Frontier Tanzania Savanna Research Programme

Nambiga Forest Reserve
Biodiversity and Resource Use Survey

Society for Environmental Exploration
University of Dar es Salaam

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2001

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PREFACE

This section outlines the responsibilities and objectives of those bodies involved in the Kilombero Valley Integrated Environmental Management Programme (KVIEMP).

The University of Dar es Salaam (UDSM)
The University of Dar es Salaam was established in July 1970 as a centre of learning and research in the arts and the physical, natural, earth, marine, medical and human sciences. The Faculty of Sciences within the University surveys and maps the flora and fauna of Tanzania and conducts research into the maintenance and improvement of the environment and the sustainable exploitation of Tanzania's natural resources.

The Society for Environmental Exploration (SEE)
The Society is a non-profit making company limited by guarantee and was formed in 1989. The Society's objectives are to advance field research into environmental issues and implement practical projects contributing to the conservation of natural resources. Projects organised by The Society are joint initiatives developed in collaboration with national research agencies in co-operating countries.

Frontier-Tanzania
The Society and the University have been conducting collaborative research into environmental issues since July 1989 under the banner of Frontier-Tanzania Research Programmes. Over 11 years, more than 2,000 international volunteers have participated in these programmes working alongside Tanzanian Catchment Forestry, Fisheries and Wildlife Officers and students to map the biodiversity of Tanzania.

Funding bodies
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SUMMARY

1. Nambiga Forest Reserve is important as a low altitude example of evergreen forest. It is important for wildlife, water management and forest products.

2. Here we report on a biodiversity survey and resource use assessment of Nambiga F. R. undertaken by Frontier-Tanzania. Zoological trapping, forest disturbance assessments and vegetation surveys were conducted from February to May 1999. Interviews with local people were used to assess the perceptions and use of Nambiga F. R. by the surrounding communities.

3. Use of Nambiga F. R. by local people was generally low and natural resources were available in large enough quantities outside the reserve to meet demand. Villagers considered people outside of the local area to be responsible for the extraction of large timber trees.

4. The forest was composed mainly of small trees and shrubs, with only a few large timber trees remaining. Tree extraction was concentrated in the north-east of the reserve near the village of Iragua. This was because of accessibility to the reserve and was not related to availability of tree products.

5. The biodiversity surveys found 10 species of small mammals, 26 large mammal species, 17 amphibian species, 26 reptile species, 62 butterfly species and 6 bat species.

6. Further research on other animal groups (e.g. birds, nocturnal frogs) are required to complete the biological inventory of the site.

7. Other forest reserves in Ulanga District now need to be surveyed as matter of a priority.

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1. INTRODUCTION

1.1 Catchment Forest Reserves

The network of Catchment Forest Reserves in Tanzanian is particularly important for environmental conservation and maintenance of water resources (Ministry of Natural Resources and Tourism 1998). Situated across the country, these forests conserve areas of rich biological value and include the internationally important Eastern Arc forests (Lovett and Wasser 1993). The high level of species endemism and the fragmented nature of the remaining Eastern Arc forests have produced the impetus for detailed biodiversity assessments and conservation reviews of these reserves (e.g. Doggart *et al*. 1999a, b).

Although Ulanga District has only eight catchment forest reserves, covering 6,407 ha, their role in providing water supplies to the major towns (e.g. Mahenge) and rivers (e.g. Kilombero River) make them important natural resources. Ruby and graphite mining, logging and fire combine to place these, often small reserves (mean size, = 968 ha s.d. = 764, Ulanga District), under increasing pressure (Lovett and Pócs 1993). Furthermore, these eight forests are of national importance because they form part of the southern limit to Tanzania's chain of Eastern Arc forests (Lovett and Pócs 1993).

Nambiga is considered the third most threatened forest in the district (Lovett and Pócs 1993) and, in common with the other reserves, its flora and fauna remain poorly studied. The need to conduct a rapid biodiversity assessment and to investigate patterns in human exploitation of the reserve was identified by Ulanga District Council and resulted in the work presented here. This study presents unprecedented information on the biological resource within Nambiga and provides an assessment of the current threats facing the reserve.

1.2 Project aims

In recognition of Nambiga's dual role in providing natural resources to the local community and conserving an important wildlife habitat, this survey consisted of two complimentary projects (1) a biodiversity survey to describe the animal and plant communities of the reserve (2) a socio-economic survey to provide information on local perceptions and resource use of Nambiga.

1.3 Nambiga Forest Reserve

1.3.1 *Location*

Nambiga Forest Reserve is located in Ulanga District, Morogoro region, between 36° 27' E to 36° 30' E and 8° 34' S to 8° 36' S. The reserve is split by the Lupiro-Malinyi road and lies between the villages of Iragua and Itete (Figures 1.1). The forest is surrounded on three sides by miombo woodland and by farmland on the other side.

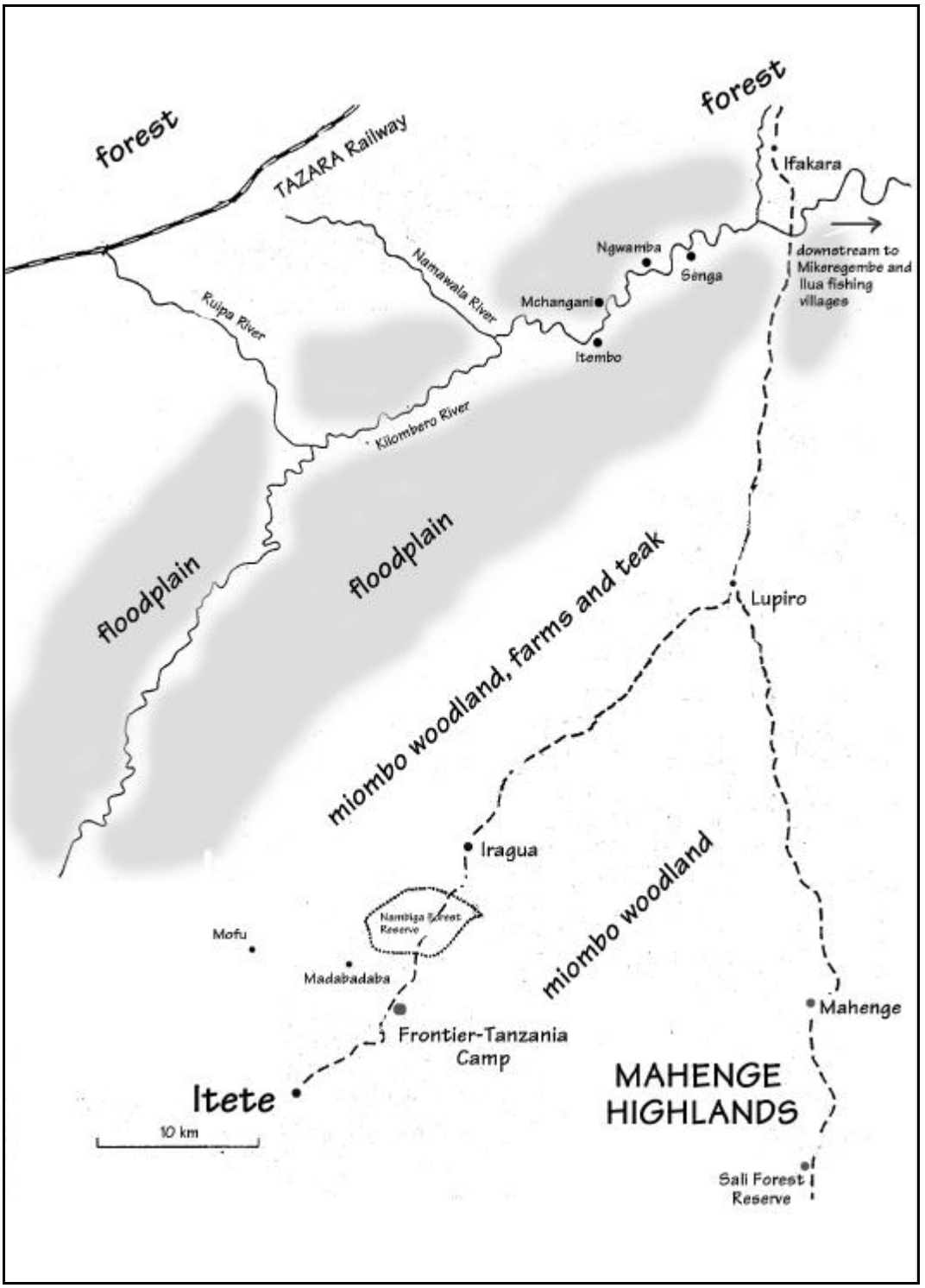

Figure 1.1. Sketch map showing the location of Nambiga F. R. in relation to the nearest towns and the main Lupiro-Itete road.

1.3.2 *Description*
Nambiga F.R. was gazetted in 1954 and covers 1,390 ha and has 16 km of boundary.

