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Mgambo Forest Reserve

A biodiversity survey

**Frontier Tanzania
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East Usambara Conservation Area Management Programme

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Mgambo Forest Reserve

A biodiversity survey

**Oliver, S.A., Bracebridge, C.E.,
Fanning, E., and Howell, K.M. (eds.)**

**Ministry of Natural Resources and Tourism,
Tanzania
Forestry and Beekeeping Division**

**Department of International
Development Co-operation, Finland
Metsähallitus Consulting**

**Frontier-Tanzania
University of Dar es Salaam
Society for Environmental Exploration**

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East Usambara Conservation Area Management Programme (EUCAMP)

The East Usambara rain forests are one of the most valuable conservation areas in Africa. Several plant and animal species are found only in the East Usambara mountains. The rain forests secure the water supply of 200,000 people and the local people in the mountains depend on these forests. The East Usambara Conservation Area Management Programme has established the Amani Nature Reserve and aims; at protecting water sources; establishing and protecting forest reserves; sustaining villager's benefits from the forest. The programme is implemented by the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism with financial support from the Government of Finland, and implementation support from the Indufor / Metsähallitus Group. To monitor the impact of the project, both baseline biodiversity assessments and development of a monitoring system are needed. The present activity is aimed at establishing baseline information on biological diversity in selected East Usambara forests.

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FOR MORE INFORMATION:

Forestry and Beekeeping Division
P.O. Box 426, Dar es Salaam, Tanzania
Tel: 255-22-2111 062/3/4
Fax: 255-22-2114 659
E-mail: misitu@twiga.com

East Usambara Conservation Area
Management Programme
P.O. Box 5869, Tanga, Tanzania
Tel: 255-27-2643453, 2646907, 2643820
Fax: 255-27-2643820
E-mail: usambara@twiga.com
Internet: www.usambara.com

Department of Zoology & Marine Biology
University of Dar es Salaam
P.O. Box 35064, Dar es Salaam, Tanzania
Tel: 255-22-2410462
E-mail: zoology@udsm.ac.tz

Department for Development Co-operation
Ministry for Foreign Affairs
Katajanokanlaituri 3
FIN-00160 Helsinki, Finland
Tel: 358-9-134 161 Fax: 358-9-1341 6293

Indufor / Metsähallitus Consulting
Töölönkatu 15, FIN-00100 Helsinki, Finland
Tel: 358-9-6840 1122
Fax: 358-9-135 2552
E-mail: indufor@indufor.fi

Society for Environmental Exploration
50-52 Rivington Street, London, U.K.
Tel: +44 20 76 13 24 22
Fax: +44 20 76 13 29 92
E-mail: info@frontier.ac.uk

TABLE OF CONTENTS

EXECUTIVE SUMMARY.....	v
FOREWORD.....	vii
ACKNOWLEDGEMENTS.....	viii
1.0 INTRODUCTION.....	1
1.1 THE EAST USAMBARA MOUNTAINS AND FOREST DIVERSITY.....	1
1.2 REPORT STRUCTURE.....	3
1.2.1 Flora.....	3
1.2.2 Fauna.....	4
1.2.2.1 Birds.....	4
1.3 MAPS.....	4
1.4 DATA AND MONITORING.....	5
1.5 SURVEY PERIOD AND PERSONNEL.....	5
2.0 AIMS OF THE SURVEY.....	6
3.0 DESCRIPTION OF THE FOREST.....	7
3.1 GENERAL DESCRIPTION.....	7
3.1.1 Description.....	7
3.1.2 Location.....	7
3.1.3 Topography.....	7
3.1.4 Land use.....	8
3.1.5 History and Status.....	8
4.0 VEGETATION.....	11
4.1 INTRODUCTION.....	11
4.2 METHODS.....	11
4.2.1 Forest composition.....	11
4.2.1.1 Quantitative vegetation analysis.....	11
4.2.1.2 Opportunistic collection and observation.....	12
4.2.1.3 Disturbance transects.....	12
4.3 RESULTS.....	14
4.3.1 Quantitative vegetation analysis.....	14
4.3.1.1 Vegetation Plots.....	14
4.3.1.2 Species Abundance.....	19
4.3.1.4 Endemic Status.....	19
4.3.1.5 Ecological type.....	21
4.3.1.6 Habitat.....	21
4.3.1.7 Range extensions.....	25
4.3.1.8 Timber species.....	27
4.3.1.10 Regeneration.....	27
4.3.1.12 Opportunistic plant collection and observation.....	28
4.3.2 Disturbance transects.....	31
4.3.2.1 Pole and Timber extraction.....	31
4.3.2.2 Other signs of disturbance.....	36
4.3.2.3 Areas of greatest disturbance.....	38
4.4 DISCUSSION.....	40
Species richness.....	40
Endemic Status.....	40
Ecological Type.....	41
Habitat.....	41
Range Extensions.....	41
Regeneration.....	41
Disturbance.....	41
5.0 FAUNA.....	43
5.1 INTRODUCTION.....	43
5.2 METHODS.....	43
5.2.1 Bucket pitfall traps.....	43
5.2.2 Sherman traps.....	43
5.2.3 Bat mist-netting.....	44

5.2.4	<i>Butterfly sweep-netting</i>	44
5.2.5	<i>Butterfly canopy traps</i>	44
5.2.6	<i>Mollusc plots</i>	44
5.2.7	<i>Millipede plots</i>	44
5.2.8	<i>Dung and sign surveys</i>	44
5.2.9	<i>Opportunistic collection and observations</i>	44
5.3	TRAPPING SITES AND SAMPLING INTENSITY	45
5.4	RESULTS.....	47
5.4.1	<i>Mammals</i>	47
5.4.1.1	Small mammals (not including bats).....	47
5.4.1.2	Dung survey	48
5.4.1.3	Mammal observations	49
5.4.1.4	Bats	51
5.4.2	<i>Birds</i>	53
5.4.3	<i>Reptiles</i>	56
5.4.4	<i>Amphibians</i>	60
5.4.5	<i>Invertebrates</i>	62
5.4.5.1	Butterflies.....	62
5.4.5.2	Molluscs.....	66
5.4.5.3	Millipedes	66
5.4.6	<i>Distribution of endemic and forest dependent species</i>	67
5.4	DISCUSSION.....	68
5.5.1	<i>Introduction</i>	68
5.5.2	<i>Species Abundance and Importance</i>	68
5.5.2.1	Mammals	68
5.5.2.2	Birds.....	69
5.5.2.3	Reptiles.....	69
5.5.2.4	Amphibians.....	69
5.5.2.5	Invertebrates.....	70
5.5.2.6	Endemics and near-endemics	70
5.5.2.7	Forest dependent species	70
5.5.2.8	High risk species.....	71
5.5.3	<i>Ecological Type</i>	71
5.5.4	<i>Endemic Status</i>	72
5.5.5	<i>IUCN Status</i>	72
6.0	CONCLUSIONS	73
6.1	<i>Disturbance</i>	73
6.2	<i>Species Richness</i>	73
6.3	<i>Flora</i>	73
6.4	<i>Fauna</i>	74
6.5	<i>Conservation</i>	74
7.0	REFERENCES	75
8.0	APPENDICES	78
	APPENDIX 1: TAXONOMIC VERIFICATION	78
	APPENDIX 2: GPS CO-ORDINATES OF VEGETATION PLOTS.....	79
	APPENDIX 3: GENERAL VEGETATION PLOT DESCRIPTIONS.....	80
	APPENDIX 4: NEW FLORA FOR THE EAST USAMBARA PLANT BIODIVERSITY DATABASE	81
	APPENDIX 5: USEFUL PLANTS.....	82
	APPENDIX 6: MEDICINAL PLANTS.....	83
	APPENDIX 7: REGENERATION PLOT DESCRIPTIONS	87
	APPENDIX 8: MAMMAL CAPTURE DATA.....	88
	APPENDIX 9: REPTILE CAPTURE DATA	89
	APPENDIX 10 : AMPHIBIAN CAPTURE DATA.....	90
	APPENDIX 11: BUTTERFLY CAPTURE DATA.....	91
	APPENDIX 12: EAST USAMBARA CONSERVATION AREA MANAGEMENT	97
	PROGRAMME TECHNICAL PAPER SERIES.....	97

TABLE OF FIGURES

Figure 1 View from Mgambo FR ridgetop looking westwards to the West Usambaras.....	8
Figure 2 The location of Mgambo FR in relation to other East Usambara forests	9
Figure 3 Topographical map of Mgambo FR.....	10
Figure 4 Typical Miombo woodland (<i>Brachystegia</i> sp.) in Mgambo FR.....	11
Figure 5 Location of vegetation plots and disturbance transects in Mgambo FR.....	13
Figure 6 Sketch map of vegetation types in Mgambo FR (based on vegetation plots).....	18
Figure 7 Distribution of endemic and near endemic tree and shrub individuals in Mgambo FR.....	20
Figure 8 Distribution of endemic and near endemic tree and shrub species in Mgambo FR.....	20
Figure 9 Distribution of forest dependent tree and shrub individuals in Mgambo FR.....	22
Figure 10 Distribution of forest dependent tree and shrub species in Mgambo FR.....	23
Figure 11 Distribution of non-forest dependent tree and shrub individuals in Mgambo FR.....	23
Figure 12 Distribution of non-forest tree and shrub species in Mgambo FR.....	24
Figure 13 Distribution of submontane and montane tree and shrub individuals in Mgambo FR.....	24
Figure 14 Distribution of submontane and montane tree and shrub species in Mgambo FR.....	25
Figure 11 The relative abundance of live, dead and cut poles in Mgambo FR.....	32
Figure 12 The relative abundance of live, dead and cut timbers in Mgambo FR.....	33
Figure 13 Comparison of cut poles to dead poles per hectare in Mgambo FR.....	34
Figure 14 Comparison of cut timbers to dead timbers per hectare in Mgambo FR.....	34
Figure 15 Actual pole extraction values per transect length along plot in Mgambo FR.....	35
Figure 16 Actual timber extraction values per transect length along plot in Mgambo FR.....	35
Figure 17 Incidence of fire as percentage of sections evidence was found in, for Mgambo FR.....	37
Figure 18 Incidence of grazing as percentage of sections evidence was found in, for Mgambo FR.....	37
Figure 19 Distribution of forest dependent, endemic and near endemic tree and shrub individuals in relation to areas of highest disturbance in Mgambo FR.....	38
Figure 20 Distribution of forest dependent, endemic and near endemic plant species in relation to areas of highest disturbance in Mgambo FR.....	39
Figure 21 Location of zoological trapsites in Mgambo FR.....	45
Figure 20 Leaf-nosed bat (<i>Hipposideros</i> sp.).....	51
Figure 22 Green mamba (<i>Dendroaspis angusticeps</i>), found in riverine forest.....	59
Figure 23 Plain grass frog (<i>Ptychadena anchietae</i>).....	61
Figure 24 Distribution of forest dependent and near endemic fauna in comparison with the most disturbed areas in Mgambo FR.....	67

