from counts of individual foot-paths in the 25 m x 50 m sample plots and an estimate of their lengths within the plot based on the average (28.5 m) of the shortest discernible foot-path (1 m long) and the longest straight line within the plot (diagonal of 56 m). This average foot-path length was multiplied by the average number of foot-path counts per plot (expressed as number of foot-paths per ha) in for each case study compartment to get an average foot path density in meters per hectare.
- (4) Wildlife habitat: The variety of wildlife habitats for Uganda's major tropical wild life species such as mammals, insects and birds was assumed to increase with forest structural diversity, as the variety of tree sizes and canopy layers offer a variety of niches for the diverse wildlife. The standard deviation of DBH for trees ≥ 10 cm was therefore used in this study as a measure of forest structural diversity for the case study compartments.
- (5) Biodiversity conservation: Measures of tree species diversity and equitability and shrub species diversity were used in this study to express the biodiversity value of the case study compartments. Tree species (with DBH ≥ 10 cm) diversity index (H) and equitability index (E) were derived from the *Shannon-Wiener* function (Krebs 1978), where $H = -\sum_{i=1}^S (p_i)(\log_2 p_i)$; $E = H/H_{\max}$; $H_{\max} = \log_2 S$ = species diversity under conditions of maximal equitability; S = total number of species; and p_i = proportion of total sample belonging to the i th species. Shrub species diversity was expressed by the average number of shrub species per sample plot (3 m x 3 m in size) for each case

APPENDIX C (Continued)

study compartment. All these indices of floristic diversity were summed to give one combined index for comparison between case study compartments.

- (6) Road density: Forest roads are a major environmental concern because their construction and use usually results in increased soil erosion and they also serve as "highways" for both legal and illegal human activities in the forest; although they are considered to have a "positive" economic value for people who use them. In this study, road density was estimated from available topographical maps and logging operations records using the relationship between forest feeder road density (D), road efficiency factor [a], and average skidding distance [s] (FAO, 1974):

$$D = a/s$$

where

- D = feeder road density in km per hectare
- a = road efficiency factor (4-5 for flat undulating terrain and 5-7 for hilly terrain)
- s = average skidding distance in km [which is 0.4 km in Uganda] (Philip, 1964)

COVER LETTER AND QUESTIONNAIRE FORM FOR MULTIPLE-USE FOREST
VALUES APPRAISAL SURVEY:

A. Cover letter:

Forestry Research Institute (FORI)
P. O. Box 1752
Kampala, UGANDA

November 20, 1995

Dear

You have been identified as a person who has interest in the management of Uganda's forest resources for providing continual economic, social, and environmental benefits.

In order to realize the above multiple-benefits, it is important for forest management policy makers and planners to determine the ecological and socioeconomic implications of various forest management practices, given the values and view points of interest groups in regard to the forests. It is for this reason that a survey is being conducted as part of a study aimed at appraising the multiple-use values and sustainability of management of two important case study tropical forest reserves, namely Budongo and Mabira Forests. The study is expected to provide useful information for enhancing appropriate choice and rationalization of forest management practices, as a basis for sustainable management and conservation of Uganda's forest resources.

The purpose of this letter therefore, is to request you to participate in the survey by filling in the attached questionnaire form. Please return the filled in form to me, c/o Office of Director, FORI, P. O. Box 1752, Kampala. I appreciate your interest in this study and thank you for your participation.

Yours faithfully,

Peter Ndemere
RESEARCH OFFICER, FORI/NARO

Encl.

APPENDIX D (Continued)

B. Multiple-use Forest Values Appraisal Questionnaire Form:

Part I: Forestry Interest Groups job category and professional attributes:

Please circle the letter(s) to the left of applicable answer:

1. What is your current professional job category?
(a) Administration (b) Research (c) Teaching (d) Field-operations
2. Where is your duty station?
(a) Forestry Department HQ (b) Field-based: Place name.....
(c) Makerere University (d) Nyabyeya Forestry College (e) FORI
3. What is your education level?
(a) Certificate (b) Diploma (c) B.A/Sc. (d) M.A/Sc. (e) Ph.D.
4. How long have you been at your current job? Number of years.....

Part II: Multiple-use Forest Values Criteria Weights Assignments:

Given below is a set of forest (management) outputs which will be used as decision criteria in the appraisal of multiple-use forest values of the case study forests. The criteria which have been selected using the current forest policy statement as a guideline, represent forest products of a value (positive if desirable or negative if undesirable) currently considered to be of major importance.

Please assign each of the six criteria a numerical relative weight, within a -10 to +10 range, expressing its relative value in relation to the others (for each forest). On this scale, a criterion assigned a weight of +4 is twice as valuable or important as the one assigned a weight of +2 (the reverse is true for negative weights!).