1.3.3 *Topography and climate*
Nambiga Forest Reserve is on the eastern side of the Kilombero Valley between the Udzungwa and Mahenge Mountains. Nambiga is a lowland forest (335-365 m asl). Rainfall is highly seasonal, ranging between 1000 mm to 2000 mm per year, with February to May the wettest period. Temperatures range from 22° C (July)to 28° C (November).

1.3.4 *Vegetation*
Nambiga F. R. is a lowland groundwater forest with a mixture of forest and woodland species. Trees recorded include *Albizia* sp., *Bombax rhodongaphalon, Borassus* sp., *Combretum molle, Khaya anthotheca, Lettowianthus stellatus, Milicia excelsa, Piliostigma thonningii, Sterculia appendiculata, Trema orientalis, Terminalai sambesiaca, Trilepisium madagascariensis. Olyra latifolia* is the dominant herb.

Mvule (*Milicia excelsa*) and Mkangazi (*Khaya anthotheca*) occur but have been mostly already extracted. Other lower grade timbers include *Terminalia sambesiaca*.

2. RESOURCE USE SURVEY

2.1 Aims and objectives

The main aim the resource use survey was to provide an assessment of the impact that local communities have on Nambiga F. R.

The objectives of the survey were to (1) provide an assessment of land use in the area immediately surrounding Nambiga F. R. (2) identify local perceptions of Nambiga F. R. and (3) identify key natural resource issues to local communities outside of Nambiga F. R.

2.2 Methods

Four group meetings (8-15 people per group) were held in the villages surrounding Nambiga. Each group was selected to provide a representative sample of the regular users of the reserve.
Group 1: agro-pastoralists, near Madabadaba.
Group 2: village elders, Iragua.
Group 3: male farmers, near Iragua.
Group 4: female farmers, north-west corner of Nambiga F. R.

The meetings were run using semi-structured interviews, a standard participatory rural appraisal (PRA) technique for obtaining information from local communities. The principle behind this method is that the community group itself directs the interview with assistance from an external facilitator. This approach allows community priorities to be more self-evident and importantly, limits the impact of preconceived ideas on the part of the interviewer.

Interviews were carried out utilising the services of a Catchment Forestry Officer who acted as an interpreter and facilitator. The guidelines for the meeting were decided beforehand by the Forest Officer in collaboration with Frontier staff members.

2.3 Results

2.3.1 *Population and settlement trends*

The area surrounding Nambiga F. R. is characterised by two centres of population, Madabadabba and Iragua. Madabadabba is a WaSukuma settlement of about 300 households. Iragua has a population of 470 households with about ten new ones moving in each year. The areas between these two centres are characterised by dispersed settlements of various sizes.

2.3.2 *Agriculture*

Agriculture in the area outside of Nambiga is predominantly traditional and land use intensity is low. Farms are only seen adjacent to the reserve on the northern roadside boundary. Different land uses surround Nambiga F. R., consisting of settled agriculture, teak plantations and agro-pastoralism.

Northern area

Farmers in the northern area practise shifting cultivation and claim to have used the same area for the past forty years, rotating fallow periods between fields. A more intensive form of shifting cultivation is practised in the hilly zone to the east of Iragua. One group of farmers interviewed had been forced to move from this location by the Village Committee following soil erosion and wind damage, thought to be a

result of cultivation on steep slopes and deforestation. No evidence of such human related land degradation was found in the area immediately outside Nambiga F. R.

Rice is the main crop in the small farms (average 2 ha) of the northern area. In all of the areas visited the risk of crop damage from baboons was considered too high to justify planting large areas of maize. Maize had instead been relegated to a more minor role in small gardens, affording better protection from crop pests. Wildlife related crop damage is a common problem. In addition to baboons *Papio cynocephalus*, losses are caused by elephant *Loxidonta africana*, bush pigs *Potamochoerus larvatus* and in the north-west, by hippopotamus *Hippopotamus amphibius* and puku *Kobus vardoni*. Wildlife related crop damage is even a problem after crops have been harvested. Communities in the roadside area believe that crop damage is worsened by the proximity of Nambiga F. R.which acts as a refuge for potential pest species. Other crops grown include cassava, sweet potato, groundnuts, sesame and millet. Annual changes in weather patterns are a major influence on the type of crops planted. In 1999, as a result of the failure of the first rains, farmers were concentrating on drought resistant crops such as millet and cassava at the expense of paddy rice and maize.

Southern area
Farming in the southern area is dominated by WaSukuma people who practise a form of agro-pastoralism, planting maize, millet, sweet potato and rice around the village and grazing up to 100 cattle per household over a large area on the floodplain fringe. Currently each of the 300 households owns an average of about 100 cattle and they play an important role in fertilising the crops.

2.3.3 *Income*
Farming is the predominant source of income for the communities surrounding Nambiga F. R. Other sources include the manual labour requirements of the Kilombero Valley Teak Company, fishing in the Kilombero River and brewing local alcohol (pombe).

In common with semi-subsistance farming, these are all low-income activities. It is only when there is a surplus that significant quantities of crops are sold and major income gained. In a typical year the amount of surplus is dependent on the weather and in 1999 most of the farmers spoken to were not expecting a surplus. The exception to this rule was simsim, which is sometimes grown purely as a cash crop, although never in large quantities. Although no quantitative income assessment was carried out it is clear that incomes were very low. This conclusion is consistent with the Poverty Profile of Ulanga District which reported the average annual expenditure for households in Iragua was just over 17,000 Tsh, the equivalent of about $22 US a year (Irish Aid 1996).

2.3.4 *Forest resource use*
Timber and non-timber forest products were used to varying extents by all of the communities interviewed. Woodland products are abundant in all areas with the notable exception of the northern roadside area around Iragua. An area of resource rich miombo woodland and patchy evergreen forest separated all of the other communities from Nambiga. The northern roadside area, however was characterised

by the highest density of farmland and as a result some of the woodland products, and building materials in particular, were in short supply.

2.3.5 *Perceptions of Nambiga*

All of the communities in the area were aware of the protected status of the reserve although most were unclear about the exact location of the boundary. There was a perception amongst local people that all of the riverine and groundwater forest in the area is part of Nambiga F. R. The actual border is much smaller and excludes large areas of this evergreen forest.

The perceptions of Nambiga F. R. were consistently positive across all four groups. In ranked order they were:

1. *Water provision*. Local people believe that the area has more reliable rainfall as a result of Nambiga F. R. In particular, they believe it causes the rain to come earlier, effectively prolonging the growing season.

2. *Meat provision*. Every group recognised that Nambiga F. R. played an important role as a wildlife habitat. All, with the exception of the WaSukuma, claimed to benefit from this in the form of meat supplied from the trophy hunting companies. One group went as far as to admit that they occasionally obtained buffalo *Syncerus caffer*, hippo and various antelopes from poachers.

3. *Forest resource provision*. This was only important for the communities living in the northern roadside and Iragua areas where some products are now in scarce supply outside of Nambiga F. R. Interviewees expressed a desire to be allowed to obtain building poles and thatching grass from the reserve.

2.3.6 *Historical change*

The meetings held for this research testified to the great amount of change that has taken place over the last thirty to forty years. Old men spoke of a time when it was unsafe to travel in the area because there was so much wildlife. It is clear that Nambiga F. R. used to be a very dense lowland forest, unique in the area, from where local people used to obtain a great variety of traditional medicines. Many of the people in the interview groups expressed concern about the current state of Nambiga F. R. The main factors thought to have caused deterioration in Nambiga F. R. are:
1. *Pit sawing***.** Interviewees accepted that it is probably local people who have been doing the pit sawing, but claimed that it was not done for local markets, but rather for traders from Dar es Salaam and Zanzibar.

2. *Teak plantations***.** Many people believe that teak has been planted inside the reserve although this probably relates to a misconception as to the location of the boundary. Representatives from every group believed that the close proximity of teak plantations to Nambiga had forced large mammals to move away and has made some areas more arid.

2.4 Discussion

The results of this research indicated that resource use by local communities does not pose an immediate threat to the resources of Nambiga F. R. Land use intensity is low

and natural resources are generally plentiful in the area outside of the reserve. The situation in the northern roadside area should be monitored carefully but this is the only potential area for concern.

The low incomes in the area, the dependency on agriculture and the susceptibility of farms to damage by wildlife and unsuitable weather means that increased exploitation of the reserve to meet immediate household needs is a future possibility.

If local testimony is to be believed, the deterioration of Nambiga F. R. has been caused by timber traders operating on a large scale. This is backed up by numerous sightings of timber lorries in the area. Furthermore, the cost of timber is beyond the reach of most households and the fact that the building requirements of most houses in the area are easily satisfied by the much more accessible miombo areas.

The distance from Nambiga F. R. to the communities that surround it mean that most people do not regularly use the reserve. This effectively limits the potential of *joint forest management* options because it is difficult to see how most communities will benefit from reserve resources. If this path to management is taken then a certain amount of imagination is required. Certainly the degree of concern expressed by local people would suggest that there may be potential for some form of community monitoring scheme.

