Forest Cover Type, Habitat Diversity, and Anthropogenic Influences on Forest Ecosystems Adjoining the Maasai Mara National Reserve, Kenya

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Abstract.—Through combined use of satellite imagery, aerial photographs, and ground truthing, a multilevel assessment was conducted in a forest block that forms a unique dispersal zone to the Maasai Mara National Reserve ecosystem. Results of the survey revealed considerable ecological diversity on an area-scale basis—in terms of ecotypes. Forest types ranged from Afro-montane dry conifer forests to semi-deciduous to dry deciduous forests. Distinct monospecific vegetation zones interspersed by mixed species clusters were delineated within the forest block. Forest edges and, in some cases, open glades within closed canopy forests are dominated by "clustered vegetation" atypical of the well-described savanna woodlands, thought to be heavily influenced by grazing and fire. Although habitat diversity in relatively undisturbed forest areas could be attributed to localized variation in altitude, soil, and drainage conditions, large and varied wildlife populations prevalent in the area as well as increased anthropogenic-related factors in recent years (forest encroachment through settlement and cultivation, forest exploitation, overgrazing, burning by forest-adjacent local populations) are largely responsible for the observed, progressive decline in vegetation diversity, and hence form the basis for design of monitoring systems. These preliminary findings suggest a need for a more detailed integrated survey approach for forest management planning involving local communities.

In the past 2 decades, forestry has taken on a new dimension. The traditional state-controlled and highly centralized forest management practices that restricted or even denied access to the forest by rural communities at whose expense forests are conserved have been found to be no longer tenable. In recent times there has been global recognition of the central role that local communities play in forest conservation and management. Furthermore, it is often neither politically feasible nor ethically justifiable to exclude poor people, who have only limited access to resources from the so-called protected forest areas, without providing them with alternative means of livelihood (Munasinghe and Wells 1992). In Kenya, forests are either gazetted as protected areas and managed as Forest Reserves by the Kenya Forestry Department (FD) or as part of the National Parks system, or they are protected areas for wildlife resources and managed by the Kenya Wildlife Service (KWS). Although these two state agencies complement each other in terms of managing the country's forest and wildlife resources, they are clearly separate and operate under different legislative frame works. Outside of this system of forest protection are forests and woodlands managed by local county councils in areas designated as "Trustlands." Trustlands are a historical concept that bestowed land stewardship on local county councils to hold in trust for the local people. In effect then, trustland forests are "community" forests. While control of forest and wildlife resources within the system of Protected Areas (PA's) could theoretically be enforced by law, this is seldom the case because of the inadequate capacity of the state agencies. Regulation outside the PA's system presents many problems.

This work focuses on the forest ecosystem adjoining the Maasai Mara National Reserve, which forms a critical dispersal area for wildlife populations moving to and from the reserve. Wildlife reliance on dispersal areas can be explained by the fact that no park or reserve is a self-sufficient, all-encompassing ecosystem (Campell *et al.* 1991). Much of the land surrounding the Maasai Mara Game Reserve has traditionally been used by the local pastoral Maasai community for herding cattle, a land-use practice that was compatible with the conservation of forest and wildlife resources. However, in recent years, there has been a progressive shift among most pastoral communities in East Africa, of which the Maasai are prominent, from mainly livestock production to subsistence and commercial modes of crop production. As a consequence of this shift, areas that were previously used as forests and rangelands used by livestock and wildlife are now being cleared for crop production. In the Maasai Mara Reserve, this has led to a reduction in wildlife and livestock habitats around the reserve, which has triggered intense resource competition between wildlife and humans with their livestock.

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For the forest ecosystems in the Maasai Mara area to continue providing various natural resources for humans and to remain viable dispersal areas for wildlife, the land must remain relatively undeveloped, which represents an opportunity cost to the landowners (Norton-Griffiths and Southey 1995). The goal should then be to identify forest and wildlife resource management options that also generate direct benefits for the local community. This study was designed with this broad objective in mind. This paper presents preliminary findings of a forest resource assessment and attempts to demonstrate that a multidisciplinary approach to forest ecosystem management is most viable in the Mara area.