TABLE OF TABLES

Table 1 Summary of biodiversity of taxa surveyed.....	v
Table 2 Forest area in the East Usambara Mountains.....	2
Table 3 Land use distribution.....	8
Table 4 Checklist of trees and shrubs recorded within the vegetation plots.....	14
Table 5 Ranked abundance of tree and shrub individuals within vegetation plots.....	19
Table 6 Summary of endemism for tree and shrub species recorded in the 50m x 20m vegetation plots (based on Table 4).....	19
Table 7 Summary of ecological type of tree and shrub species recorded in the 50m x 20m vegetation plots (based on Table 4).....	21
Table 8 Summary of habitat type for tree and shrub species recorded in the 50m x 20m vegetation plots (based on Table 4).....	21
Table 9 Submontane and/or montane species and the altitudinal ranges at which they were recorded in Mgambo FR.	21
Table 10 Tree and shrub species found within Mgambo FR not listed by Ruffo <i>et al.</i> , 1989.....	26
Table 11 Tree and shrub species found in Mgambo FR but new to the East Usambara Plant Biodiversity Database (Pohjonen, 2001).....	27
Table 12 The abundance of selected timber and plywood species.....	27
Table 13 Species recorded exclusively in the regeneration layer.....	28
Table 14 Checklist of opportunistic plant collection and observation.....	29
Table 15 Disturbance transect results showing total pole counts and average pole counts per hectare...32	
Table 16 Disturbance transect results showing total timber counts and average timber counts per hectare.....	33
Table 17 The incidence of various types of disturbance shown as percentage and rank.....	36
Table 18 Descriptions and locations of zoological trapsites in Mgambo FR.	46
Table 19 Zoological sampling intensities in Mgambo FR.....	46
Table 20 Bat mist-netting sites and sampling intensities in Mgambo FR.....	47
Table 21 Summary of captured small mammals from Mgambo FR.....	48
Table 22 Summary of dung survey in Mgambo FR.....	49
Table 23 Summary of mammal observations in Mgambo FR.....	50
Table 24 Summary of bat records in Mgambo FR.....	52
Table 25 Summary of birds observed opportunistically in Mgambo FR.....	53
Table 26 Summary of forest dependant birds with corresponding threat status categories.....	55
Table 27 Restricted ranges of near endemic birds.....	56
Table 28 Summary of reptile pitfall and opportunistic captures in Mgambo FR.....	57
Table 29 Summary of reptile observations in Mgambo FR.	58
Table 30 Summary of pitfall and opportunistic amphibian captures in Mgambo FR.....	60
Table 31 Amphibians observed casually in Mgambo FR.....	61
Table 32 Restricted ranges for near-endemic amphibians (UDSM, 1997).....	62
Table 33 Summary of butterflies captured in Mgambo FR.....	63
Table 34 Summary of faunal families and species (identified to date) and inclusive of casual observations, dung surveys etc.....	68
Table 35 Summary of ecological type of mammal, bird, reptile, amphibian and butterfly species.....	72
Table 36 Summary of endemic status of mammal, bird, reptile, amphibian and butterfly species.....	72

EXECUTIVE SUMMARY

Mgambo Forest Reserve (FR) is located in the north-east of the main East Usambara Mountain range, adjacent to the savanna plateau that reaches into Kenya. Mgambo FR covers an area of 13.46 km² (1346 ha). It lies in the district of Muheza, Maramba Division, Tanga Region and covers land approximately 10 km north from Maramba town, located on latitude 4°46'00" and longitude 38°45'15". Mgambo FR was gazetted in July 1998, as delineated and described on the Forest and Beekeeping Division map number. Jb. 2291. It was gazetted primarily to protect the catchment areas supplying Bwiti, Mavovo, Mgambo and Daluni villages. The region has an average annual rainfall of between 1000 and 1500mm per year, falling principally from March to June although, in recent years, rain has been unpredictable and low. Vegetation cover within Mgambo Forest Reserve has previously been recorded as containing 1,295 ha of poorly stocked lowland forest and 51 ha of cultivation under lowland forest (Johansson, 1996). The biodiversity survey within Mgambo FR shows that this has now changed.

As part of the East Usambara Conservation Area Management Programme, (EUCAMP), (formerly the East Usambara Catchment Forest Project), Frontier-Tanzania conducted a biological survey of Mgambo FR between April and June 2002 for a total of 10 research weeks. The systematic vegetation survey covered all parts of the reserve with a sampling intensity of 0.25%, the zoological survey was focussed on 4 ten night trapping sites and 2 two night sites. This report provides an inventory of the trees, shrubs, herbs, mammals, reptiles, amphibians, birds and butterflies recorded during the survey. The report also describes patterns of human disturbance within the reserve. The species richness, endemism and ecological affinities of the taxa recorded are summarised in Table 1.

Table 1 Summary of biodiversity of taxa surveyed

Taxon	Total no. of species	% forest dependent	No. of non-forest species	No. of endemic species	No. of near-endemic species	No. of forest dependent endemics and near-endemics
Trees and shrubs	128	5.0	29	1	12	2
Mammals	45	9.5	12	0	3	1
Birds	52	6.0	31	0	2	0
Reptiles	20	10.0	18	0	2	0
Amphibians	14	36.0	3	0	5	5
Butterflies	138	17.0	44	0	11	7
Total	397	n/a	137	1	35	15

Relative to other reserves surveyed by Frontier-Tanzania, Mgambo FR has a low floral diversity and low to average faunal diversity.

In terms of flora, Mgambo FR is made up of patches of several different vegetation types including dry lowland forest, riverine lowland forest, scrub forest, open woodland and miombo woodland (*Brachystegia* sp.). A large proportion of species recorded within Mgambo FR were categorised as non-forest dwelling (Table 1). Lowland riverine forest and some of the lowland scrubby habitats were the most important habitats for endemic and near endemic species, although the majority of the reserve suffers substantially from fire and overgrazing disturbances. Only one plant species was identified as endemic to the Usambaras, this was *Cassia abbreviata*.

Despite its small size, Mgambo Forest Reserve supports a high diversity of butterfly species and several near endemic amphibian species. The reserve is home to 3 endangered and 5 vulnerable species according to the National Biodiversity Database (UDSM, 1997) and IUCN categories.

To this day, Mgambo FR has spiritual value to local Washambaa communities and serves as a source of medicinal plants and non-timber forest products. A number of ritual areas were observed during the course of the study. These sites were often located in the better forest areas such as the riverine forest areas and site locations included bases of trees and caves.

The greatest threat to Mgambo FR is fire disturbance, to provide fresh grass for illegal livestock grazing in the forest. Pole and timber cutting and animal hunting continue illegally on a small scale within the reserve, generally close to inhabitation.

The information collected by this survey will be used for management planning by the EUCAMP. The survey results are also available as a baseline for monitoring. The data are stored on a Microsoft Access (version Windows 97) database in the EUCAMP library in Tanga, and parts of it are available on the Internet at the following address: www.usambara.com

Animal specimens have been deposited at: the Department of Zoology and Marine Biology, University of Dar es Salaam; Natural History Museum, London; Zoological Museum of Copenhagen, Denmark; Frankfurt Zoological Museum, Germany; The Natural History Museum of Zimbabwe, Bulawayo and the African Butterfly Research Institute, Nairobi. Contact names and addresses are listed in Appendix 2.

Botanical specimens are held at the National Herbarium of Tanzania (NHT) in Arusha, Missouri Botanical Gardens, USA and Kew Royal Botanical Gardens, UK.

FOREWORD

The East Usambara forests in northeastern Tanzania are part of the Eastern Arc mountains. More than one hundred years of biological interest and research have shown that these forests have a unique diversity of flora and fauna, and an exceptionally high degree of endemism. They have gained global recognition as being part of a Biodiversity Hotspot (Conservation International), an Endemic Bird Area (BirdLife), a Centre of Plant Diversity (WWF and IUCN) and a Globally Important Ecoregion (WWF). Since 1990, the East Usambara Conservation Area Management Programme (EUCAMP) (formerly known as the East Usambara Catchment Forest Project (EUCFP)) has worked in the East Usambara Mountains with the mission to protect these natural forests. The project is implemented by the Forestry and Beekeeping Division (FBD) of the Ministry of Natural Resources and Tourism (MNRT) with financial support from the Government of Finland, and technical support from Metsähallitus Consulting.

Although a considerable amount of biological information exists from the East Usambara Mountains, systematic surveys were previously largely restricted to the Amani area. In order to acquire more comprehensive information on the forests, biodiversity surveys were initiated and contracted in July 1995 to Frontier Tanzania, a joint venture between the University of Dar es Salaam and the Society for Environmental Exploration, together with EUCAMP. The aim of the surveys is to provide systematic baseline information on the biological values of different forests as a basis for management planning and long-term monitoring. They will help to set priorities in the conservation of this valuable area. In addition, the surveys provide training for forestry staff in the use of biological inventory techniques.