3. FOREST COMPOSITION AND DISTURBANCE SURVEY

3.1 Introduction

Nambiga F. R. is a valuable resource and has been used by local communities for many years. However, in recent times the utilisation has increased and commercial pit-sawing operations may have caused a change in the forest structure. A vegetation survey of Nambiga F. R. was therefore undertaken to describe the composition of the forest and to record the type and level of human disturbance. The survey concentrated on the diversity of mature trees, and on the identification of the regenerating species.

3.2 Methods

3.2.1 *Botanical survey*

A grid system of transect lines were cut throughout the forest reserve, in order to provide easy access, and to act as boundaries for the study plots within the reserve (January-May 1999). Transect lines were cut along north-south and east-west compass bearings, in 50 m sections. Vegetation plots (50 m x 20 m) were situated within each of the 48 grid squares (450 m x 900 m, Figure 3.1). Every tree with a DBH (diameter at breast height) > 10cm was noted and identified in each vegetation plot. To assess the composition and size of the regenerating plants, 3 m x 3 m sub-plots were undertaken in all main vegetation plots. The DBH of all trees and shrubs <10 cm DBH and height of trees and shrubs < 1 cm DBH within the sub-plots were measured.

3.2.2 *Disturbance survey*

Disturbance surveys were conducted along the vegetation transect lines and were divided into 50 m sections. Poles and timber trees within 5 m either side of the transect line were counted. Before data collection commenced, all spotters participated in a rigorous training procedure to ensure that any differences in disturbance levels could not be attributed to observer bias. All spotters unable to acquire the necessary level of accuracy were used as data recorders only.

A pole was defined as having a DBH greater than 5 cm and less than 14.5 cm, with at least 2 m of straightness. This definition was selected to reflect the specifications required by local people for construction. A timber tree was defined as having a DBH of over 14.5 cm with at least 3 m of straightness. This definition was selected because it is the minimum length needed for planks. All poles and timbers were further classed as alive, naturally dead, newly cut or old cut. The presence of pit-saws, planks, burnt areas, past cultivation, roads and illegal trapping was also noted for each 50 m section.

3.3 Results

3.3.1 *Botanical survey*

Table 3.1 gives a summary of the 93 confirmed plant species from both vegetation and regeneration plots in Nambiga F. R. The forest was composed mainly of small trees and shrubs, with only a few large timber trees remaining (e.g. *Milicia excelsa*, *Khaya anthotheca* and *Xylopia parviflora*). *Dichapetalum stuhlmanii*, *Harrisonia abyssinia*, *Markhamia lutea*, *Milettia dura* and *Rothmania engelrina* were recorded from the most vegetation plots, with all other species found in < 20 % of plots (Table 3.1). The vegetation in the regeneration plots was clearly dominated by the small trees *Alchornea laxiflora* and *Dichapetalum stuhlmanii* (Table 3.1). Thirty-six of the

species recorded from the vegetation plots were absent from the regeneration plots, whilst only 15 regeneration species were not found in the main vegetation plots.

Thirty-six of the species from Nambiga were plants usually associated with riverine woodland or moist forest, whilst the remainder consisted of a variety of dry woodland, open grassland and secondary forest species (Palgrave 1983, Beentje 1992).

Vegetation height, mean DBH, species richness and abundance of dead trees showed no relationship with proximity to the reserve boundary, with values evenly distributed across all plots. There was also no clear pattern in the distribution of poles and timber trees, with both occurring at a relatively uniform abundance throughout the reserve (Figures 3.1 and 3.2). There was, however, a trend for the plots in the north-east of the reserve to have the highest density of poles (Figure 3.2).

3.3.2 *Disturbance survey*

Some evidence of logging was found in 20 of the 48 plots and of these occurrences, six were recent.

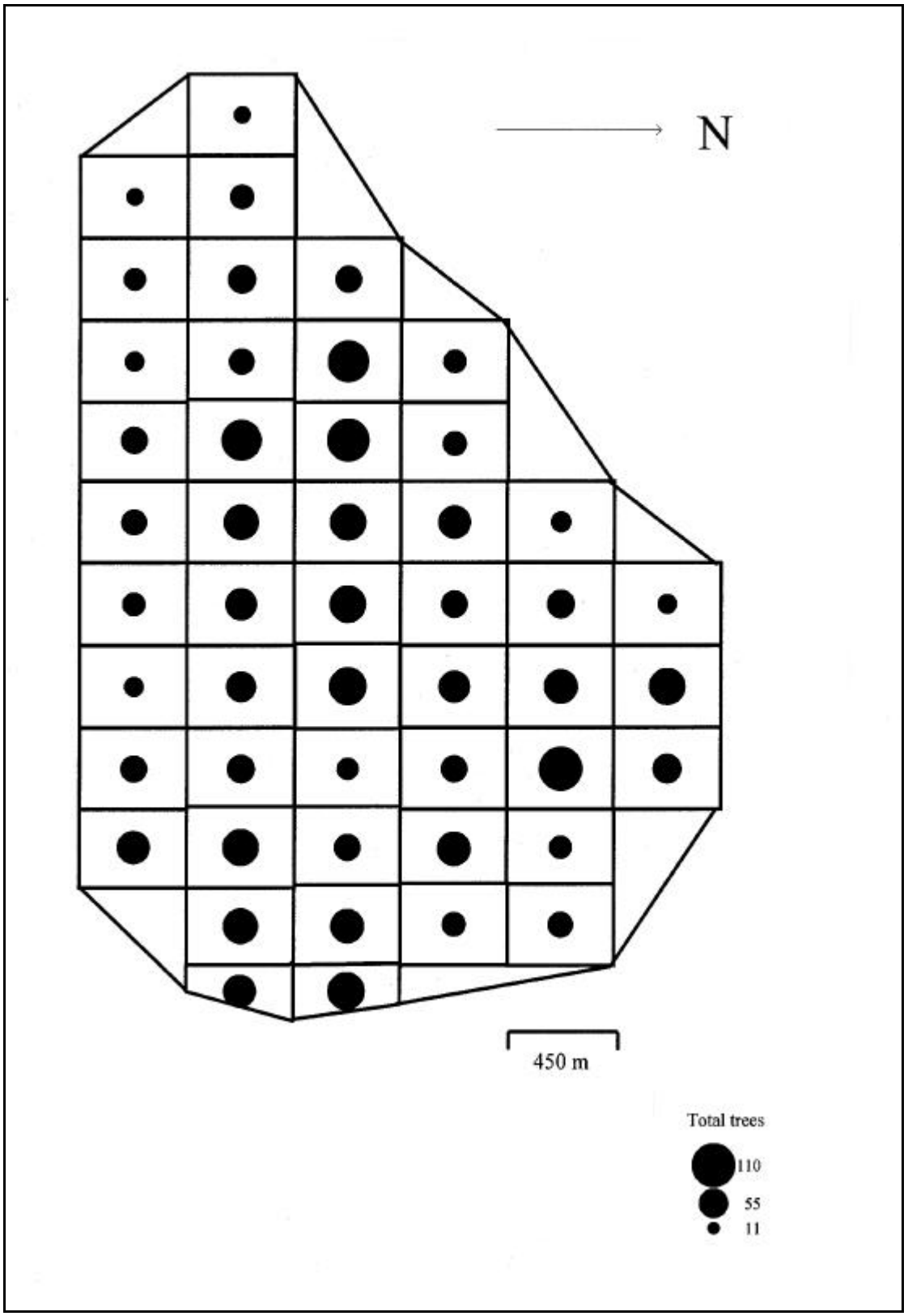

Figure 3.1 Timber trees (see methods for definition) per 100 m^2 in Nambiga Forest Reserve. A thematic map with each circular symbol proportional to the value for the plot.