MULTIPLE-USE VALUES CRITERIA	RELATIVE WEIGHTS	
	<u>Budongo Forest*</u>	<u>Mabira Forest*</u>
1. Timber [and charcoal (Mabira)] production ^o		
2. Local jobs provision		
3. Non-commercial products for local people (e.g. firewood, rattans & medicines)		
4. Wildlife habitat maintenance		
5. Biodiversity conservation		
6. Forest road construction		

*Brief profiles of the two forests are attached on the next two pages to facilitate assignment of weights

^oIn Mabira Forest, timber has been produced along with charcoal sometimes

C. Profiles of Budongo and Mabira Forests (After Howard, 1991):**1. Budongo Forest****(i) Location:**

- on the escarpment east of L. Albert, on the edge of the western Rift Valley
- 14 km from Masindi District town.

(ii) Area:

- 793 km² of forest contiguous with Murchison falls National Park and Bugungu and Karuma Game Reserves

(iii) Elevation:

- ranges from 700 m to 1270 m

(iv) Physical Features:

- occupies gently undulating terrain with easy general NNW slope to the edge of the escarpment
- annual mean temperatures range from 17-20°C to 28-29°C
- annual rainfall: 1150 mm - 1500 mm

(v) Vegetation:

- mostly medium elevation moist semi-deciduous forest
- consists of some grassland areas capable of supporting forest cover
- 240 tree species (56% of country's total), four of which are listed as endangered

(vi) Fauna:

- reasonably well known: includes 150 spp. of forest bird (49% of country's total); 5 spp. of diurnal forest primate (42% of country's total); and 42 spp. of forest swallowtail and *Charaxes* butterfly (60% of country's total)

(vii) Economic Importance:

- most important tropical timber forest with the highest stocking in the country
- has been commercially logged since 1910 to today
- local people use the forest as an important source of building poles, fibers, firewood, bush meat and other products for local consumption

2. Mabira Forest

(i) Location:

- close to Lake Victoria shoreline, immediately to the west of Victoria Nile
- 56 km from Kampala and traversed by the Kampala-Jinja cities highway

(ii) Area:

- 306 km² of forest with boundaries grown with *Cassia spectabilis* as well as with direction trenches and cairns

(iii) Elevation:

- ranges from 1070 m to 1340 m

(iv) Physical Features:

- occupies gently undulating terrain with numerous flat-topped hills and wide shallow valleys
- annual mean temperatures range from 16-17°C to 28-29°C
- annual rainfall: 1250 mm - 1,400 mm

(v) Vegetation:

- mostly medium elevation moist semi-deciduous forest
- 202 tree species (47% of country's total), five of which are listed as endangered
- partially encroached by agriculture during 1970s to 1980s

(vi) Fauna:

- reasonably well known: includes 151 spp. of forest bird (46% of country's total); 2 spp. of diurnal forest primate (17% of country's total); and 39 spp. of forest swallowtail and *Charaxes* butterfly (57% of country's total)

(vii) Economic Importance:

- long usage by local people
- has been commercially logged since 1906 to today
- local people use the forest as an important source of building poles, fibers, firewood, bush meat and other products for local consumption

ANALYSIS OF VARIANCE AND INDEPENDENT *t*-TESTS FOR BUDONGO FOREST CASE STUDY COMPARTMENTS:

A. One-way Analysis of Variance:

1. Independent variable: COMPARTMENT
2. Number of compartments: THREE (N1, N2, and N15)
3. Dependent variable: TREE GENERA RICHNESS (average number of tree genera per 25 m x 50 m plot)

4. Hypotheses:

$$H_0: \mu_{N1} = \mu_{N2} = \mu_{N15}$$

$$H_1: \mu_{N1} \neq \mu_{N2} \neq \mu_{N15}$$

5. Confidence level: 95% ($\alpha = 0.05$)

6. One-way ANOVA Table:

DEP VAR: TREE GENERA RICHNESS N: 52 MULTIPLE R: 0.555 SQUARED
MULTIPLE R: 0.308

ANALYSIS OF VARIANCE

SOURCE	SUM OF SQUARES	DF	MEAN-SQUARE	F-RATIO	PROB
COMPART.	379.248	2	189.624	10.903	< 0.001
ERROR	852.194	49	17.392		

7. Inference: All case study compartments in Budongo Forest do not have similar (have significantly different) tree genera richness ($F = 10.90$, $df = 2, 49$, $p < 0.01$)

B. Independent multiple-comparison *t*-tests:

1. Hypothesis for *t*-test on compartment N1 vs compartment N2

$$H_0: \mu_{N1} = \mu_{N2}$$

$$H_1: \mu_{N1} \neq \mu_{N2}$$

2. Confidence level: 95% ($\alpha = 0.05$)

APPENDIX E1 (Continued)

3. Independent *t*-test Table:

INDEP. SAMPLES T-TEST ON TREE GENERA RICHNESS GROUPED BY COMPARTMENTS			
COMPART.	N	MEAN	SD
N1	14	18.500	3.546
N2	20	11.750	4.822
SEPARATE VARIANCES T = 4.702 DF = 31.9 PROB < 0.001			
POOLED VARIANCES T = 4.454 DF = 32 PROB < 0.001			

4. Inference: There was a significant difference in tree genera richness between compartments N1 and N2 ($t = 4.45$, $df = 32$, $p < 0.01$).