The programme involves locally employed field assistants, permanent staff from EUCAMP, Frontier-Tanzania, University of Dar es Salaam, and Tanzania Forestry Research Institute, as well as an international network of taxonomists and other experts. The surveys have become progressively more systematic and quantitative, and have already resulted in the discovery of several previously unknown taxa. This will further raise awareness of the unique conservation values of the East Usambara Mountains. EUCAMP has also commissioned the development of a biodiversity database. All data collected during the surveys is entered into this database, which is linked to the Tanzanian national biodiversity database held at the Department of Zoology and Marine Biology, University of Dar es Salaam.

The reports are the result of the work of many people – too many to be listed here. We would like to thank all of them for their invaluable effort. We hope that the surveys will make yet another contribution to the long historic chain of efforts to study and understand these unique forests. Perhaps even more than that we hope that this information will contribute to better management and conservation of the East Usambara Mountains so that the beauty of the area will remain for future generations to know and enjoy.

Mr. Mathias Lema
Project Manager

Dr Veli Pohjonen
Chief Technical Adviser

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EUCAMP

Project Manager:	Mr. Mathias Lema
Assistant Project Manager:	Mr. Matiko Wambura
Chief Technical Advisor:	Dr. Veli Pohjonen
Research and Monitoring:	Ms. Lucia Mshana
Biodiversity Co-ordinator:	Mr. Raymond R. Killenga.
Biodiversity Co-ordinator and Botanical collector	Mr. Albert Ntemi Sallu

Foresters:	Mr. Johari Mtango, Mr. Francis Tunguli and Mr. Josephat Maingu.
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SOCIETY FOR ENVIRONMENTAL EXPLORATION

Managing Director:	Ms. Eibleis Fanning
Development Programme Manager:	Ms. Elizabeth Humphreys
Research Programme Manager:	Dr. Damon Stanwell-Smith
Operations Manager:	Mr. Matthew Willson

UDSM

FT Co-ordinators:	Dr. M. Muruke & Prof. K. M. Howell.
-------------------	-------------------------------------

FRONTIER-TANZANIA

Project Co-ordinator:	Ms. Nicola Beharrell
Research Co-ordinator:	Ms. Susannah Hall
Assistant Research Co-ordinators:	Ms. Claire Bracebridge and Ms. Sophie Oliver
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Field Assistants:	Mr. Hassani Abedi, Mr. Ramathan Rajabu, Ms. Zahara Rashidi, Mr. Ashraf Omari, Mr. Amiri Saidi, Ms. Mwadjuma Esekiel and Mr. Omari Abdallah.
FT Driver:	Mr. Betram Hyera
Research Assistants:	Ms. Tracy Beer, Ms. Kirsty Blott, Mr. Alistair Carlisle, Ms. Emma Clarke, Ms. Rosie Irwin, Mr. Martin Kelling, Mr. Christopher King, Mr. Andy Meldrum, Ms. Maria Sandberg and Ms. Emma Thompson.

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1.0 INTRODUCTION

1.1 The East Usambara Mountains and forest diversity

The East Usambara Mountains are situated in northeastern Tanzania within 40 km of the coastal town of Tanga between 4°48'-5°13'S and 38°32'-38°48'E. These mountains form part of a chain known as the Eastern Arc that stretches down the coast of East Africa from southern Kenya to southern Tanzania. This is a chain of isolated mountains composed of Precambrian rock exposed by block faulting and slow uprising (Griffiths, 1993). Being adjacent to the Indian Ocean, considerable orographic rainfall occurs in this area. The rainfall distribution is bi-modal, peaking between March and May and between September and December. The dry seasons are from June to August and January to March. However precipitation occurs in all months. Rainfall is greatest at higher altitudes and in the southeast of the mountains, increasing from 1,200 mm annually in the foothills to over 2,200 mm at higher altitudes. Due to topographic and climatic interactions, the west-facing slopes of the mountains are drier compared to the east-facing slopes. Due to their age, isolation and their role as condensers of the moisture from the Indian Ocean, the East Usambara Mountains support ancient and unique forests, rich in endemic species (Hamilton, 1989).

Research in the East Usambara Mountains began in the late 1890s with substantial botanical collections being undertaken. Later, in 1928, surveys were undertaken on amphibians and, by the 1930s, detailed ornithological work had begun. Since these early studies biological research in the mountains has steadily increased .

The East Usambara forests have been likened to the African equivalent of the Galapagos Islands in terms of their endemism and biodiversity (Rodgers and Homewood, 1982; Howell, 1989). They are considered to be one of the most important forest blocks in Africa (Tye, 1994). Currently, at least 3450 species of vascular plants have been recorded in the Usambara Mountains of which it is suggested that over one quarter are endemic or near-endemic (Iversen, 1991a) and many species are threatened (Rodgers, 1996).

The forests of the East Usambara Mountains are not only important for their biodiversity, they also play an important role in maintaining the hydrological cycle that feeds the Sigi River. This river is a vital water source for the local communities as well as supplying water for the large coastal town of Tanga. Deforestation in the area will lead to increased soil erosion, particularly from the steeper slopes. Soil erosion is liable to result in a more irregular run off and deterioration in water quality due to siltation.

The latest survey of the East Usambara Mountains, conducted by Johansson and Sandy (1996) shows that approximately 45,137 ha of the East Usambara Mountains remain as natural forest. This can be divided into two types: submontane rain forest and lowland forest. Altitude is the factor differentiating these two forest types (Hamilton, 1989), with submontane forest generally occurring above 850m. The area recorded as forest in the East Usambara Mountains according to these categories is described in Table 2.

Table 2 Forest area in the East Usambara Mountains (based on Johansson and Sandy, 1996).

Forest type	Area	% of area
Lowland forest	29497.4	62.9
Submontane forest	12916.6	30.6
Forest plantation	2723.6	6.5
TOTAL	45137.6	

The mammals of the East Usambara Mountains show limited endemism (Kingdon and Howell 1993). However, there are several species of special interest. These include: the restricted Zanzibar elephant shrew, *Rhynchocyon petersi*, which is common in the Usambara Mountains (Collar and Stuart, 1987) yet listed as globally 'Endangered' by IUCN due to a decline in habitat extent and quality; Eastern tree hyrax, *Dendrohyrax validus*, listed as 'Vulnerable' by IUCN (Hilton-Taylor, 2000), and the Lesser pouched rat, *Beamys hindei* which is also considered 'Vulnerable' by IUCN (Hilton-Taylor, 2000).

There are at least 11 species of reptiles and amphibians endemic to the East and West Usambara Mountains (Howell, 1993). The East Usambara Biodiversity Surveys provide further information on new species and species' range extensions. A new species of snake, *Prosymna semifasciata*, was recently found in Kwangumi and Segoma Forest Reserves (Broadley, 1995) and a recently described amphibian species; *Stephopaedes usambarae* (Poynton and Clarke, 1999) has been recorded by the surveys in Mtai and Kwangumi Forest Reserves.

The forest avifauna of the East Usambara Mountains has a high diversity with at least 110 species (Stuart, 1989). Six species occurring in the lowland forests are considered 'Vulnerable' to global extinction: Sokoke scops owl, *Otus ireneae*; the endemic Usambara eagle owl, *Bubo vosseleri*; Swynnerton's robin, *Swynnertonia swynnertoni*; East coast akalat, *Sheppardia gunningi*; Amani sunbird, *Anthreptes pallidigaster* and the Banded green sunbird, *Anthreptes rubritorques* (IUCN, 1996).

The East Usambara Mountains are essentially forest 'islands' (Lovett, 1989). There has been natural forest in the area for several million years. The Usambara Mountains harbour many species that have been geographically separated from their closest relatives for long periods. They also serve as a refuge for formerly widespread flora and fauna that have become extinct over much of their former area (Iversen, 1991a).

These forests have been under continuous exploitative human pressure for at least 2,000 years (Schmidt, 1989). Until recently, especially before the past 50 years, (Kikula, 1989), this pressure was sustainable. However, the growing human population in the area is leading to increased pressure on the remaining natural forest, and represents the main threat to their survival.

1.2 Report structure

This report provides a floral and faunal inventory of Mgambo Forest Reserve (Mgambo FR). Each species is described in terms of its ecological requirements and its endemic status.

Ecological requirements are defined as:

- **Forest dependent species (F):** Species dependent on primary forest only. This category does not include forest edge or secondary forest species;
- **Forest non-dependent species (f):** Forest dwelling but not dependent on primary forest: species occurring in primary forest as defined above as well as other vegetation types. It should be emphasised that many of these species are still dependent on a forest habitat albeit forest edge or disturbed forest. Most species in this category will still be adversely affected by forest destruction.
- **Non-forest species (O):** These are species that do not normally occur in primary or secondary forest or forest edge.

Levels of endemism are defined as:

- **Endemic (E):** Occurring only in the Usambara Mountains;
- **Near-endemic (N):** Species with ranges restricted to the Eastern Arc Mountains and / or the East African lowland forests;
- **Widespread (W):** Species with ranges extending beyond the Eastern Arc and East African lowland forests.

The typical habitat association of plant species is categorised as either:

- **Lowland (L):** Species occurring at altitudes of <850m.
- **Submontane (S):** Species occurring at altitudes of >850m.
- **Montane (M):** Species occurring at altitudes of >1250m.

This refers to the habitat(s) in which they are typically found in East Africa, rather than to where they have been recorded in the reserve.

These three criteria are used to analyse the uniqueness of the biodiversity of the reserve and its vulnerability to disturbance. The categories are based on information from various sources.

1.2.1 Flora

Floral nomenclature generally follows the following databases located on the internet:

www.mobot.org (TROPICOS database in University of Missouri, Botanical Garden)

www.ipni.org (International Plant Names Index)

Family organisation follows Iversen (1991b).

For plants the ecological type and endemic status are primarily based on Iversen (1991b). Forest dependent species refers to those species listed as being exclusively associated with Iversen's categories 1a (wet evergreen forest), 1b (dry evergreen forest) and/or 1c (riverine forest). Species defined as forest dwelling also occur in other habitats.