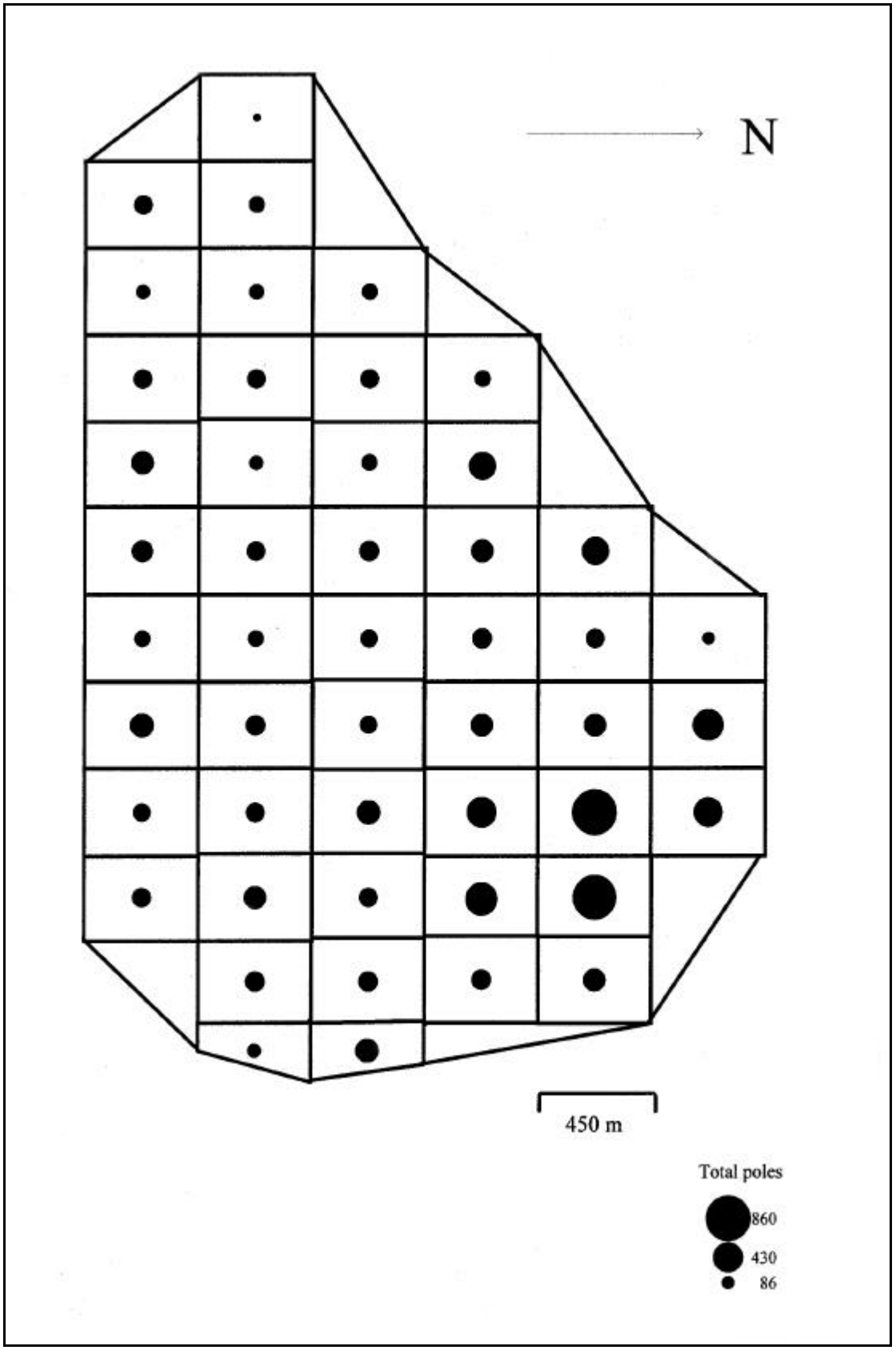

Figure 3.2. Total poles per 100 m^2 in Nambiga Forest Reserve.

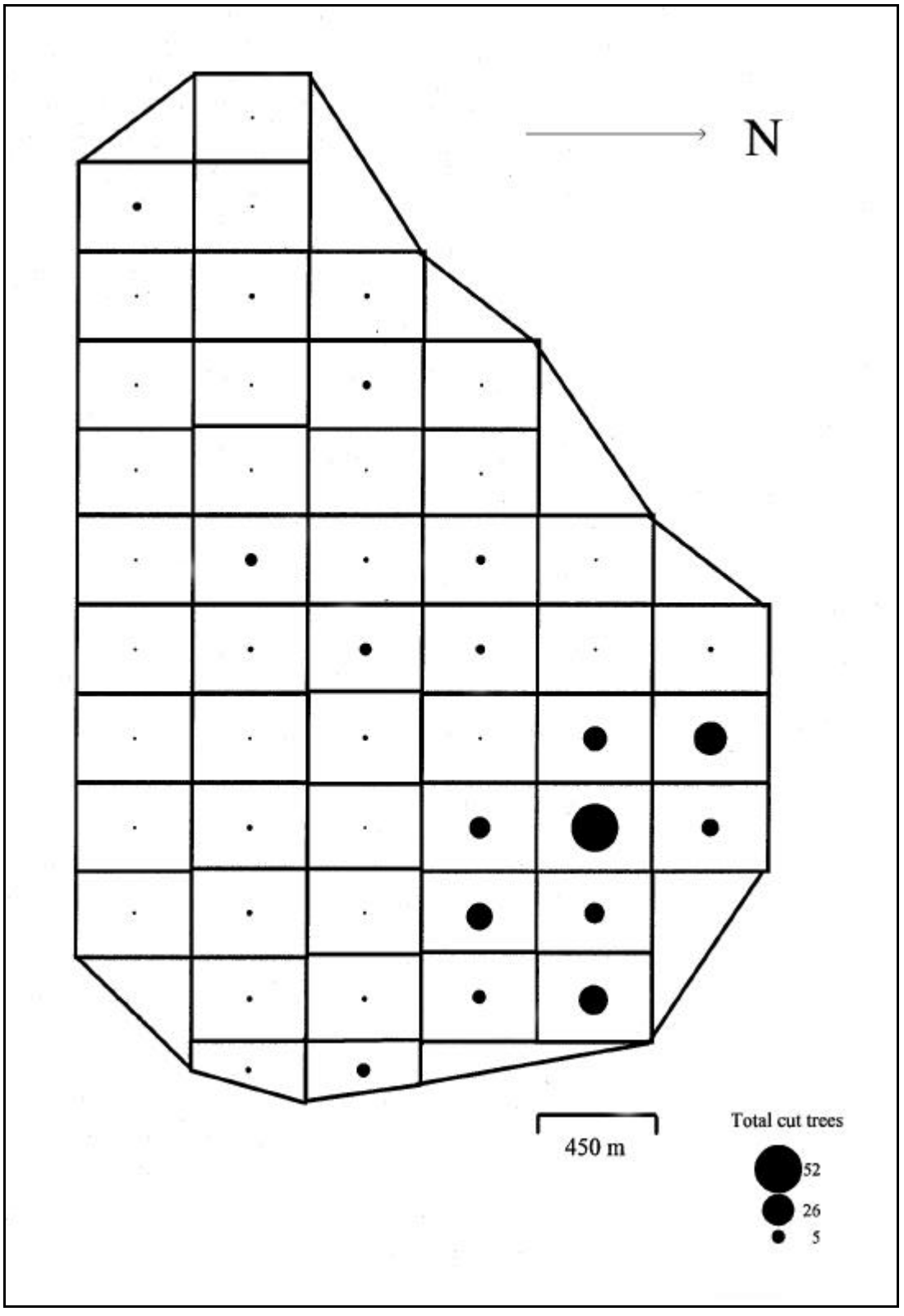

Figure 3.3. Total cut timber trees per 100 m^2 in Nambiga Forest Reserve.