MATERIALS AND METHODS

The Maasai Mara Game Reserve forms the northern part of the greater Serengeti ecosystem (Sinclair and Norton-Griffiths 1979), in southwestern Kenya, stretching along the Kenya-Tanzania border. The Maasai Mara Game Reserve comprises 1,368 km^2 of relatively low-lying plains (usually < 1,000 m.a.s.l). To the northwestern part of the park in the Transmara District of Kenya is a series of forest blocks (fig. 1) making up approximately 400 km^2 of closed canopy forests, dispersed within 1,700 km^2 of natural rangeland and bush or clustered woodland. The altitude at the Maasai Mara is about 1,500 m.a.s.l. and rises sharply to between 1,600 and 1,950 m.a.s.l. in most of the forested or rangeland areas in the central part of Transmara District. The rainfall regime also ranges considerably from a mean annual rainfall of less than 1,000 mm in the reserve to over 1,800 mm in the higher parts of the district. Because of permanent water sources, wildlife and livestock use the major forest blocks as critical dry season grazing when grass becomes scarce in the open rangelands within and without the reserve.

Forest Sampling

By satellite imagery, major forest blocks were identified in the first stage of the inventory. Selection of forests for sampling was based primarily on size, importance as wildlife habitats, and catchment value. In total, 29 forests were sampled, covering over 100 km^2 (forming one more or less contiguous forest block) in the central Transmara extending to the edge of the Maasai Mara Game Reserve. Aerial photographs taken in 1993 were used to delineate various forest types and formed the basis for determining transects, transect direction, and number of plots per transect. In total, 468 plots distributed among 64 transects were established and surveyed. Plot sizes ranged from 0.02 to 0.08 ha, depending on the density of the forest. Plots were established 100 to 200 m apart depending on the length of the transect and variation within the forest block being sampled. Data collection in each plot consisted of measuring the diameter at breast height (dbh) of all trees in the plot with dbh of > 10 cm, bole height, bole diameter (using a spiegal relascope), and total tree height of four to five randomly selected trees per plot. General site characteristics (drainage, slope, forest floor conditions) were assessed qualitatively. Evidence of forest degradation, such as tree cutting, charcoal burning, debarking, animal trails, and seedling damage, was also recorded. Timber volumes (bole volumes) obviously were crudely estimated following the procedures described in the Wass (1995) report on Kenyan indigenous forests.

Assessing Other Forest Values

In addition to forest assessment, local people were interviewed, engaged in discussions, and asked their views on the following issues:

Forest ownership: Who owns the forest? Communal, group, or private ownership? Is ownership clear?

Forest values: Water catchment: Does the forest have a significant value in terms of water conservation? Are there natural springs or rivers flowing through the forest? Have any changes been observed in streamflow through the area over the years? Socio-cultural values: Are there sacred sites, medicinal plants, ceremonial uses for plants, and wood and nonwood forest products? Are there any watering points and salt licks for animals?

Wildlife habitats: Is the forest frequented by wild animals? Which (migratory, resident, or both) animals? Is the forest a wildlife corridor or source area? Likely destination? Which time of the year are the animals most common in the forest? Damages/ problems caused by wildlife? What are the possible intervention measures?

Conservation: Do people support forest and wildlife conservation or are they indifferent to conservation? Who pays and who benefits in forest and wildlife conservation?

Awareness: How aware are the people of the value of the forest and wildlife resources? Is the process participatory? Are people aware of any conservation initiatives?

Involvement: How should human-wildlife conflicts be addressed? Compensation question? Role of the local people, state agencies (KWS, FD, bilateral, local, and international conservation non-governmental organizations)?

RESULTS AND DISCUSSION

Forest Characterization in Transmara District

Forest Microtopography

The physical microenvironmental features such as slope, susceptibility to erosion, and drainage are forest specific. Differences observed along a transect are often related to