Definitions of habitat type are based on Hamilton (1989). For those species not listed by Iversen (1991b) or Hamilton (1989), the information is taken from the Flora of Tropical East Africa and from the List of East African Plants (LEAP), Knox (2000).

Endemic and near-endemic status for plants was taken from Iversen (1991b) and FTEA categories Tanzania T3, T6, T8 and Kenya K7.

1.2.2 Fauna

For fauna, the following references were used:

Mammals:	Kingdon (1997), Kingdon (1989), Kingdon (1974), Walker (1996).
Birds:	Zimmerman <i>et al.</i> (1996), Stattersfield <i>et al.</i> (1998), Mlingwa <i>et al.</i> (2000), Stuart (1989).
Reptiles:	Spawls <i>et al.</i> (2002).
Amphibians:	Passmore and Carruthers (1995).
Butterflies:	Kielland (1990) and Larsen (1996).

For animals, the endemic and near-endemic status was gleaned from the Tanzanian National Biodiversity Database (NBD) (UDSM, 1997).

1.2.2.1 Birds

Ecological type of bird species recorded were based on, Mlingwa *et al.* (2000) which is turn is based on Bennum *et al.* (in press). Those species not included in the above were categorised by Zimmerman *et al.* (1996) and Stuart (1989).

Forest dependence Mlingwa *et al.* (2000):

- **Forest specialist (FF):** Species that are typical of forest interior and likely to disappear when the forest is modified to any extent.
- **Forest generalist (F):** Species that can occur in undisturbed forest but which are able to exist (and may even be numerous) at the forest edge or in modified and fragmented forests. However, these generalists continue to depend upon forests for some of their resources, such as nesting sites.
- **Forest visitors (f):** Species that occur outside forest areas but which might visit forest.

Stuart (1989) categorises species by adaptability:

1. those which live in forest but are not dependent upon it for their survival
2. those which live in forest and 'overspill' into adjacent habitats, but are dependent upon forest for their continued survival
3. those that can only survive in forest and hardly 'overspill' into adjacent habitats.

The NBD (UDSM, 1997) and IUCN 2000 were used to categorise threat status of the animals listed. The NBD lists were compiled with regard to status and threat within Tanzania and East Africa. The status of most species are undergoing national and international evaluation. IUCN, categorises species in terms of global threat and produces Red data books, available from 1996 and earlier. However, a new IUCN 2000 CD-Rom has been released. Many Tanzanian species are not included in the 2000 IUCN Red data CD-Rom. IUCN 2000 status is given, where available, in addition to NBD for all taxa groups and is the main source of threat status for bird species.

1.3 Maps

The distribution of plant species within the reserve is presented as a series of maps. These are thematic maps where the size of each spot is directly proportional to the value that they represent. In the plots where no spot is shown, the relevant taxa were either not found or not surveyed. Only one map summarises animal data. Not enough capture data was available to produce useful thematic maps for each animal taxa.

1.4 Data and monitoring

Data are stored in a Microsoft Access (version Windows 97) database currently stored at the East Usambara Conservation Area Management Programme and Frontier-Tanzania. Parts of it are now available on the Internet. Zoological data are also stored on the National Biodiversity Database at the Department of Zoology and Marine Biology, University of Dar es Salaam. This is also a Microsoft Access database. The data are geographically referenced and so can be used as a baseline for biodiversity monitoring.

1.5 Survey period and personnel

The survey of Mgambo FR was conducted between 9th April and 17th June 2002 for a total of 10 research weeks. Frontier-Tanzania staff, Catchment Forest Officers, and locally employed field assistants from Maramba, Tanga, Amani and Bwiti conducted the survey.

2.0 AIMS OF THE SURVEY

The specific aims of the biodiversity survey as outlined in the Terms of Reference between the Frontier Tanzania Forest Research Programme and the East Usambara Conservation Area Management Programme (EUCAMP) are:

- to conduct biological baseline surveys in selected forests as a baseline against which to monitor future changes in biodiversity status;
- to provide information on the biological value and importance of these forests in order to assist in the development of management plans and practices for these forests;
- to provide information on human disturbance and levels of resource use in different areas of the forest;
- to develop specific, quantitative methods of monitoring key biodiversity indicators, and assist in establishing long term monitoring procedures to address specific aspects of the forest ecology and management such as regeneration and hunting;
- to train Tanzanian personnel from EUCAMP, UDSM, the TAFORI and the Forestry and Bee Keeping Division in forest survey work;
- to contribute to global biodiversity assessment and conservation efforts through collaboration with specialists elsewhere, and the sharing of information, data and material collected during surveys.

Furthermore, the aims of the survey methods applied are:

- to sample the vegetation and tree species composition of selected forests of the East Usambara Mountains using systematic sampling techniques along systematically located vegetation transects, which sample 0.25% of the area of each forest reserve;
- to assess levels of disturbance by systematically sampling the incidence of tree cutting, animal trapping and other illegal activities along the vegetation transects;
- to use standardised and repeatable methods to record biodiversity values of the forest in terms of small mammal, reptile, amphibian, and invertebrate species;
- to collect opportunistic data on all other groups of vertebrate and invertebrates. Species lists resulting from this will be compared against IUCN categories of threat and other conservation criteria in order to assess the overall biodiversity values of each forest.

By using standardised and repeatable methods these surveys provide an assessment of the biodiversity value of the forests, enabling their importance to be determined and their biodiversity value to be monitored in future.

An additional aim of the project that is covered in a separate report includes:

- to provide small scale feedback with regard to the survey findings through environmental education activities within school and village committee networks, in co-operation with the EUCAMP Village Forestry Programme.

3.0 DESCRIPTION OF THE FOREST

3.1 General description

3.1.1 Description

- Name: Mgambo Forest Reserve
Muheza District, Tanga Region, Tanzania.
- Area: 1346 ha
- Status: Catchment Forest Reserve
Gazetted July 1998 as delineated and described on Forest and Bee Keeping Division Map No. Jb. 2291
Gazettement notice GN 99 (1931; (1995).
Central Authority Status
- Maps: Ordnance Survey topographic maps 1: 50 000 Series Y742 (D.O.S. 422)
Sheet 110/4 'Gombero' of 1989 and Sheet 110/2 'Mwakijembe' of 1989
Forest and Bee Keeping Division maps:
Jb 2291 1996 'Mgambo Forest Reserve' 1:10,000

3.1.2 Location

- Lat/Long: S 04°44'53" - S 04°47'50", E 38°47'18" - 38°49'11" E
- UTM/UPS: 94 75228 - 94 69784 S, 04 76554 - 04 80020 E
- Elevation: 320m – 820m above sea level

Mgambo Forest Reserve (FR) is located in the north-east of the main East Usambara Mountain range with Mpanga and Mtai forest reserves to the south. Mgambo FR lies adjacent to the savanna plateau that reaches into Kenya (Figure 2). Mgambo FR covers an area of 13.46 km² (1346 ha). It lies in the district of Muheza, Maramba Division, Tanga Region and covers land approximately 10 km north from Maramba town, located on latitude 4°46'00" and longitude 38°45'15". Mgambo FR was gazetted in July 1998, as delineated and described on the Forest and Beekeeping Division map number. Jb. 2291. It was gazetted primarily to protect the catchment areas supplying Bwiti, Mavovo, Mgambo and Daluni villages. The region has an average annual rainfall of the area is between 1000 and 1500 mm per year falling principally from March to June although, in recent years, rain has been unpredictable and low. Vegetation cover within Mgambo Forest Reserve has previously been recorded as containing 1,295 ha of poorly stocked lowland forest and 51 ha of cultivation under lowland forest (Johansson, 1996).

3.1.3 Topography

Mgambo FR consists of two ridges running north to south in the western and eastern halves of the reserve (Figure 3). A photograph of the view from a northerly point along the eastern ridge top can be found in Figure 1. The ridge top reaches an altitude of 800m above sea level. All but one or two rocky cliff areas is accessible by foot. There is a water source feeding Bwiti village and subvillages and another that is used by Mgambo village.

3.1.4 Land use

The latest survey of the area was carried out by Hyytiäinen (1995), and updated by Johansson and Sandy (1996). The most common habitat found within Mgambo FR from this survey was recorded as poorly stocked lowland forest (Table 3).



Figure 1 View from Mgambo FR ridgetop looking westwards to the West Usambaras.

Table 3 Land use distribution
(Johansson and Sandy, 1996).

Mgambo PFR ('proposed' FR at time of consideration)	Area (hectares)	% of area
Lowland forest:		
Poorly Stocked forest	1295.0	96.2
Cultivation under forest	51.0	3.8
Total	1346.0	100%

3.1.5 History and Status

There has been human pressure in the East Usambara Mountains for at least 2000 years. In the 19th Century it appears populations were markedly lower in the East Usambara Mountains relative to the West Usambara Mountains with much of the area remaining forested.

Since gazettement, the Mgambo FR has continued to be used for the collection of cultural resources and worshipping. Regular and extensive fires and grazing practices in recent years have occurred within the Forest Reserve and have significantly reduced the quality and expanse of closed forest habitat.

In comparison with other Forest Reserves in the East Usambara Mountains, little research has been conducted within Mgambo FR. This survey is the first comprehensive, systematic and comparable survey of all accessible parts of the forest reserve.