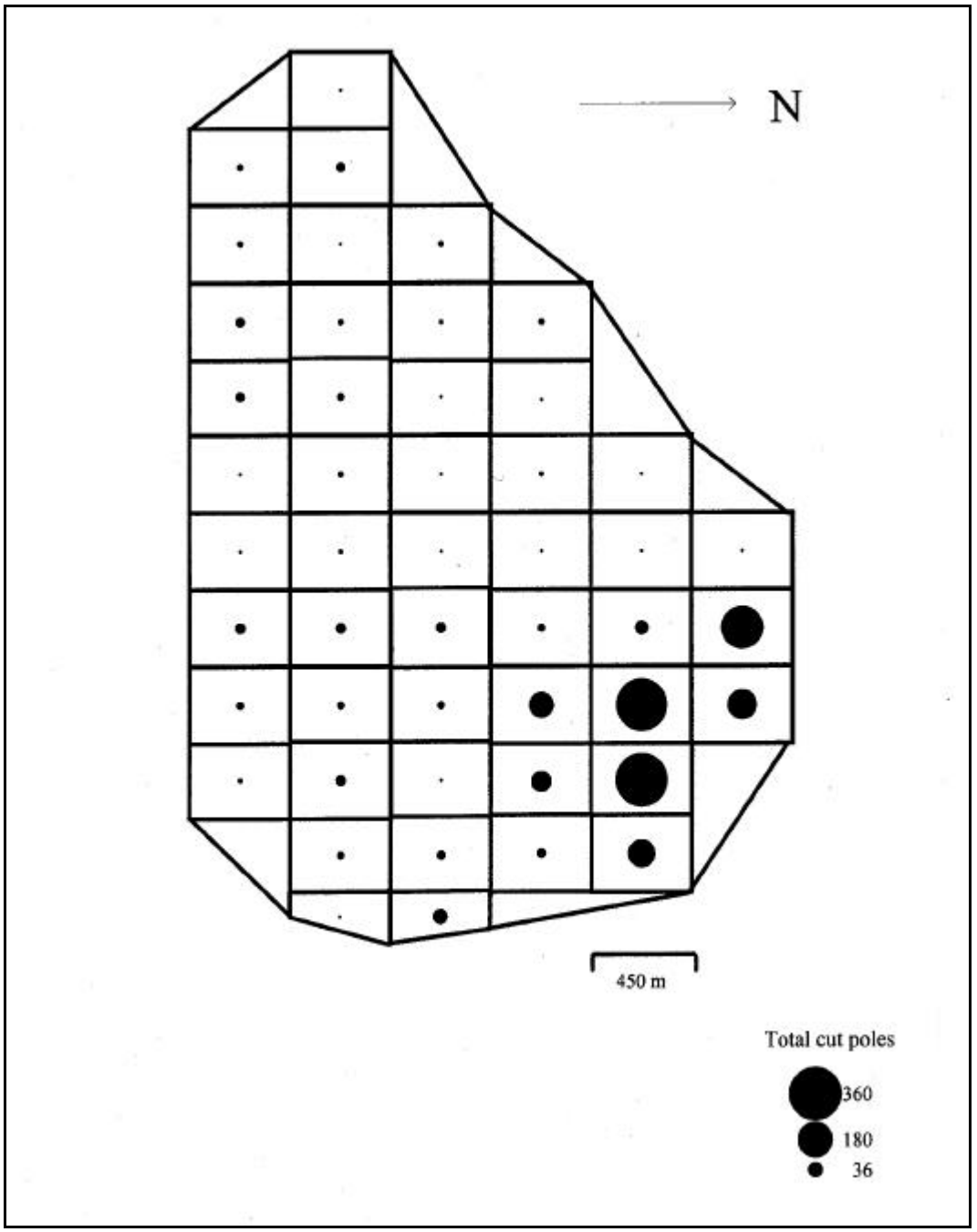

Figure 3.4. Total cut poles per 100 m^2 in Nambiga Forest Reserve.

Furthermore, all specimens of the hardwood *Melicia excelsa*, which is an important timber tree, encountered on the vegetation transects showed evidence of previous exploitation. Exploitation patterns of timber trees and poles both revealed the highest level in the north-east corner of the reserve (Figures 3.3 and 3.4). This section of the reserve borders the main road and is also close to Iragua village. The highest index of pole cutting was 0.84 poles / 100 m^2 for fresh cut and 7.89 / 100 m^2 for old cut poles. These areas were mainly comprised of colonising forest with a high numbers of saplings.

Illegal trapping activities were found in 11 separate locations distributed throughout the forest. The types of trapping found were pitfall traps (designed for antelope and buffalo), snare wires (for duiker) and raised log traps (for cane rats).

Of these methods, pitfall trapping presents the most serious threat because they can continue to kill animals up to several years after their construction. During the work in Nambiga F. R., a dead young elephant was found in a poachers' pitfall trap.

3.4 Discussion

3.4.1 *Botanical survey*

The varied composition of Nambiga F. R., containing both dry woodland and moist forest species reflects its location as an isolated evergreen forest surrounded by agriculture and miombo woodland. Further evidence for the transitional nature of areas within Nambiga F. R. was found from the presence of *Harrisonia abyssinia*, a species typical of the dry-evergreen forest transition zones (Palgrave 1983, Beentje 1992).

The forest was composed mainly of small trees and shrubs, with a noticeable absence of large trees. The small tree *Dichostrchys cinerea* was found in 4% of all plots and is considered an indicator of over-grazing (Palgrave 1983, Beentje 1992). Other trees in Nambiga F. R. also indicated disturbance, with the presence of secondary growth (e.g. *Deinbolia borbonica*), edge (e.g. *Rauvolfia mannii*) and weed indicator species (*Triumfetta rhomboidea*).

Table 3.1. Plant species, type and relative abundance from vegetation plots in Nambiga Forest Reserve. Relative abundance was calculated as the percentage of total plots in which each species was recorded. All species descriptions are after Palgrave (1983) and Beentje (1992).

Relative abundance scale

□ absent

● < 5 %

●● 6 to 20 %

●●● 21 to 50 %

●●●●● > 51 %

Plant species	Plant type	Vegetation plots	Regeneration plots
Acacia polyacantha	large tree	●	●
Afzelia quanzensis	medium / large tree	●	□
Albizia versicolor	small / medium tree	●	□
Albizia petersiana	large tree	●●	□
Alchornea hirtella	shrub	●	□
Alchornea laxifora	shrub / small tree	●	●●●●●
Allophyllus africanus	shrub	●	●
Annona senegalensis	shrub / small tree	●●	●
Antiaris toxicaria	large tree	●●	●
Blighia unijugata	medium / large tree	●●	●
Brachystegia spiciformis	medium / large tree	●●	●●
Bridelia cathartica		□	●
Bridelia micrantha	small / medium tree	●	□
Cassipourea malosana	small / medium tree	●●	●●
Cassipourea stuhlmani		●	●
Catunaregum spinosa	shrub / small tree	●	●
Combretum apiculatum	small / medium tree	□	●
Combretum molle	small / medium tree	●●	●●
Cordia africana	small / medium tree	●●	●
Crosopteryx febrifuga	shrub / small tree	●●	●
Dalbergia melanoxylon	small tree	●	□
Dalbergia nitidula	shrub	●	□
Dalbergia obovata	climber / small tree	□	●●
Deinbolia borbonica	shrub / small tree	●●	●●
Dialium holtzii	small / medium tree	●●	□
Dichapetalum stuhlmanii	shrub / small tree	●●●	●●●●●
Dichrostachys cinerea	shrub / small tree	●	●
Diospyros mespiliformis	medium tree	●●	●●
Diospyros usambarensis	shrub / small tree	●	●
Diospyros zombensis	shrub / small tree	●●	●●
Diplorynchus mombansens		●	●

Table 3.1 (continued).

Plant species	Plant type	Vegetation plots	Regeneration plots
Diplroynchus condylocarpon	shrub / small tree	●●	●
Dombeya shuppangae	small tree	●	□
Ehretia amoena	shrub / small tree	●	□
Ehretia cymosa	medium / large tree	●●	□
Erythroxylum fischeri	shrub / small tree	●●	●●
Ficus sur	shrub / small tree	●	□
Flueggea virosa	shrub	●	●
Grewia bicolor	shrub	●	□
Grewia microcarpa	shrub / small tree	●	□
Grewia phabaseae	small tree	●●	□
Haplocoelopsis africana	small / medium tree	●●	●●
Harrisonia abyssinia	shrub	●●●	●●
Holarrhena pubescens	shrub / small tree	●	●●
Hugonia castaneifolia	shrub / liana	●	●●
Indigofera arrecta	shrub / herb	□	●
Khaya anthotheca	large tree	●	□
Landolphia kirkii	climber	□	●●
Lannea schweinfurthii	shrub / small tree	●	□
Leptactina platyphylla	shrub / small tree	●●	□
Lettowianthus stellatus	small / large tree	●●	□
Lonchocarpus bussei	small / large tree	●●	□
Margaritaria discoidea	small / large tree	●●	●
Markhamia lutea	small / large tree	●●●	●
Milcia excelsa	large tree	●●	□
Millettia dura	shrub / small tree	●●●	●●
Monanthotaxis buchananii	shrub, tree, climber	●	●
Ochna atropurpurea	shrub / small tree	●	●
Olax saliciafolia	small tree	□	●
Pavetta schumanniana	shrub / small tree	□	●
Pericopsis angolensis	medium / large tree	●●	●
Piliostigma thonningii	small / medium tree	●	●
Pseudolachnostylis maprouneifolia	medium / large tree	●●	●●
Pteleopsis myrtifolia	shrub / small tree	●●	□
Rauvolfia mannii	shrub / small tree	□	●
Rothmania engelrina	shrub / small tree	●●●	●●
Rothmaia manganjae	shrub / small tree	●	●
Saba comorensis	liana	□	●
Salacia madagascariensis	shrub / liana	□	●
Salvadora persica	shrub / small tree	●●	□

Table 3.1 (continued).

Plant species	Plant type	Vegetation plots	Regeneration plots
Schrebera trichoclada	shrub / small tree	●●	□
Seridae madagascarensis		●	□
Sorindeia madagascariensis	tree	●	●
Sterculia appendiculata	large tree	●	□
Sterculia quinqueloba	large tree	●	□
Stereospermum kunthianum	medium tree	●●	●
Strychnos madagascariensis	small / large tree	●●	□
Synaptolepis kirkii	shrub	□	●
Tamarindus indica	medium / large tree	●	□
Terminalia kilimandscharica	small / large tree	●●	□
Terminalia sambesciaca	small / large tree	●●	●
Tetracera litoralis	liana	□	●
Tinchilisia parvifolia		●	●
Trema orientalis	shrub / small tree	●	□
Triumfetta rhomboidea	weed	□	●
Uapaca nitida	small / medium tree	●	□
Uvaria acuminata	shrub / tree/ liana	□	●●●
Vangueria infausta	small tree	●	□
Veronia glabra	shrub / small tree	□	●
Xeroderris stuhlmannii	medium / large tree	●●	●
Ximenia americana	shrub / small tree	●	□
Xylopia parviflora	large tree	●	□
Ziziphus mucronata	small / medium tree	●●	□

Regeneration was clearly dominated by the small trees *Alchornea laxiflora* and *Dichapetalum stuhlmanii* and reflects the dense nature of the vegetation in Nambiga F. R. Interestingly, none of the three large tree species (*Milicia excelsa*, *Khaya anthotheca* and *Xylopia parviflora*) were found in the regeneration plots. It is evident from these results that both types of plot are necessary to fully describe the composition and structure of forest vegetation because many of the plant species were not recorded in both vegetation and regeneration plots.