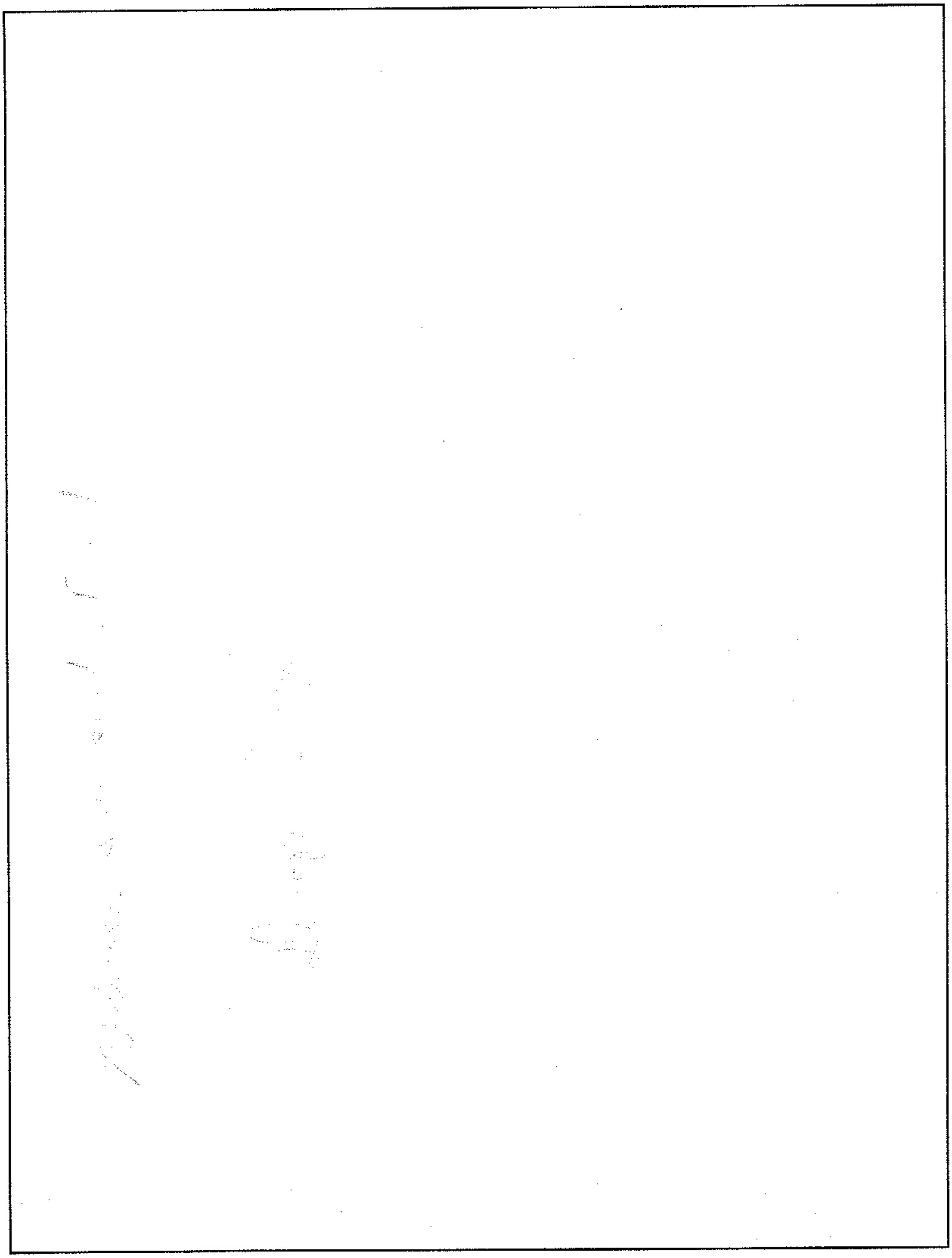

Figure 1.—*Transmara District Land Use Map.*

forest types (species associations). Localized drainage patterns appear to have a significant influence on the growth and distribution of some tree species. In general, most forests in Transmara are found on plains (< 5 percent slope) underlain by poorly drained clay soils. However, differences in topography greatly influence drainage conditions, even within a small area under the same soil type, hence the high diversity of forest types. For example, *Trichocladus ellipticus* is a low canopy shrub that is very prevalent in most parts of the Transmara and usually forms an impenetrable vegetation zone along the forest edge, although the forest floor is virtually bare on poorly drained sites. *Trichocladus ellipticus* has no timber volume but is used for poles, fencing, and fuelwood. In better drained sites, much taller trees and more dense understory vegetation is found. Evidence of erosion was minimal in most forests except along cattle or elephant trails. Most of the forested areas in the district are dissected by a network of perennial and seasonal streams. Any unplanned, wanton destruction of forests, therefore, has the potential to accelerate runoff with an obvious increase in downstream flow and deposition.