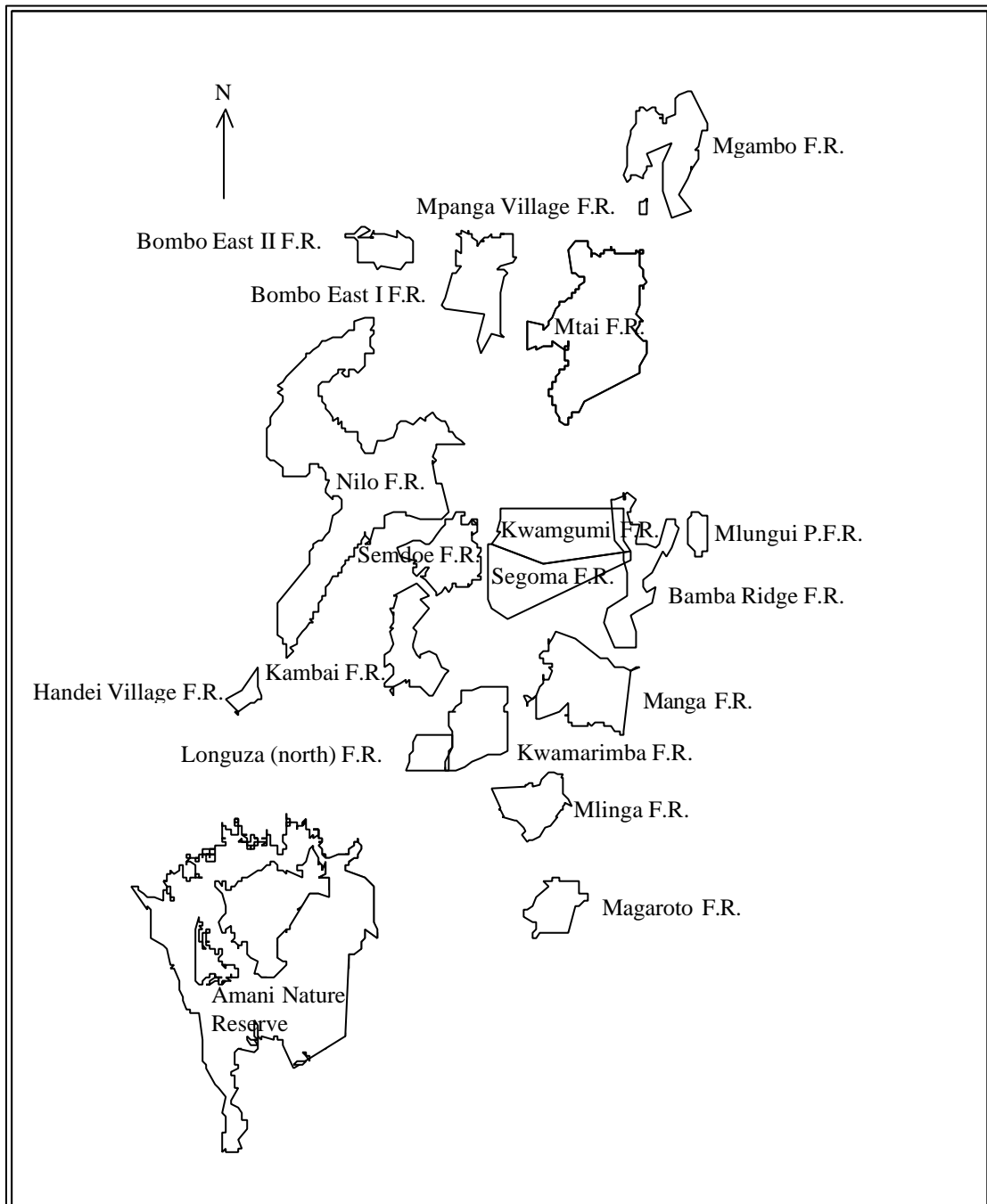


Figure 2 The location of Mgambo FR in relation to other East Usambara forests

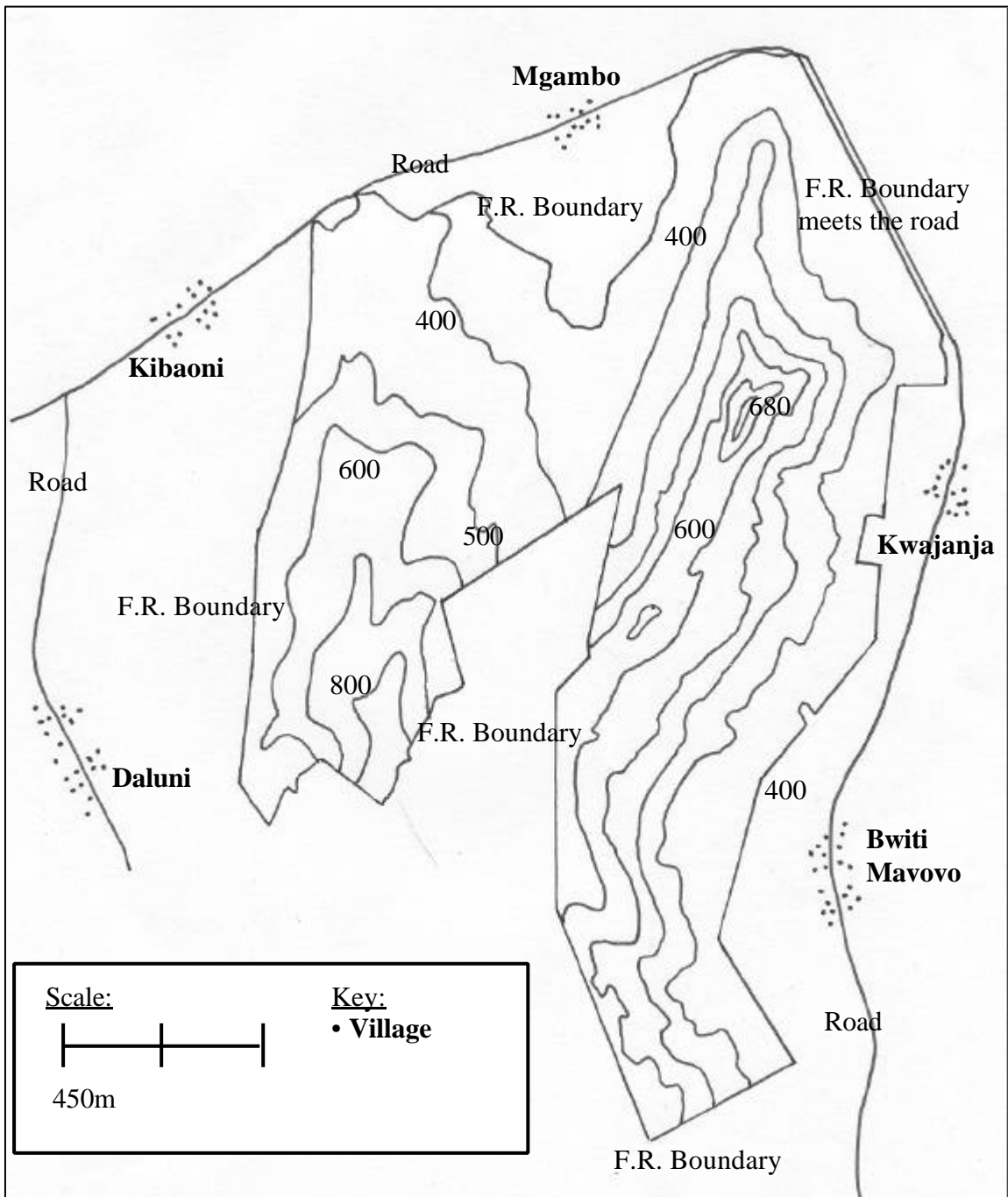


Figure 3 Topographical map of Mgambo FR.

4.0 VEGETATION

Authors: Oliver, S.A., Ntemi, A.S., Bracebridge, C.E. pp. 11-42

4.1 Introduction

A species inventory was compiled of the trees and shrubs found within the Mgambo Forest Reserve (FR). Simple, quantitative and repeatable methods were employed and the results are comparable with other forest surveys undertaken by FT FRP. Human disturbance within the forest was also documented. Botanical and disturbance data collected by this survey have been entered onto the EUCAMP database.



Figure 4 Typical Miombo woodland (*Brachystegia* sp.) in Mgambo FR

4.2 Methods

The forest reserve was divided into a grid of numbered squares marked in the field by tagged transect lines. All methods are based on this grid system and are detailed in the FT FRP methodologies report (SEE, 1998). A brief description is presented below. The location of vegetation plots and disturbance transects were recorded using Global Positioning System (GPS) (see Appendix 2) and their locations on the Mgambo FR outline are illustrated in Figure 5.

4.2.1 Forest composition

Three methods were used to analyse forest composition: (1) quantitative vegetation analysis; (2) opportunistic observations and (3) disturbance transects.

4.2.1.1 Quantitative vegetation analysis

The botanical survey was based on a 900m x 450m grid marked in the field using tagged transect lines. One plot 50m x 20m was sampled in each grid square, giving an approximate sampling intensity of 0.25%. The 50m x 20m vegetation plots were located in the southeast corner of each of the 900m x 450m grid rectangles. Within each sample (vegetation) plot, every tree with a diameter at breast height (dbh) of 10cm and over was recorded, marked with red paint, and identified. An EUCAMP botanist provided the field identification of plant species. Specimen collection was made of fertile individuals, and difficult to identify species.

The regeneration layer was sampled within 3m x 3m nested subplots at the centre of each vegetation plot. All trees and shrubs with a dbh below 10cm were counted and identified within these plots. The ground cover (of herbaceous vegetation, bare soil, leaf litter and rocks), and the dominance of other vegetation (such as grasses, forbs, mosses, lichens and ferns) were documented as percentages. Systematically sampled vegetation data is presented in the form of checklists and analytical calculations summarised in tables, graphs and maps.

4.2.1.2 Opportunistic collection and observation

Opportunistic collections and observations of ground, shrub and tree floras were made throughout the survey. Fertile individuals were collected as specimens and dried in the field using a kerosene stove. Detailed field notes were made of each specimen and are stored with the specimens. All botanical specimens are held at the National Herbarium, Arusha and Missouri Botanical Gardens, USA. Some specimens are also kept at Kew National Herbarium, UK. Opportunistic data is presented as a checklist, with location information for specimens that were collected.

4.2.1.3 Disturbance transects

Disturbance transects were used to record the intensity of pole and timber cutting and incidence of other disturbance types in the forest reserve. The disturbance transects were based on the 900m x 450m grid prepared for the vegetation plots (Figure 3). Each transect running east-west was sampled from border to border where accessible. Disturbance was recorded per 50m section along each transect.