Many of the trees in Nambiga F. R. are important for timber, fuel, food, nitrification and soil conservation (Table 3.2). This list summarises the uses of these trees from the whole of Tanzania (Mbuya *et al*. 1994) and indicates the potential of many of the trees to provide resources to the local community. Further community research around Nambiga F. R. may discover new uses for some of these trees.

Table 3.2. KiSwahili names and uses of trees found in Nambiga (from Mbuya *et al*. 1994). Note that 63 species (see Table 3.1) with no recorded use or name have been excluded from this table.

		Use						
Species	**KiSwahili name**	**Fuel**	**Timber**	**Food**	**Medicine**	**Fodder**	**Nitrification**	**Soil conservation**
Acacia polyacantha	Mgunga	●	●		●		●	
Afzelia quanzensis	Mbumbakofi		●		●			
Albizia versicolor	Mchanidovu	●	●		●		●	
Annona senegalensis	Mchekwa			●	●	●		
Brachystegia spiciformis	Miombo	●	●	●	●	●		
Bridelia micrantha	Mkarati	●	●	●				
Combretum molle		●	●	●	●	●		●
Cordia africana	Mninganinga	●		●				
Dalbergia melanoxylon	Mpingo	●	●		●	●	●	
Dalbergia nitidula		●				●		
Dichrostachys cinerea	Mkulagembe	●			●	●		
Diospyros mespiliformis	Mginiti	●	●	●	●	●		
Grewia bicolor		●	●		●	●		
Khaya anthotheca	Mkangazi	●	●		●	●		
Lannea schweinfurthii			●	●	●	●		
Milcia excelsa	Mvule	●	●					
Millettia dura						●		●
Pericopsis angolensis		●	●		●		●	
Piliostigma thonningii		●	●	●	●	●	●	
Pseudolachnostylis maprouneifolia		●	●		●	●		
Sterculia appendiculata			●	●				
Sterculia quinqueloba			●		●			
Stereospermum kunthianum		●			●	●		
Tamarindus indica		●	●	●	●			
Trema orientalis		●				●		●
Vangueria infausta		●						
Xeroderris stuhlmannii		●			●	●		
Ximenia americana		●			●	●		
Ziziphus mucronata		●			●	●		

3.4.2 *Disturbance survey*

Nambiga is an important source of timber for local people (Lovett and Pócs 1993) and levels of tree exploitation were high in the north eastern section of the reserve, near Iragua (Figures 3.3 & 3.4). The proportion of plots with evidence of logging for the whole reserve was 42%. This is likely to be an under-estimate because eight of the plots in the south-west end of the reserve consisted of miombo species, unsuitable for timber. After excluding these miombo areas, 50% of the plots showed signs of exploitation.

As in other forest reserves (e.g. Doggart *et al*. 1999a), accessibility appeared to be the main determinant of the rate and distribution of timber exploitation. Although tree cutting was concentrated in one area, it also occurred at a lower intensity across the whole reserve (Figures 3.3 and 3.4). As timber from the more accessible parts of the reserve is depleted, the pressure on the forest interior increases. Previous timber extraction and use of the area by farmers may have opened the forest canopy and could explain current day high densities of poles in the north-east section (Figure 3.2). Timber extraction can alter the structure of the remaining forest and create more habitat with 'forest edge' characteristics. Forest edge is a different environment to the interior with more variable temperatures, higher evaporation, greater exposure to wind and higher light levels (Murcia 1995). The presence of tree exploitation in Nambiga F. R.'s interior could have been caused by a general depletion of timber resources and the need for villagers to access further into the forest. However, the pattern could also have been produced by microhabitat requirements of the commonly used timber trees. For example, species which do not favour edge habitats will naturally be found in the forest interior. The continued exploitation of the reserve boundary will increase the amount of habitat with edge characteristics and lead to a reduction in available habitat for the forest interior specialists.

Although evidence for illegal poaching was widespread in Nambiga F. R., it is not currently thought to represent a major threat to biodiversity. However, continued alteration of the forest structure and a shift towards more dense vegetation will have ramifications for the large mammal community.

4. FAUNAL BIODIVERSITY SURVEY

4.1 Introduction

Biodiversity surveys are used to describe areas of high conservation value and allow comparisons between reserves and geographical regions (e.g. Raxworthy and Nussbaum 1994). The faunal biodiversity of Nambiga Forest Reserve was assessed using standard methods (SEE 1998). The study groups were selected because they are diverse, represent a wide range of ecological requirements and are sensitive to environmental change. These factors combined with the existing knowledge of their ecology means that they can be useful indicators of environmental quality and are potentially suitable for monitoring programmes.

4.2 Methods

The groups selected for survey were amphibians, butterflies, bats, reptiles and small mammals. All large mammal signs were also recorded. Species identifications were verified by international taxonomists and District Game Office staff from Ulanga District Council (Appendix 1). Trapping activities were located at five sites containing habitat representative of the whole reserve. Each site was trapped for ten consecutive days and consisted of the following protocol:

4.2.1 *Bucket pitfall*

Each of three 50 m lines consisted of eleven 20 litre plastic buckets sunk, flush to the ground, at five metre intervals. A continuous strip of plastic sheeting linked all buckets and was used as a drift fence to divert terrestrial animals into the traps. The sheeting was kept on the ground by a layer of soil. This method is particularly suitable for surveying amphibians, reptiles and small mammals (Sutherland 1996). The traps were checked at first light and late in the afternoon.

4.2.2 *Sherman traps*

Sixty sherman traps were placed in three lines at each trap-site. The traps were at least 2m apart and were baited with fried coconut and peanut butter.

4.2.3 *Butterfly traps*

Four butterfly traps, baited with rotting banana, were situated in representative locations around each trap-site, to sample canopy species composition and abundance. The traps work on the principal that butterflies can only fly upwards and consisted of two metal discs separated by a metre long cylinder of fine mesh. There was a 4 cm gap between the bottom disc and the mesh to allow entry.

4.2.4 *Butterfly sweep nets*

Two man-hours of sweep-netting per day were undertaken with sweep nets to sample the species composition of the forest understorey This was carried out around midday, when the butterflies are most active and are easier to catch.

4.2.5 *Bat catching*

The diversity of bats was assessed in flight corridors (e.g. rivers and paths) in six separate locations using standard bird mist-nets. The nets were erected at dusk and removed at dawn, providing approximately 12 hours netting in each location.

4.2.6 *Opportunistic collection and observation*
Specimens of amphibians, reptiles and large mammal observations were sampled by carefully searching suitable refuges.

4.2.7 *Capture/release protocol*
All individuals of the groups above were preserved for identification unless they represented multiple catches of the same species. The aim was to provide a species inventory for the forest reserve, with detailed abundance data not required.

4.2.8 *Sampling intensity*
Sampling intensity (number traps x number of nights) was 1,650 for pitfalls, 3,000 for sherman traps and 200 for butterfly traps.

4.3 Results
4.3.1 *Small mammals*
In total there were 35 small mammal captures, of which 25 were retained as specimens. The collected individuals represented 10 genera and at least 10 different species (Table 4.1). The Kilombero valley is the most westerly lowland site for *Beamys hindei* (lesser pouched rat) and the collection of *Cricetomys gambianus* (giant pouched rat) and *Graphiurus sp.* (African dormouse) were the first records for the valley.

Table 4.1. Summary of the small mammals found in Nambiga Forest Reserve during the 1999 wet season.

Species		**Capture frequency**
MUROIDEA		
Beamys hindei	Lesser pouched rat	3
Cricetomys gambianus	Giant pouched rat	1
MURIDAE		
Praomys natalensis	Soft-furred rat	3
Aethomys chrysophilus	Bush rat	7
Acomys spinosissimus	Spiny mouse	3
Mus minutoides	Pygmy mouse	10
Grammomys sp.	Narrow-footed pygmy mouse	1
Graphiurus sp.	African dormouse	1
Rattus rattus	Common rat	3
SORICIDAE		
Crocidura sp.	White-toothed shrew	3

4.3.2 *Large mammals*
In total, 26 species of large mammal were found within Nambiga F. R. (Table 4.2). These were rarely sighted, with the main indication of their presence being tracks or sign such as faeces or damage to surrounding vegetation. Nambiga F. R. is considered seasonally important for elephant *L. africana* and buffalo *S. caffer*, and signs of elephant presence were noted in 58 % of the 48 study plots.