Forest Classification and Physiognomy

Forests in Transmara have not been classified but appear to conform to forest classification by White (1983) and Lamprecht (1989). Three main vegetation types were distinguished:

Afro-montane dry conifer: this formation is dominated by *Podocarpus latifolius*. Other important species are *Olea africana*, *Olea capensis*, and *Diospyros abyssinica*. The lower canopy consists of evergreen to deciduous vegetation.

Semi-deciduous (semi-evergreen): this vegetation type occurs in a huge drainage basin forming the single most extensive, contiguous closed canopy forest in central Transmara. The characteristic species are *Olea capensis*, *Diospyros abyssinica*, *Olea africana*, *Warbugia ugandensis*, and *Manilkara butugi*. The lower canopy is comprised of evergreen to semi-deciduous tree species such as *Teclea nobilis*, *Grewia sp.*, *Turrea holstii*, and *Trichocladus ellipticus*.

Dry deciduous: this is the most widespread forest type in low rainfall areas (< 1,200 mm) occurring mainly in the transitional zone separating medium altitude (1,000 to 1,600 m.a.s.l.) vegetation from Afro-montane forests. The most abundant species in this formation are *Euclea divinorum* and *Trichocladus ellipticus*. Interspersed within the Euclea/Trichocladus spp. mixed are other less abundant species such as *Elaeodendron buchananii*, *Manilkara butugi*, *Warbugia ugandensis*, *Olea africana*, *Olea capensis*, and *Diospyros abyssinica*. Infrequent species include *Apodytes dimidiata* and *Pistacia aethiopica*. In addition to these broad classifications of the closed canopy forests, 50 to 60 percent of Transmara consists of open woodland to savanna woodland. The open woodland vegetation has a deciduous tree layer that is rather low in density with mostly separate crowns.

These woodland formations at the landscape level represent a mosaic of "clustered forests." Unlike the savanna woodland that is characterized by scattered trees and grassland, the clustered forest formations can in some cases be as dense and diverse (i.e., species composition) as the closed canopy forest. Conditions within these clustered forests are in most respects similar to the adjacent closed canopy forest. These formations are clearly different from the well-described savanna woodlands. How can this patchwork of "clustered forests" within an open grassland be explained? The frequent use of fire and grazing in these ecosystems has led to random effects of selective burns and subsequently differential vegetation growth. The combined effects of fire and grazing, localized erosion, and deposition (as evidenced by the higher ground level in the clustered forests relative to the surrounding grassland) is a possible explanation. In terms of forest resources assessment, the varying sizes of clusters and random nature of their occurrence present serious sampling difficulties. Yet much of the wood and other forest products of the this entire region in Kenya are found in the clustered forests and should be included in management plans.

In terms of forest structure, the relationship between the number of trees per hectare to diameter class in most of the forest blocks in Transmara generally follows the classical J-inverse shaped curve for most species (fig. 2), except in highly disturbed forests where local exploitation has concentrated on small pole-size classes. Some species, such as *Manilkara butugi* and *Warbugia ugandensis*, were found only in large diameter classes, and species such as *Euclea divinorum* were found in diameter classes below 50 cm. Distributions of individual tree species clearly reflect the successional status of the species, with the light-demanding species such as *Olea capensis* not occurring in lower diameter classes except in forest edges. In terms of vertical forest structure, two categories are distinguished:

1. Low canopy forests with the uppermost canopy layer from 10 to 20 m in height and characterized by one to two layers.
2. High canopy forests with the uppermost canopy layer from 30 to 40 m in height and with at least three layers. Very tall trees (sometime up to 40 m) such as *Diospyros abyssinica* are predominant. Some of these forests are characterized by vertical forest structures typical of those found in tropical rain forests that have multistory canopy layers.