Every self-standing tree and sapling (not lianas or creepers) 5cm or above dbh was measured within 5m either side of each transect line. Each plant was recorded under one of four categories: live, old cut, new cut or naturally dead. Within these categories a distinction was made between poles and timbers. Poles were classified as having a dbh (diameter at breast height) between 5 and 15cm and a minimum of 2m relatively straight trunk. Timbers were classified as having a dbh of 15cm or above with a minimum 3m relatively straight trunk. These divisions are based on differences in use. New cut stems were determined by cream coloured slash and classified as freshly cut within recent months (approximately within the past 3 months). Old cut stems were determined by black coloured slash and classified as old cut (approximately more than 3 months old). Timber and pole cutting data are presented as an average per hectare and summarised in graphs and maps.

The incidence of other signs of disturbance (such as fire, cultivation, grazing, animal trapping and pitsawing) were documented every 50m section and summarised in a table and maps. The most disturbed plots were calculated using pole and timber cutting counts and incidence figures for 'other signs of disturbance'. Pole and timber cutting counts were combined, summed and then ranked, with the most disturbed plot ranked first. Incidence of fire and grazing disturbance was also summed and ranked, with the most disturbed plot ranked first. The combined top nine plots were used within Figures 19 and 24.

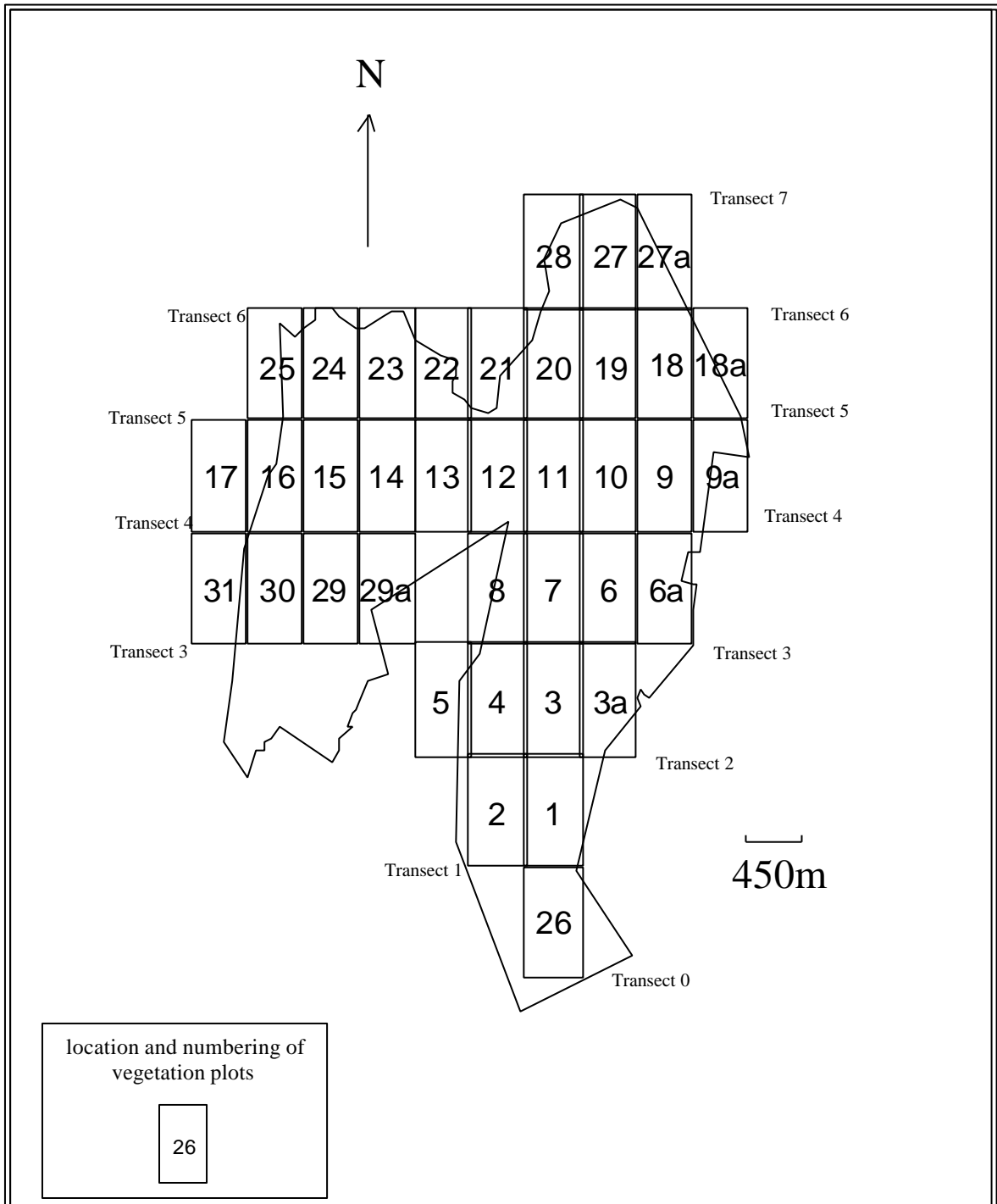


Figure 5 Location of vegetation plots and disturbance transects in Mgambo FR. (GPS co-ordinates of vegetation plots are summarised in Appendix 2).

4.3 Results

4.3.1 Quantitative vegetation analysis

4.3.1.1 Vegetation Plots

A total of 31 50 x 20m vegetation plots were established. By far the most dominant vegetation type within vegetation plots was found to be open woodland (65% of plots), with lowland forest found in just 16% of plots. There was none submontane forest vegetation plots. Almost 65% of all vegetation plots had an average canopy height of less than 10m, and there were no vegetation plots recorded with canopy heights greater than 20m. A total of 68% of vegetation plots had been affected by fire. The average slope for all accessible vegetation plots was moderately steep at 20.5 degrees. Vegetation plot descriptions are summarised in Appendix 3 and a vegetation map shown in Figure 6.

A total of 858 individuals, representing 31 families and 101 species were recorded in thirty-one 20m x 50m vegetation plots at 0.25% sampling intensity. Species are described, where adequate information exists, in terms of their ecological type, their habitat and their endemic status. Nomenclature follows Iversen (1991b), the Flora of Tropical East Africa (Polhill, 1988) and the LEAP database (Knox, 2000). Table 4 presents a checklist of these tree and shrub species.

Table 4 Checklist of trees and shrubs recorded within the vegetation plots.

	Ecol. Type	Habitat	End. Status	Total no. of individuals	Present in n plots	Local name
Angiospermae – Dicotyledonae						
ANACARDIACEAE						
<i>Lannea schweinfurthii</i> (Engl.) Engl. 1897	f	L&S	W	19	9	Mumbu
<i>Lannea schweinfurthii</i> var. <i>stuhlmannii</i> (Engl.) J.D. Kokwaro 1980	f	L&S&M ¹	W	12	9	Mumbu
<i>Ozoroa insignis</i> Delile	f	L	W	2	1	
<i>Sclerocarya birrea</i> (A. Rich) Hochst	O ¹	L&S&M ¹	W ¹	4	2	Mng'ongo
<i>Sorindeia madagascariensis</i> Thouars ex DC. 1825	f	L&S	W	6	1	Mkwingwira
ANNONACEAE						
<i>Asteranthe asterias</i> (S. Moore) Engl. & Diels Verde	f	L	N	3	1	
<i>Annona senegalensis</i> Pers. 1806	f	L&S	W	7	5	Mtonkwe
<i>Monodora grandidieri</i> Baill. 1867	O	L	N	3	1	
ARALIACEAE						
<i>Cussonia arborea</i> Hochst. ex A. Rich. 1847	f	L&S&M	W	2	2	Mtindii
BALANITACEAE						
<i>Balanites aegyptica</i> Wall	O	S&M ²	W ²	9	4	
BIGNONIACEAE						
<i>Markhamia lutea</i> (Benth.) K. Schum. 1895	f	L&S	W	18	3	Mtalawanda
<i>Stereospermum kunthianum</i> Cham. 1832	f	L&S	W	27	9	Mkande
BOMBACEAE						
<i>Rhodognaphalon schumannianum</i> A.Robyns 1963 (basonym <i>Bombax rhodognaphalon</i> K.Schum.ex Engl. 1895)	f	L ²	W ²	2	2	Msufimwitu
BORAGINACEAE						
<i>Cordia ovalis</i> R.Br. ex. DC. 1845	f ¹	L&S&M ¹	W ¹	22	9	Mzei
<i>Ehretia amoena</i> Klotzsch	O	L ¹	W	11	8	
BURSERACEAE						
<i>Commiphora africana</i> (A. Rich) Engl.	O	L&S	W	3	3	Mbambaa
<i>Commiphora eminii</i> Engl. ssp. <i>zimmermannii</i> (Engl.) J. B. Gillet 1991 (basonym. <i>C. Zimmermannii</i> Engl.)	F	L&S	W	3	2	
CAPPARACEAE						
<i>Maerua kirkii</i> (Oliv.) F.White 1958	f	L&S ¹	W ¹	1	1	