4.3.2 *Amphibians*
In total there were 176 captures of amphibians and of these 64 individuals were retained for taxonomic purposes. These comprised specimens from 12 genera and at least 17 species (Table 4).

4.3.4 *Reptiles*

In total there were 46 reptile captures of which 26 were retained as specimens. The captures comprised 15 genera and at least 25 species (Table 4.5).

Table 4.2. Summary of the large mammals found in Nambiga Forest Reserve during the 1999 wet season.

Family	Species	Common name
CERCOPITHECIDAE	*Papio cynocephalus*	Yellow baboon
	Cercopithicus pygerythrus	Vervet monkey
	Cercopithicus. mitis	Blue monkey
GALAGONIDAE	*Galago galago*	Lesser bushbaby
HYSTRICIDAE	*Hystrix cristata*	Crested porcupine
HERPESTIDAE	*Mungos mungo*	Banded mongoose
HYAENIDAE	*Crocuta crocuta*	Spotted hyena
VIVERRIDAE	*Genetta* sp.	Gener
	Civettictis civetta	African civet
FELIDAE	*Felis serval*	Serval
	Panthera pardus	Leopard
	Panthera leo	Lion
TUBILIDENTATA	*Orycteropus afer*	Aardvark
ELEPHANTIDAE	*Loxodonta africana*	Elephant
EQUIDAE	*Equus burchelli*	Zebra
HIPPOPOTAMIDAE	*Hippopotamus amphibius*	Hippopotamus
SUIDAE	*Potamochoerus larvatus*	Bush pig
	Phacochoerus africanus	Warthog
BOVIDAE	*Syncerus caffer*	Buffalo
	Tragelaphus scriptus	Bushbuck
	Taurotragus oryx	Eland
		Duiker
	Kobus ellipsiprymnus	Waterbuck
	Alcelaphus buselaphus	Hartebeest
	Hippotragus niger	Sable

Table 4.3. Summary of the amphibians found in Nambiga Forest Reserve during the 1999 wet season.

Species	Common name	Capture frequency
ARTHROLEPTIDAE		
Arthroleptis stenodactylus	Common squeaker	8
Arthroleptis xenodactyloides	Dwarf squeaker	2
**Arthroleptis sp.*		13
BUFONIDAE		
Bufo gutturalis	Guttural toad	5
Buto maculatus		3
**Bufo gutteralis/maculatus*		14
Stephopaedes loveridgei		3
HYPEROLIDAE		
Afrixalus fulvovittatus		1
Chiromantis xerampolina	Great grey tree frog	5
Leptopelis flavomaculatus	Johnston's tree frog	4
HEMISOTIDAE		
Hemisus marmoratus	Mottled shovel-nosed frog	21
RANIDAE		
Phrynobatrachus acridoides	Small puddle frog	3
Phrynobatrachus mababiensis	Puddle frog	6

Table 4.3 continued

Species	Common name	Capture frequency
RANIDAE		
Phrynobatrachus natalensis	Puddle frog	4
**Phrynobatrachus sp.*	Puddle frog	6
Ptychadena anchietae	Savanna ridged frog	2
Ptychadena mossambica	Mozambique ridged frog	1
Rana angolensis	Deep-throated frog	2
MICROHYLIDAE		
Spelaeophyrne methneri		1
PIPIDAE		
Xenopus muelleri	Mueller's clawed frog	2

***** Specimens either only identified to genus or released in the field

In addition, four other species were sighted but not collected. Snouted night adder (*Causus defilippii*) and Schlegel's blind snake (*Typhlops schlegelli mucroso*) were the most commonly found of the nine snake species, representing 19% and 24% of captures respectively.

Table 4.5. Summary of the reptiles found in Nambiga Forest Reserve during the 1999 wet season.

Species	Common name	Capture frequency
CHAMELEONIDAE		
Chamaeleo dilepis	Flap-neck chameleon	2
GEKKONIDAE		
Hemidactylus platycephalus	Flat-headed tropical house gecko	1
Lygodactylus sp.	Dwarf gecko	1
Hemidactylus mabouia	Moreau's tropical house gecko	2
SCINCIDAE		
Mabuya maculilabris	Speckled-lipped skink	2
Panaspis wahlbergii	Wahlberg's skink	3
CORDYLIDAE		
**Gerrhosaurus major*	Rough-scaled plated lizard	1
VARANIDAE		
**Varanus niloticus*	Nile monitor	1
TYPHLOPIDAE		
Typhlops schlegelli mucruso	Schlegel's blind snake	6
Typhlops lineolatus		1
PSAMMOPHINAE		
Psammophis orientalis		1
VIPERIDAE		
Bitis arietans	Puff adder	1
ELAPIDAE		
Naja melanoleuca	Forest cobra	1
**Dendroaspis anguticeps*	Green mamba	4
COLUBRIDAE		
Lamprophis fuliginosus	Common house snake	1
Lycophidion capense		1
Dasypeltis medici	East African egg eater	1
Causus defilippii	Snouted night adder	4
Philothamnus hoplogaster	Green snake	1
Thelotornis capensis mossambicus	Mozambique vine snake	2

Table 4.5 continued

Species	Common name	Capture frequency
COLUBRIDAE continued		
Amblyodipsas polylepis hildebrantii	Purple-glossed snake	1
Aparallactus guentheri	Black centipede eater	1
Aparallactus capensis	Cape centipede eater	1
***Dispholidus t. typus*	Boomslang	1
Meizodon semiornata	Semiornate snake	1

The *Lydodactylus* dwarf geckos were of particular interest because the specimens from Nambiga F. R. may represent at least one new species (D. Broadley, *personal communication*).

4.3.5 *Butterflies*

The sampling of butterflies by raised traps and sweep-nets resulted in the capture of six families (Table 4.6). The families were Hesperiidae (1 genus), Lycaenoidae (4), Nymphalidae (15), Papillionidae (1), Satyridae (3) and Pieridae (5). Nymphalidae was the most speciose family (38) and Hesperiidae the least (1). The dry woodland and evergreen forest matrix of Nambiga F. R. was reflected in the butterfly species composition. Species such as *Charaxes guderiana*, *Charaxes bohemani* and *Precis antilope* are found predominantly in miombo woodland (Kielland 1990). Other species were more characteristic of lowland and sub-montane forest, such as *Charaxes aubyni ecketti* or montane forest (e.g. *Harma theobene blassi*; Kielland 1990). Most butterfly species encountered, however, were generalists and found from a variety of woodland, forest and grassland habitats.

The collection of *C. chepalungu* was of note as because in Tanzania this was previously only known from the Serengeti (Kielland 1990). Two other species captured from Nambiga F. R., *Colotis daira jacksoni* and *Byblia i. Ilithya*, are regarded as uncommon in Tanzania.

Table 4.6. Species list of butterflies from Nambiga Forest Reserve during the 1999 wet season.

Family	Species
PAPILIONIDAE	*Graphium angolanus angolanus*
	Graphium antheus antheus
	Graphium leonidas leonidas
	Graphium philonoe philonoe
	Graphium policenes
	Graphium polistratus polistratus
PIERIDAE	*Catopsila florella florella*
	Colotis daira jacksoni
	Colotis euippe omphale
	Dixeia orbona vidua
	Dixeia pigea
	Eurema hecabe solifera
	Leptosia alcesta inalcesta
SATYRIDAE	*Gnophodes betsimena*
	Bicyclus campinus
	Bicyclus ena

Table 4.6 continued

Family	Species
SATYRIDAE	*Bicyclus safitza safitza*
Continued	*Bicyclus angulosus angulosus*
	Henotesia perspicua
	Melanitis leda leda
NYMPHALIDAE	*Acraea eponina eponina*
	Acraea zetes zetes
	Amauris niavius dominicanus
	Byblia ilithya ilithya
	Byblia anvatara acheloia
	Charaxes achaemenes achaemenes
	Charaxes aubyni ecketti
	Charaxes baumanni granti
	Charaxes bohemani bohemani
	Charaxes brutus
	Charaxes castor
	Charaxes cithaeron kennethi
	Charaxes cithaeron
	Charaxes cynthia parvicaudatus
	Charaxes etisipe tavetensis
	Charaxes guderiana guderiana
	Charaxes lasti magombero
	Charaxes macclounii maclounii
	Charaxes protoclea azota
	Charaxes saturnus saturnus
	Charaxes varanes vologeses
	Charaxes violetta melloni
	Charaxes zoolina zoolina
	Euphaedra neopphron littoralis
	Eurytela dryope angulata
	Harma theobene blassi
	Hypolimnas anthedon anthedon
	Junonia hierta cebrene
	Junonia natalica natalica
	Junonia terea
	Neptidopsis ophione velleda
	Phalanta eurytis eurytis
	Phalanta phalantha
	Precis antilope
	Sallya amulia rosa
	Tirumala petiverana
	Anthene indefinita indefinita
LYCAENIDAE	*Anthene ligures*
	Hemiolaus coeculus littoralis
	Leptotes pirithous pirithous
	Pentila pauli
HESPERIDAE	*Spialia diomos diomos*

4.3.5 *Bats*

Twenty six individuals representing six species were captured (Table 6). Fourteen were fruit bats (*Epomorphorus* and *Rousettus)* and 12 insectivorous. Eighteen specimens were taken for taxonomic verification

Table 4.7. Summary of the bats found in Nambiga Forest Reserve during the 1999 wet season.