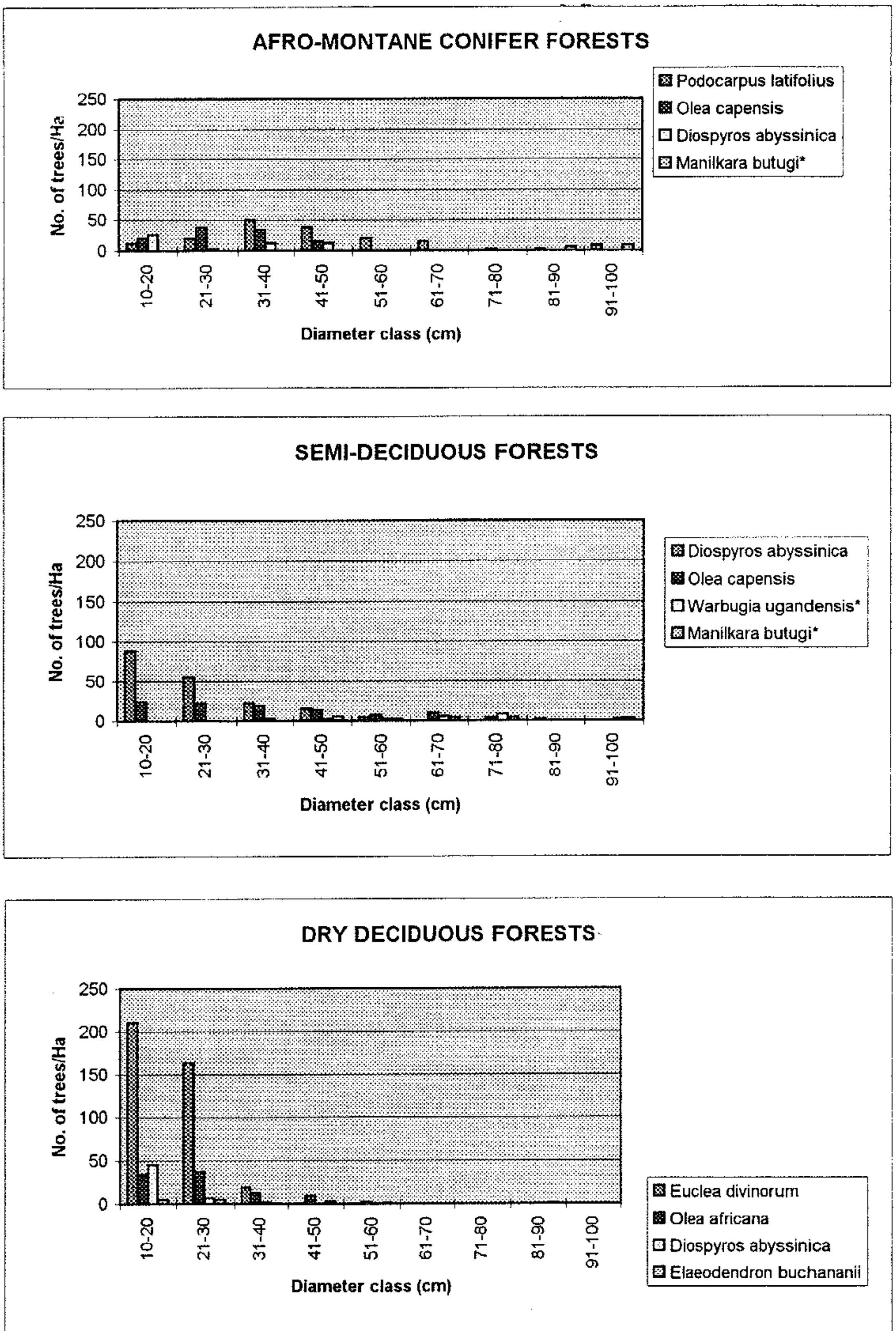

Figure 2.—*Diameter distribution for the most dominant tree species in the three main forest types in Transmara.*

The forests of Transmara are characteristically dominated by a few species (on a unit area basis) forming high "single-species concentrations" of almost pure stands or two- to three-species mixed zones. The dominant species (e.g., those shown in fig. 2) contribute as much as 60 to 70 percent of the overstory vegetation cover. The lack of high tree species diversity in the forests of Transmara is intriguing because the rainfall is high and altitude is similar to other forests in Kenya that have a high tree species diversity. This could be attributed to poor drainage and possibly to impacts of high wildlife (elephants, buffaloes, zebras) and livestock densities. The soils are generally poorly drained. Considerable soil compaction and browsed and trampled tree seedlings were evident in most forest areas.