Table 4 continued

	Ecol. Type	Habitat	End. Status	Total no. of individuals	Present in n plots	Local name
CELASTRACEAE						
<i>Maytenus sp.</i>	?	?	?	3	1	
<i>Maytenus undata</i> (Thunb.) Blakelock 1956	f	L&S&M ²	W	14	5	
<i>Mystroxyloa aethiopicum</i> Loes.	f	L	W	4	1	
COMBRETACEAE						
<i>Combretum exalatum</i> (Engl.) 1895	f	L	N	1	1	
<i>Combretum molle</i> R. Br. ex G. Don 1827	O	L	W	15	10	Mnama
<i>Combretum schumannii</i> Engl. 1895	f	L&S ²	W	6	2	Mperamwitu
<i>Combretum zeyheri</i> Sond. 1950	O	L	W	77	16	Mgodogodo
<i>Pteleopsis myrtifolia</i> (Laws) Engl. & Diels	f	L	W	15	8	Myovu
<i>Terminalia prunioides</i> M. Laws	f	L	W	1	1	
<i>Terminalia sambesiaca</i> Engl. & Diels 1900	f	L	W	3	2	Mkenge
COMPOSITAE						
<i>Brachylaena huillensis</i> O. Hoffm. 1902	f	L&S	W	11	3	
EBENACEAE						
<i>Diospyros squarrosa</i> Klotzsch.	f	L	W	4	3	
<i>Euclea natalensis</i> A. DC	f	L&S	W	7	5	Mdaa
EUPHORBIACEAE						
<i>Bridelia cathartica</i> Bertol.f. 1854	O	L	W	3	2	
<i>Bridelia micrantha</i> (Hochst.) Baill 1862	f	L&S&M	W	1	1	Mwiza
<i>Euphorbia candelabrum</i> Tremaut ex. Klotzshy 1857	O	L	W	2	2	Kibaranga
<i>Magaritaria discoides</i> (Baill.) Webster 1967	O	L&S	W	4	4	
<i>Phyllanthus sp.</i>	?	?	?	2	1	
<i>Ricinodendron heudelotii</i> (Baill.) Pierre ex Pax 1911	f	L&S	W ¹	1	1	
<i>Spirostachys africana</i> Sond. 1850	O	L	W	5	1	Mshaaka
<i>Suregada zanzibarensis</i> (Baill.) Mill 1861	f	L	W	3	3	
FLACOURTIACEAE						
<i>Caloncoba welwitschii</i> (Olive.) Gilg 1908 (basionym <i>Oncoba welwitschii</i> Oliv. 1868)	f ¹	S&M ²	W ²	1	1	
<i>Dovyalis hispidula</i> Wild	f	L	W	9	2	
LEGUMINOSAE subfamily:						
CAESALPINIDAE						
<i>Afzelia quanzensis</i> Welw. 1858	f	L	W	1	1	Mbambakofi
<i>Brachystegia spiciformis</i> Benth 1866	f	L	W	33	3	Miombo
<i>Cassia abbreviata</i> Oliver	O ¹	L ¹	E ¹	4	3	
<i>Piliostigma thonningii</i> (Schumach.) Milne-Redh.	f	L&S&M	W	2	2	Kigona mbogo
<i>Scorodophloeus fischeri</i> (Taub.) J. Leonard 1951 (basionym. <i>Theodora fischeri</i> Taub. 1895)	O	L&S	N	15	3	Mhande
LEGUMINOSAE subfamily: MIMOSOIDAE						
<i>Acacia hockii</i> De Wild. 1913	O	L	W	19	5	
<i>Acacia mellifera</i> Benth ¹ 1842	O	S	W	6	3	Kikwata
<i>Acacia nilotica</i> Delile	f	S ¹	W	17	2	Mgunga
<i>Acacia polyacantha</i> Willd.	f	L&S	W	15	5	Mgunga
<i>Acacia sp. (new)</i>	?	?	?	4	1	Mgunga
<i>Albizia anthelmintica</i> Brongn 1860	O	L&S	W	31	14	Mfueta
<i>Inga glaberrima</i> (Schumach. & Thonn.) Roberty 1954 (basionym <i>Albizia glaberrima</i> (Schumach. & Thonn.) Benth. 1844)	f	L&S	W	1	1	Mshai

Table 4 continued

	Ecol. Type	Habitat	End. Status	Total no. of individuals	Present in n plots	Local name
LEGUMINOSAE subfamily: MIMOSOIDAE cont.						
<i>Albizia gummifera</i> (J.F. Gmel.) C.A. Sm. 1930*	f	L&S&M	W	24	9	Mshai
<i>Feuillea versicolor</i> (Welw. ex Oliv.) Kuntze 1891	O	L&S&M	W	6	2	Mshai
<i>Albizia versicolor</i> (Welw.ex) Oliv. 1871						
<i>Dichrostachys cinerea</i> (L.) Wight & Arn. 1834	f	L&S&M ²	W	12	3	Kikulagembe
<i>Julbernardia globiflora</i> (no author)	f	L&S	W	1	1	
<i>Tamarindus indica</i> (L.)	f	L	W	2	2	Mkwaju
LEGUMINOSAE subfamily: PAPILIONIDAE						
<i>Dalbergia melanoxylon</i> Guill & Perr	f ¹	L&S&M ¹		8	5	Mpingo
<i>Erythrina abyssinica</i> D.C.	f	L&S&M ¹	W	2	2	
<i>Lonchocarpus bussei</i> Harms 1902	O	L&S&M	W	22	8	Mfumbii
<i>Milletia dura</i> Dunn	f	S&M	W	3	2	Mhata
<i>Xeroderris stuhlmannii</i> (Taub.) Mendonça & E.P Sousa	f	L&S&M ¹	W	4	2	
LABIATAE						
Unknown species	?	?	?	2	1	Msoo
LOGANIACEAE						
<i>Strychnos henningsii</i> Gilg.	f	L	W	1	1	
<i>Strychnos innocua</i> Delile 1826	O ¹	M ²	W ²	2	2	Mkwakwa
<i>Strychnos spinosa</i> Lam (syn. <i>Strychnos madagascariensis</i> Poir)	f	L ¹	W	1	1	Mkwakwa
MELIACEAE						
<i>Trichilia emetica</i> Vahl	f	L&S	W	2	1	Mgoimazi
<i>Turraea holstii</i> Guerke 1894	F	L&S&M	W	22	7	Mduayu
MORACEAE						
<i>Artocarpus heterophyllus</i> Lam. 1789 (exotic)	O	other	W	1	1	Mfenesi
<i>Ficus ottoniifolia</i> (S. Miq.)	f	L	N	3	1	Mkuyu
<i>Ficus</i> sp. (new)	?	?	?	1	1	Mkuyu
<i>Milicia excelsa</i> (Welw.) C.C. Berg 1982	f	L&S	W	1	1	Mvule
MYRSINACEAE						
<i>Baeobotrys lanceolata</i> (Forssk. Vahl 1790 (basionym <i>Maesas lanceolata</i> Forssk 1775)	f	L&S&M	W	1	1	
OLACACEAE						
<i>Ximenia americana</i> Linn.	O	L&S	W	1	1	
RHAMNACEAE						
<i>Ziziphus mucronata</i> Willd. 1809	f	L&S&M ²	W	1	1	
RUBIACEAE						
<i>Canthium mombazense</i> Baill.	f	L&S	N	10	5	
<i>Rothmannia manganjae</i> (Hiern) Garcia 1958*	F	L&S&M	W	1	1	
<i>Rutidea fuscenscens</i> Hiern.	f	L	W	1	1	Mshembeshe mbe
<i>Rytigynia</i> sp.	?	?	?	2	1	
<i>Vangueria tomentosa</i> Hochst. 1842	f	L	W	5	3	Mviu
RUTACEAE						
<i>Vepris amaniensis</i> (Engl.) Mziray 1992	f	L	W	1	1	
<i>Vepris trichocarpa</i> (Engl.) Mziray 1992 (basionym <i>Toddalia trichocarpa</i> Engl.)	f	L	W	10	5	Kidimu
<i>Zanthoxylum deremense</i> (Engl.) Kokwaro	F	L&S	N	2	2	Muungu
<i>Zanthoxylum</i> sp.	?	?	?	1	1	Mhombo

Table 4 continued

	Ecol. Type	Habitat	End. Status	Total no. of individuals	Present in n plots	Local name
SAPINDACEAE						
<i>Allophylus calophyllus</i> Gilg.	f	L	W	4	3	
<i>Allophylus ferrugineus</i> Taub.	f	L	W	1	1	
<i>Allophylus melliodorus</i> Gilg ex Radlk. 1909	f	S&M	N	1	1	
<i>Deinbollia kilimandscharica</i> Taub. 1895	F	S&M	N	1	1	
<i>Haplocoelum inopleum</i> Radlk. 1878	f ¹	L ¹	N ¹	2	2	Kigogodeka
<i>Haplocoelum foliolosum</i> (Hiern) Bullock 1931	O	L	W	1	1	
<i>Lecaniodiscus fraxinifolius</i> Baker*	f	L&S&M	W	27	9	Mbwewe
SAPOTACEAE						
<i>Manilkara sulcata</i> (Engl.) Dubard 1915	f	L ²	W	28	6	Mgambo
SIMAROBACEAE						
<i>Harrisonia abyssinica</i> Oliver	f	L	W	1	1	
STERCULIACEAE						
<i>Dombeya kirkii</i> Mast.	O	L	W	6	1	Kwengaa
<i>Dombeya shupangae</i> K. Schum. 1900	O	L ²	N	55	12	Mkiika
<i>Sterculia africana</i> (Lour.) Fiori 1911	O	S	W	7	3	Mosa
TILIACEAE						
<i>Grewia bicolor</i> Juss. 1804	O	S	W	41	13	Mkole
<i>Grewia goetzeana</i> K. Schum	f	L&S ¹	N	4	2	Mkole- ngombe
<i>Grewia holstii</i> Burret 1910	f	L&S ¹	W	5	3	Mkole
<i>Grewia microcarpa</i> K. Schum.	O	L	W	21	9	Mkole- mbuzi
VERBENACEAE						
<i>Clerodendrum</i> sp.	?	?	?	3	2	

¹ Information is based on FTEA

² Information is based on LEAP (Knox, 2000)

KEY TO ABBREVIATIONS FOR TABLE 4

Ecological type: (based on Iversen, 1991b)

- F - Forest dependent species: Species previously recorded as restricted to primary or closed canopy forest only, e.g. wet evergreen forest, dry evergreen forest and/or riverine forest;
- f - Forest dwelling but not forest dependent: Species previously recorded in primary or closed canopy forest as defined above and/or in forest edge, clearings, secondary forest, deciduous forest and woodland, and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge (e.g. species that have been recorded in bushland, heathland, thicket, secondary scrub, grassland, rocky outcrops, swamps, wastelands and cultivation).