	Capture frequency
VESPERTILIONIDAE	
Scotophilus leucogaster	4
HIPPOSIDERINAE	
Hipposideros caffer	4
MOLOSSIDAE	
Chaerophon pumila	3
Chalinolobus variegatus	1
PTEROPODIDAE	
Rousettus aegyptiacus	2
Epomorphorus wahlbergi	12

4.4 Discussion

Many of Tanzania's forest-dependent species have limited distributions and are under increasing threat from habitat degradation. Describing the biodiversity of small forest reserves is therefore a conservation priority.

4.4.1 *Small mammals*

The *Beamys hindei* (lesser pouched rat) and *Cricetomys gambianus* (giant pouched rat) were unexpected captures in ground traps because both species are predominantly climbers (Kingdon 1974). *C. gambianus* is widely distributed across Africa (Kingdon 1997), but *B. hindei* is restricted to dense forests in East Africa (Kingdon 1997). Given that these records, in addition to the *Graphiurus sp.* (African dormouse), were the first for Kilombero the valley, the small mammal trapping indicates the need to comprehensively document all major habitat types in the reserve.

4.4.2 *Large mammals*

Nambiga F. R. is locally considered as an area of high importance for large mammals because it supports populations of forest specialists and provides suitable habitat in the wet season for the floodplain animals. The several large game trails running through the reserve may act as seasonal migration routes between the floodplain and miombo woodland for animals such as buffalo and elephant. Although no formal assessment of the species composition or habitat use was made during this survey, the occasional observations provide a sample of the reserve's large mammal community in the wet season. Nambiga F. R. was found to have 27 species of large mammal, with particularly high antelope (8) species richness.

The species composition recorded during this survey was similar to that found in the reserve by Hinde (2000). Evidence of crested porcupine, lion, common genet, hippopotamous, hartebeest and bush duiker were found during this present survey only.

4.4.3 *Amphibians*

The species list for Nambiga F. R., though indicative of the diversity, was by no means complete. The capture of *Leptopelis flavomaculatus* was significant because this is a species dependent on primary forest (Howell 1993).

Amphibians were readily caught in bucket pitfall traps and by opportunistic collection, and are potentially suitable for ecological monitoring. However, the taxonomy of many East African amphibian genera is incompletely understood and

many specimens have to be sent to museums for identification. Species inventories are an important first step in ascertaining the conservation status of an area (Howell 1993), but subsequent monitoring should consider working with indicator species that are easy to identify in the field.

4.4.4 *Reptiles*

The majority of the reptile captures were through casual collection and mostly following periods of heavy rain. For example, all captures of the burrowing Schlegel's blind snake *T. schlegelli mucroso* occurred after heavy rainfall, probably as a result of the rising water-table flooding their burrows. The capture of *Aparallactus guentheri* was significant because this is a species dependent on primary forest (Howell 1993).

The opportunistic capture of reptiles is entirely dependent on the skill of the collector, making reptiles less suitable for monitoring. However, careful targeting of a reptile group for detailed study has proved successful in the past (e.g. chameleons, Jenkins *et al*. 1999) and future work could employ a similarly focussed approach.

4.4.5 *Butterflies*

Nambiga F. R. has a diverse butterfly fauna with a species richness similar to forest reserves in the East Usambaras (e.g. Doggart *et al*. 1999a, b). Their environmental sensitivity and close association with host plants make butterflies suitable for ecological monitoring (Kremen 1992).

4.4.6 *Bats*

Bat species diversity was approximately half of that recorded in forest reserves of the East Usambaras (e.g. Doggart a, b), but this study nevertheless contributed some important biological records. The most frequently caught species (*Epomorphorus wahlbergi*) is usually restricted to primary forest (Kingdon 1989).

4.4.7 *Forest structure*

The high disturbance levels in certain areas of Nambiga F. R. have created a habitat mosaic, with forest structure dense and consisting of many small regenerating trees in some areas and other patches of less disturbed forest with large timber trees (Chapter 3). This variation in forest structure will affect the composition, distribution and abundance of the fauna. There were only a few species found which are considered dependent on primary forest conditions and these are the most vulnerable to habitat alteration. The disturbed nature of Nambiga F. R.'s vegetation is however, suitable for certain other animals. Hinde (2000) identified similarities between the antelope and pig fauna in Nambiga F. R. and a nearby teak plantation. They proposed that the dense understorey characteristic of both sites provided suitable food and shelter for bush pig, duiker and bushbuck.

Although there are no long-term data available on animal abundance in Nambiga F. R., anecdotal evidence from local people (Chapter 3) has reported a decline in large game since the 1970's.

4.4.8 *Forest conservation*

Forest loss and degradation is a major threat to Tanzania's wildlife resources (Kielland 1990, Howell 1993, UNEP 1998). The response of many groups to disturbance remains poorly understood (e.g. amphibians, Poynton 1998). Evergreen

forests such as Nambiga F. R. are important and have to be managed for wildlife and resource extraction. The exploitation of these forests for their natural products is increasing and the need to sustainably manage for people and animals is a priority (Ministry of Natural Resources and Tourism 1998). Of particular concern to conservation biologists is that the fact that the flora and fauna of these forests are yet to be fully described.

The transitional nature of Nambiga F. R., between ground-water dependent evergreen forest and fire-dependent miombo woodland, makes it an important reserve to study because most previous research has focussed on other areas of the Eastern Arc (e.g. Lovett and Wasser 1993, Doggart 1999a, b).

4.4.9 *Socio-economic importance*

Land use surrounding protected areas influences the status of the protected area itself. In situations of resource scarcity the integrity of the reserved area is more likely to be under threat from local communities than in situations of resource abundance. This is particularly true in areas, such as Nambiga F. R., where livelihoods are based on agriculture and communities utilise non-timber woodland and forest products such as foods, building materials, fuel and traditional medicines.

5. RECOMMENDATIONS

5.1 Management

Nambiga F. R. is clearly an important resource for wildlife and local communities. Although resource use and extraction of timber and non-timber products is poorly monitored in the forest reserve, enough of the forest is left to justify enhanced management and protection.

In conjunction with Ulanga District Council Game and Forestry Offices, Catchment Forestry Project and the local communities the following actions should be considered:

1. Land use planning workshops to set levels of resource use which are sustainable and agreeable to all stakeholders.
2. Encourage the use of Nambiga F. R. for non-timber product extraction so that the forest can be valued for its renewable resources..
3. Improve the boundary marks so that the local people know which areas constitute the forest reserve.
4. More patrols to deter animal poachers and illegal timber extractors.

5.2 Research

The biodiversity survey conducted here has provided new information on the flora and fauna of Nambiga F. R.. Biodiversity surveys of Ulanga's other forest reserves is now a priority.

This work presented here has demonstrated the importance of Nambiga to wildlife and has indicated that the future research priorities should be:

1. Bird survey of Nambiga F. R., to include the effect of season and disturbance levels. High disturbance levels may result in a loss of forest-dependent species as the forest becomes more overgrown. Seasonality may be important because forest like Nambiga F. R. may act as refuges for birds which leave the highlands in the non-breeding season.

2. Survey of large mammals of Nambiga F. R., to include the effect of season and disturbance levels. Specimens or photographs of some species will be very valuable. For example, it is not known whether the red duiker seen in Nambiga F. R. is the Natal *Cephalophus natalensis* or Harvey's *C. harveyii*. Similarly, suni (*Neotragus moschatus*) has been recorded in the district (Rees 1964) but there have been no confirmed sightings from Nambiga. F. R.

3. Long-term monitoring of selected taxa to assess the effect of continued habitat alteration. This report has shown that butterflies, amphibians and large mammals would be most suitable study groups. Amphibians are sensitive to environmental change (Blaustein and Wake 1990), and may be especially prone to local extinctions because of the spatially and temporally dynamic nature of their populations (Gibbs 1998). An additional advantage of amphibians, and an important consideration during their selection for this study, is that surveys are highly mobile and give the potential to cover a large area in a short time. This study has shown that butterflies can be easily sampled in large numbers and the reliance on the canopy for many species could make them particularly sensitive to the removal of large trees. Large mammal

populations in Nambiga F. R. are of a conservation and economic value. The potential conflict between local people and the large animals makes this group a particular priority for the future.

4. An assessment of the use of each tree species by local and national markets. Such information could provide information on the trees that are in most urgent need of protection or management.

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APPENDIX 1

Taxomonic verification

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