Commercial Timber Species

The average basal area for all forests sampled in this study is 39.0 m^2 per hectare. Except for recent disturbances and encroachments coming from the forest edges, the remnant forest blocks in Transmara still appear to be in relatively good condition. Bole volume for the tree species in the forests fell between 350 m^3 and 450 m^3 per hectare in the semi-deciduous and Afro-montane dry conifer forests. These volumes are considered high and comparable to well-managed indigenous and plantation forests. Unlike other tropical forests, forests occur in the Transmara in which a single tree species may have more than 50 m^3 per hectare. Species in this category include *Podocarpus latifolius*, *Diospyros abyssinica*, *Olea capensis*, and *Manilkara butugi*. *Warbugia ugandensis* is one of the few dominant species that has high overall volume but is distributed sparsely within the forests. In contrast, *Manilkara butugi* tends to clump together, occasionally resembling an exotic plantation. The overall, average gross merchantable volume of wood in the forests where the commercial species occur in large numbers to be used economically is 137.53 m^3 per hectare; of these, *Diospyros abyssinica* accounts for 25.3 percent of the volume. The proportion of other commercial species is as follows: *Olea capensis*—17.6 percent; *Manilkara butugi*—16.4 percent; *Elaeodendron buchananii*—10.2 percent; *Olea africana*—9.6 percent; and *Warbugia ugandensis*—5.2 percent. *Podocarpus latifolius*, although occurring only in one forest, is in such a high concentration in that forest that it accounts for 24 percent of all the harvestable commercial volume. Commercial timber exploitation is currently non-existent in this region, but the local people are interested in the sustainable use of this resource, hence the need for refining these data. Given the crude volume estimates here and the lack of data on growth rates of virtually all the tree species, timber exploitation at this point is not recommended.

Habitat Diversity

Forests in Transmara are important wildlife sanctuaries and form a crucial dispersal zone for the Maasai Mara National Reserve. The survey revealed numerous wildlife dependent on the forests. Animal movement is both localized as well as migratory within the forest, and to and from the Maasai Mara National Game Reserve. Some of the wildlife populations are residents of the forest, while others, like the elephants, migrate seasonally. The value of the Transmara forests as wildlife habitats comes from variation in site conditions. The diversity of habitats within the forests (riparian forests, open woodlands, open glades within closed canopy forests, old-growth forests, swamps and permanent natural water springs, and salt licks) is reflected in its rich animal diversity. Animals such as elephants are often found in central parts of the forests in dense vegetation. In some areas, understory vegetation dominated by the succulent *Dracina afromontana* evident in several closed canopy forest blocks appears to be maintained by elephants with the consequence that regeneration of tree species is suppressed. During the dry season when pastures and water resources in the low-lying open plains of the Maasai Mara Reserve are scarce, wildlife take refuge in these higher altitude forests and inevitably come into conflict with humans and their domestic animals. The killing of livestock and damage to crops by wildlife are common in the area, and the lack of a compensation system makes conservation difficult to sell to the local people.

Wildlife can have both positive and negative impacts on forest structure and on the overall integrity of the forest ecosystem. The two main influences relate to actual physical damage to trees and other vegetation and to forest floor-soil compaction through trampling, both of which affect tree regeneration. Tree regeneration was generally low in most forest blocks in the district, which could be attributed in part to high animal populations (both wild and domestic). In all forests frequented by wildlife, over 40 percent of the area sampled showed evidence of damage in the form of soil compaction, numerous animal trails, trampled seedlings or saplings, and trees felled by elephants (or broken branches).

Anthropogenic Forest Influences

Forest Disturbance

The main human threats to the forests include cultivation, forest clearing for settlement, tree felling for charcoal production, cutting of building poles, overgrazing, and medicinal extraction. Cultivation is done either by the Maasai landowners or by cultivators from other parts of the country who lease the land. The drive to cultivate in the traditional pastoral Maasai is a socioeconomic issue that has direct consequences on the conservation of forests and wildlife in much of Kenya. Charcoal production has increased in the area because of the existence of large urban markets elsewhere in the country and because Transmara is one of the few remaining parts of Kenya endowed with rich wood resources. Building of houses and construction of fences by individual farmers following the subdivision of land from a traditionally communal form of ownership to private ownership have exerted much pressure on forests in the form of cutting of pole-size trees. Another consequence of land subdivision is the people's desire to own and settle on their own piece of land, leading to forest clearings for settlement, and at the landscape level, habitat fragmentation. Reduced land area arising from the a forementioned uses has led to overgrazing, and this problem is expected to increase unless management interventions are put in place. Invasion of rangelands by *Acacia gerrardii* forming virtually impenetrable thorn thickets and the prevalence of low quality "wire grass" *(Pennisetum hohenackeri)* in most of the Transmara area are clear indicators of poor rangeland conditions caused by mismanagement. Bark extraction from some tree species (e.g., *Olea capensis)* for traditional bee hives and from *Warbugia ugandensis* for medicinal purposes has led to high tree mortality. When an dominant overstory species like *Olea capensis* dies, huge forest gaps are created, which in most cases leads to invasion of weed species that alter the forest composition and structure.