5. Hypothesis for *t*-test on compartment N1 vs compartment N15

$$H_0: \mu_{N1} = \mu_{N15}$$

$$H_1: \mu_{N1} \neq \mu_{N15}$$

6. Confidence level: 95% ($\alpha = 0.05$)

7. Independent *t*-test Table:

INDEP. SAMPLES T-TEST ON TREE GENERA RICHNESS GROUPED BY COMPARTMENTS			
COMPART.	N	MEAN	SD
N1	14	18.500	3.546
N15	18	13.944	3.811
SEPARATE VARIANCES T = 3.488 DF = 29.0 PROB = 0.002			
POOLED VARIANCES T = 3.456 DF = 30 PROB = 0.002			

8. Inference: There was a significant difference in tree genera richness between compartments N1 and N15 ($t = 3.46$, $df = 30$, $p < 0.01$).

9. Hypothesis for *t*-test on compartment N2 vs compartment N15

$$H_0: \mu_{N2} = \mu_{N15}$$

$$H_1: \mu_{N2} \neq \mu_{N15}$$

10. Confidence level: 95% ($\alpha = 0.05$)

APPENDIX E1 (Continued)

11. Independent t-test Table:

INDEP. SAMPLES T-TEST ON TREE GENERA RICHNESS GROUPED BY COMPARTMENTS			
COMPART.	N	MEAN	SD
N2	20	11.750	4.822
N15	18	13.944	3.811
SEPARATE VARIANCES T = 1.564 DF = 35.4 PROB = 0.127			
POOLED VARIANCES T = 1.544 DF = 36 PROB = 0.131			

12. Inference: There was no significant difference in tree genera richness between compartments N2 and N15 ($t = 1.54$, $df = 36$, $p = 0.13$).

ANALYSIS OF VARIANCE AND INDEPENDENT *t*-TESTS FOR MABIRA FOREST CASE STUDY COMPARTMENTS:

A. One-way Analysis of Variance:

1. Independent variable: COMPARTMENT
2. Number of compartments: FOUR (E176, E187, W216, and W224)
3. Dependent variable: TREE GENERA RICHNESS (average number of tree genera per 25 m x 50 m plot)
4. Hypotheses:

$$H_0: \mu_{E176} = \mu_{E187} = \mu_{W216} = \mu_{W224}$$

$$H_1: \mu_{E176} \neq \mu_{E187} \neq \mu_{W216} \neq \mu_{W224}$$
5. Confidence level: 95% ($\alpha = 0.05$)
6. One-way ANOVA Table:

DEP VAR : TREE GENERA RICHNESS N: 68 MULTIPLE R: 0.524 SQUARED
MULTIPLE R: 0.274

ANALYSIS OF VARIANCE

SOURCE	SUM OF SQUARES	DF	MEAN-SQUARE	F-RATIO	PROB
COMPART.	263.356	3	87.785	8.059	< 0.001
ERROR	697.158	64	10.893		

7. Inference: All case study compartments in Mabira Forest do not have similar (have significantly different) tree genera richness ($F = 8.06$, $df = 3, 64$, $p < 0.01$).

B. Independent multiple-comparison *t*-tests:

1. Hypothesis for *t*-test on compartment E176 vs compartment E187:

$$H_0: \mu_{E176} = \mu_{E187}$$

$$H_1: \mu_{E176} \neq \mu_{E187}$$

2. Confidence level: 95% ($\alpha = 0.05$)

APPENDIX E2 (Continued)

3. Independent *t*-test Table:

INDEP. SAMPLES T-TEST ON TREE GENERA RICHNESS GROUPED BY COMPARTMENTS			
COMPART.	N	MEAN	SD
E176	12	15.000	3.045
E187	12	15.250	3.957
SEPARATE VARIANCES T = 0.173 DF = 20.6 PROB = 0.864			
POOLED VARIANCES T = 0.175 DF = 22 PROB = 0.864			

4. Inference: There was no significant difference in tree genera richness between compartments E176 and E187 (*t* = 0.17, *df* = 22, *p* = 0.86).