Sociocultural and Other Forest Values

Over 95 percent of the people interviewed expressed high appreciation of the role of trees in their culture and the need to conserve the forests. Trees are widely used for treating ailments, in warding off dangers, and as final arbiters in the settlement of human disputes. Interactions with local people in the course of this study revealed a considerable level of sociocultural, and socioeconomic value attached to the forest. The subsistence economy of the communities living in or adjacent to the forest depends directly or indirectly on the forest. The preponderance of relatively undeveloped rangeland in Maasailand is evidence of a conservation-oriented culture that has had elaborate traditional land-use systems. Traditional medicine is not only of local value, but also is now being recognized and patronized by governments in many parts of the world. The screening of medicinal plants is carried out by specialized institutions (Baquar 1995). There is, therefore, a valid case in exploiting indigenous plant knowledge of medicine and promoting land-use practices that are compatible with the conservation of forests. There is considerable potential for commercial medicinal plant extraction in Transmara forests to benefit the local community.

The local people's attitude to forest conservation is overwhelmingly positive. However, the presence of large populations of wildlife and associated conflicts has significantly changed this attitude in recent years. Among the individuals interviewed, only 8 percent favored forests and wildlife conservation under existing conditions, while 73 percent favor conservation of forests if they do not harbor wildlife. Eighty-eight percent would support wildlife conservation if animals are confined to the PA system or if there is adequate compensation for damages caused by wildlife. In conclusion, unless adequate benefits are derived from the Transmara forests, the fact that they are *habitats* for wildlife threatens their existence and that of wildlife itself as people seek to clear forests to chase animals away.

Forest Management Implications

Several important management considerations and further research questions come out of this study. Firstly, it is clear that the Transmara forests have remained relatively intact for a long time, largely as a result of the pastoral system of land use by the local community whose culture is compatible with conservation. The major form of forest exploitation is a subsistence economy with minimal impact on the forest. However, recent shifts in the pastoral lifestyle toward crop production put a premium on forest land. Will commercial forestry lend itself as a competitive land-use alternative in this district and are the indigenous hardwoods a sustainable resource? Transmara contains some valuable wood resources, but the forests form a crucial habitat for wildlife. Wildlife is perhaps of more national importance than commercial forestry. Research on logging generally shows selective logging operations that involve the removal of only a few trees per hectare, which obviously has less impact than complete clearing and may even be beneficial. There is currently no mechanized timber industry in Transmara. Species such *Olea capensis*, *Olea africana*, and *Warbugia ugandensis* are in some instances converted into less valuable uses such as charcoal production when they could fetch much more money as timber.

Although the forest assessment has revealed a considerable raw material base to support some wood industry, data are not available on tree growth rates, harvesting methods, logging costs, and the sustainability of indigenous timber exploitation vis a vis other land-use options. A central objective for the multiple exploitation of forests is to determine which products can be removed, which harvesting techniques to use, and what level of exploitation can ensure sustainability. This principle must, however, be well understood by all the forest users; the situation can become very complicated where the main beneficiaries of a particular forest product are not the inhabitants of the area.