5. Hypothesis for *t*-test on compartment E176 vs compartment W216:

$$H_0: \mu_{E176} = \mu_{W216}$$

$$H_1: \mu_{E176} \neq \mu_{W216}$$

6. Confidence level: 95% (α = 0.05)

7. Independent *t*-test Table:

INDEP. SAMPLES T-TEST ON TREE GENERA RICHNESS GROUPED BY COMPARTMENTS			
COMPART.	N	MEAN	SD
E176	12	15.000	3.045
W216	24	10.458	3.257
SEPARATE VARIANCES T = 4.121 DF = 23.5 PROB < 0.001			
POOLED VARIANCES T = 4.027 DF = 34 PROB < 0.001			

8. Inference: There was a significant difference in tree genera richness between compartments E176 and W216 (*t* = 4.03, *df* = 34, *p* < 0.01).

9. Hypothesis for *t*-test on compartment E176 vs compartment W224:

$$H_0: \mu_{E176} = \mu_{W224}$$

$$H_1: \mu_{E176} \neq \mu_{W224}$$

10. Confidence level: 95% (α = 0.05)

11. Independent *t*-test Table:

INDEP. SAMPLES T-TEST ON TREE GENERA RICHNESS GROUPED BY COMPARTMENTS

COMPART.	N	MEAN	SD
E176	12	15.000	3.045
W224	20	12.450	3.069

SEPARATE VARIANCES	T = 2.287	DF = 23.5	PROB = 0.032
POOLED VARIANCES	T = 2.282	DF = 30	PROB = 0.030

12. Inference: There was a significant difference in tree genera richness between compartments E176 and W224 ($t = 2.28$, $df = 30$, $p = 0.03$).

13. Hypothesis for *t*-test on compartment E187 vs compartment W216:

$$H_0: \mu_{E187} = \mu_{W216}$$

$$H_1: \mu_{E187} \neq \mu_{W216}$$

14. Confidence level: 95% ($\alpha = 0.05$)15. Independent *t*-test Table:

INDEP. SAMPLES T-TEST ON TREE GENERA RICHNESS GROUPED BY COMPARTMENTS

COMPART.	N	MEAN	SD
E187	12	15.250	3.957
W216	24	10.458	3.257

SEPARATE VARIANCES	T = 3.625	DF = 18.7	PROB = 0.002
POOLED VARIANCES	T = 3.874	DF = 34	PROB < 0.001

16. Inference: There was a significant difference in tree genera richness between compartments E187 and W216 ($t = 3.87$, $df = 34$, $p < 0.01$).

17. Hypothesis for *t*-test on compartment E187 vs compartment W224:

$$H_0: \mu_{E187} = \mu_{W224}$$

$$H_1: \mu_{E187} \neq \mu_{W224}$$

18. Confidence level: 95% ($\alpha = 0.05$)

19. Independent t-test Table:

INDEP. SAMPLES T-TEST ON TREE GENERA RICHNESS GROUPED BY COMPARTMENTS			
COMPART.	N	MEAN	SD
E187	12	15.250	3.957
W224	20	12.450	3.069
SEPARATE VARIANCES T = 2.101 DF = 18.9 PROB = 0.050			
POOLED VARIANCES T = 2.241 DF = 30 PROB = 0.033			

20. Inference: There was a significant difference in tree genera richness between compartments E187 and 224 (t = 2.24, df = 30, p = 0.03).

21. Hypothesis for t-test on compartment 216 vs compartment 224:

$$H_o: \mu_{W216} = \mu_{W224}$$
$$H_1: \mu_{W216} \neq \mu_{W224}$$

22. Confidence level: 95% ($\alpha = 0.05$)

23. Independent t-test Table:

INDEP. SAMPLES T-TEST ON TREE GENERA RICHNESS GROUPED BY COMPARTMENTS			
COMPART.	N	MEAN	SD
W216	24	10.458	3.257
W224	20	12.450	3.069
SEPARATE VARIANCES T = 2.085 DF = 41.3 PROB = 0.043			
POOLED VARIANCES T = 2.073 DF = 42 PROB = 0.044			

24. Inference: There was a significant difference in tree genera richness between compartments W216 and W224 (t = 2.07, df = 42, p = 0.04).

Name: Peter Ndemere

Date and Place of Birth 21 March, 1963
Rukungiri, UGANDA

Education	Name and Location	Date	Degree
High School:	Makobore High School Rukungiri, UGANDA	1981 - 1983	
University/College:	Makerere University Kampala, UGANDA	1983 - 1987	B.S.
	Kotka Forestry College Kotka, FINLAND	1988 - 1989	
	University of Helsinki Helsinki, FINLAND	1989 - 1991	M.S.
	State University of New York Syracuse, New York, USA	1993 - 1997	Ph.D.

Employment	Position	Date
Ministry of Natural Resources Forest Department Kampala, UGANDA	Forest Officer	1987 - 1992
National Agricultural Research Organization (NARO) Kampala, UGANDA	Research Officer	1992 - 1997