There is the question of wildlife as a natural resource and heritage. Current legislation prohibits game hunting in Kenya. There is a marked increase in human-wildlife conflict in Transmara. Conflict is intense when agriculture is involved, particularly where cropland borders forested areas and where pockets of agriculture are surround by rangelands. Conflicts arise because wildlife destroy property and may injure or even kill humans and domestic animals. During this study, baboons and vervet monkeys were the most notorious crop raiders while elephants were the most destructive and problematic wildlife species. This is the major problem facing the communities living in the Transmara area where wildlife conservation is practiced. For years, the Maasai have coexisted with wildlife, and there is ample historical evidence to show that present human-wildlife conflicts in much of Maasailand can be traced back to inappropriate policy decisions as well as to the exploitative tourist industry in Kenya that until recently totally disregarded the rights of local people at whose expense wildlife is conserved. In the Transmara area, for example, forests have remained important wildlife habitats because for many years landowners simply did not bother about their economic value. People now understand the economic value of land and wildlife and are set on exploiting it to its full potential. Norton-Griffiths and Southey (1995) present an interesting economic analysis that clearly shows that for the Maasai landowner:

$$\text{Net Revenue}_{(\text{agriculture})} >>> \text{Net Revenue}_{(\text{from livestock})} >> \text{NR}_{(\text{from Conservation})}$$

The additional costs to conserve natural resources over and above the costs local people are willing to bear, because of direct and intrinsic values they derive from use of the resources, must be the responsibility of both the national government and the larger international community. There is no point extolling the virtues of conservation without a fair consideration of the conservation costs. Ecotourism has been suggested as one mechanism through which local people can reap benefits from wildlife. As an option, it has a great potential given the beautiful scenery and large wildlife populations in the district, but this is a fragile industry dependent on external factors that are beyond not only the control of local communities, but also the national government. To what extent should local people be involved in tourism or ecotourism as a means of reaping direct benefits that accrue from wildlife conservation? What local institutional mechanisms exist for cost and benefit sharing, if and when such revenues accrue? What are the vital wildlife dispersal areas and how can human-wildlife conflicts be minimized in the Transmara?

The solution to forest and wildlife resource management appears multifaceted. Forests, wildlife, and humans are inextricably linked in Transmara. A conservation strategy will inevitably need to address the different levels of these interactions. The conservation argument must be presented in terms of the full range of benefits (controlled level of forest product exploitation—timber and non-timber forest products, sociocultural and service functions, ecotourism) within a well-elaborated management plan derived from multiple-level land-use planning. For this to happen, a well-defined institutional framework is required in which identifiable and democratic local community institutions exist with necessary technical backing from government agencies such as KWS and FD, and support of international conservation agencies. The question of institutional collaboration (KWS, FD, local community institutions, and concerned conservation agencies) in natural resource management is very important. Many forest and wildlife conservation initiatives have failed more as a result of institutional impediments than for technical reasons.

From a forest resource assessment and monitoring standpoint, two significant conclusions can be drawn. First, that the current emphasis on multiple use and forest management represents a major shift in conventional forest assessment practice and presents greater research challenges in terms of forest assessment tools. It also requires an interdisciplinary approach. Secondly, due to a diversity of land tenure regimes, especially in sub-Saharan Africa, there is a need to recognize the broad spectrum of forest resource use patterns within and beyond PA's and involve local landowners in resource assessment, management planning, and resource use monitoring.

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LITERATURE CITED

Baquar, S.R. 1995. The role of traditional medicine in rural environment. Nairobi, Kenya: East Africa Education Publishers Ltd..

Campell, K.I.I.; Huishi, S.A.; Kajuni,. A.R., eds. 1991. Serengeti National Park Management Plan for (1991-1995), Arusha, Tanzania National Parks. Dar es Salaam.

Lamprecht, H. 1989. Silviculture in the tropics: tropical forest ecosystem and their tree species - possibilities and methods for the long term utilization. Eschborn.

Munasinghe, M.; Wells, M. 1992. Protection of natural habitats and sustainable development of local communities. In: Cleaver, K.; Munasinghe, M.; Dyson, M.; Egli, N.; Peuker, A.; Wencelius, F., eds. Conservation of west and central Africa rainforests. World Bank Environ. Pap. 1. 353 p.

Norton-Griffiths, M.; Southey, C. 1995. The opportunity costs of biodiversity conservation in Kenya. Ecological Economics. 12: 125-139.

Sinclair, A.R.E.; Norton-Griffiths, M., eds. 1979. Serengeti: dynamics of an ecosystem. Chicago: Chicago University Press. 389 p.

Wass, P., ed. 1995. Kenya's indigenous forests: status, management and conservation. IUCN, Gland, Switzerland and Cambridge, UK. 205 p.