Habitat: (where possible based on Hamilton, 1989)

- L - Lowland: Species occurring at altitudes less than 850m above sea level;
- S - Submontane: Species occurring at altitudes greater than 850m above sea level.
- M - Montane Species occurring at altitudes greater than 1,250m above sea level.

If species occur in more than one habitat range, this has been recorded (e.g. L&S – this species has been recorded at altitudes between 0 and 850m above sea level).

Endemic status: (based on Iversen, 1991b):

- E - Endemic: Occurring only in the Usambara mountains, EU - Range limited to the East Usambara Mountains, WU - Range limited to the West Usambara Mountains;
- N - Near endemic: Species with limited ranges in the Eastern Arc mountains and/or the East African lowland forests;
- W - Widespread distribution.

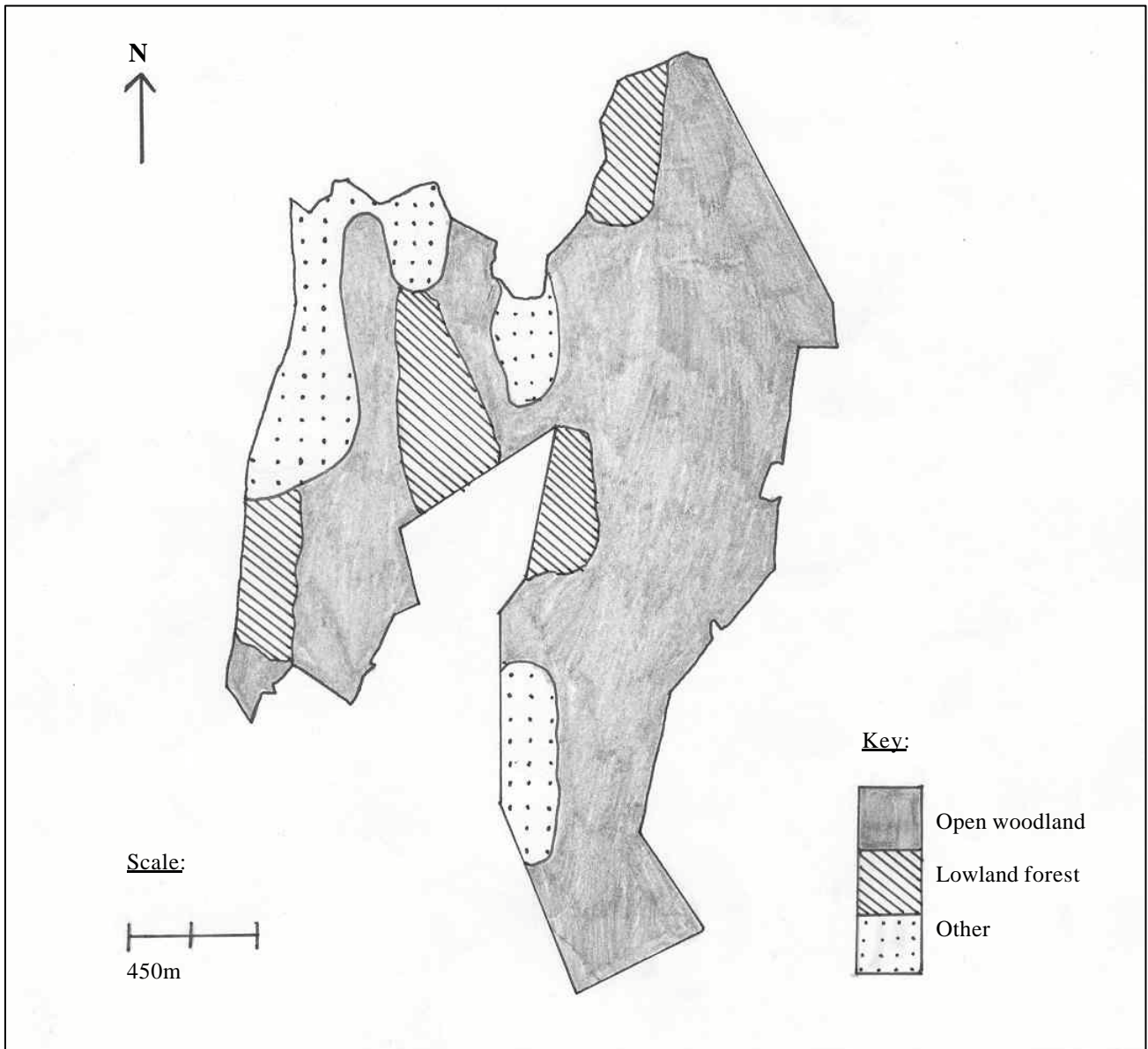


Figure 6 Sketch map of vegetation types in Mgambo FR (based on vegetation plots).

4.3.1.2 Species Abundance

The most abundant species within vegetation plots was *Combretum zeyheri* representing 9.0% of all individuals sampled. This species was present within 16 vegetation plots and was the most dominant species in 5 vegetation plots (Table 5). *Combretum zeyheri* was common at low altitudes in open woodland and lowland forest margins. *Dombeya shupangae* was ranked as the second most abundant species within vegetation plots representing 6.4% of all individuals sampled. This woodland species was found in 12 vegetation plots. All of the most abundant species are widespread in their distribution and common in woodland and lowland forest.

Table 5 Ranked abundance of tree and shrub individuals within vegetation plots.

Family	Species	Rank	Number of Individuals	% of total no. individuals	In x plots (n=31)	% of total no. plots
COMBRETACEAE	<i>Combretum zeyheri</i>	1	77	9.0	16	51.6
STERCULIACEAE	<i>Dombeya shupangae</i>	2	55	6.4	12	38.7
TILIACEAE	<i>Grewia bicolor</i>	3	41	4.8	13	41.9
LEGUMINOSAE	<i>Brachystegia spiciformis</i>	4	33	3.8	3	9.7
LEGUMINOSAE	<i>Albizia anthelmintica</i>	5	31	3.6	14	45.2
SAPOTACEAE	<i>Manilkara sulcata</i>	6	28	3.3	6	19.4
SAPINDACEAE	<i>Lecaniodiscus fraxinifolius</i>	7	27	3.1	9	29.0
BIGNONIACEAE	<i>Stereospermum kunthianum</i>	7	27	3.1	9	29.0
LEGUMINOSAE	<i>Albizia gummifera</i>	9	24	2.8	9	29.0
BORAGINACEAE	<i>Cordia ovalis</i>	10	22	2.6	9	29.0
LEGUMINOSAE	<i>Lonchocarpus bussei</i>	10	22	2.6	8	25.8
MELIACEAE	<i>Turraea holstii</i>	10	22	2.6	7	22.6
TILIACEAE	<i>Grewia microcarpa</i>	13	21	2.4	9	29.0

Combretum zeyheri and *Dombeya shupangae* were present in the greatest numbers of plots (9.0% and 6.4% of total individuals respectively) (Table 5). Both of these are woodland species that are fire tolerant.

Combretum zeyheri was also found in the most number of vegetation plots (51.6% of all plots). *Albizia anthelmintica*, *Grewia bicolor* and *Dombeya shupangae* were also found in a large proportion of the vegetation plots (45.2%, 41.6% and 38.7% respectively). These are also all woodland species.

4.3.1.4 Endemic Status

Only 4 individual specimens from 1 species recorded in vegetation plots was endemic to the Usambara Mountains, this species was *Cassia abbreviata*. There were 12 species (11.8% of total) and 97 individuals recorded as near endemic. The majority of species recorded were therefore widespread in their distribution (Table 4). Endemic and near endemic species were found in greater numbers on the western side of the reserve (Figures 7 and 8).

Table 6 Summary of endemism for tree and shrub species recorded in the 50m x 20m vegetation plots (based on Table 4).

	Number of species	% of species	Number of individuals	% of individuals
Endemic to the Usambara Mountains (E)	1	1.0	4	0.5
Near endemic (N)	12	11.8	97	11.3
Widespread (W)	81	80.2	741	86.4
Unknown (?)	7	7.0	16	1.8
Total	101	100	858	100

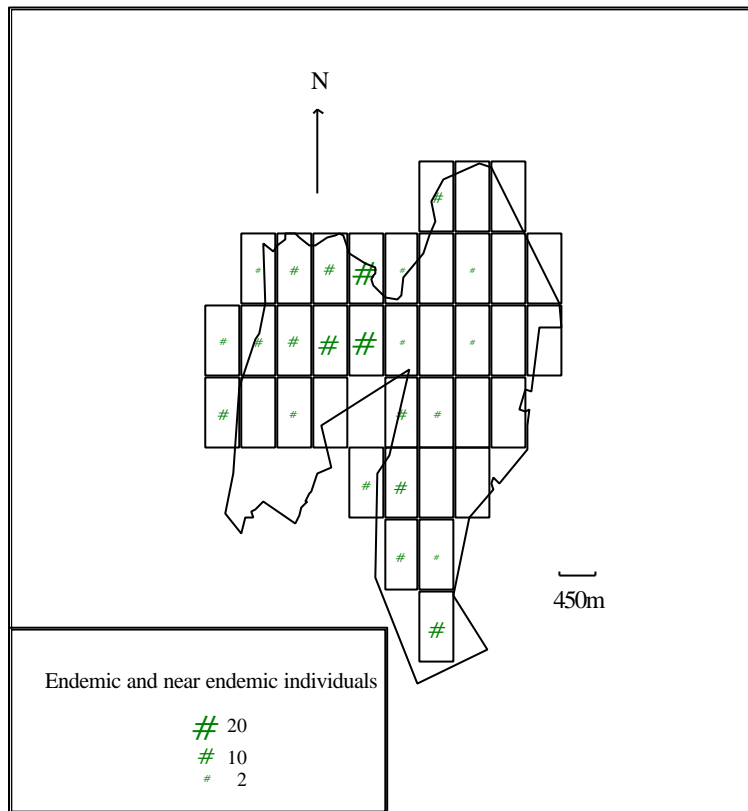


Figure 7 Distribution of endemic and near endemic tree and shrub individuals in Mgambo FR.

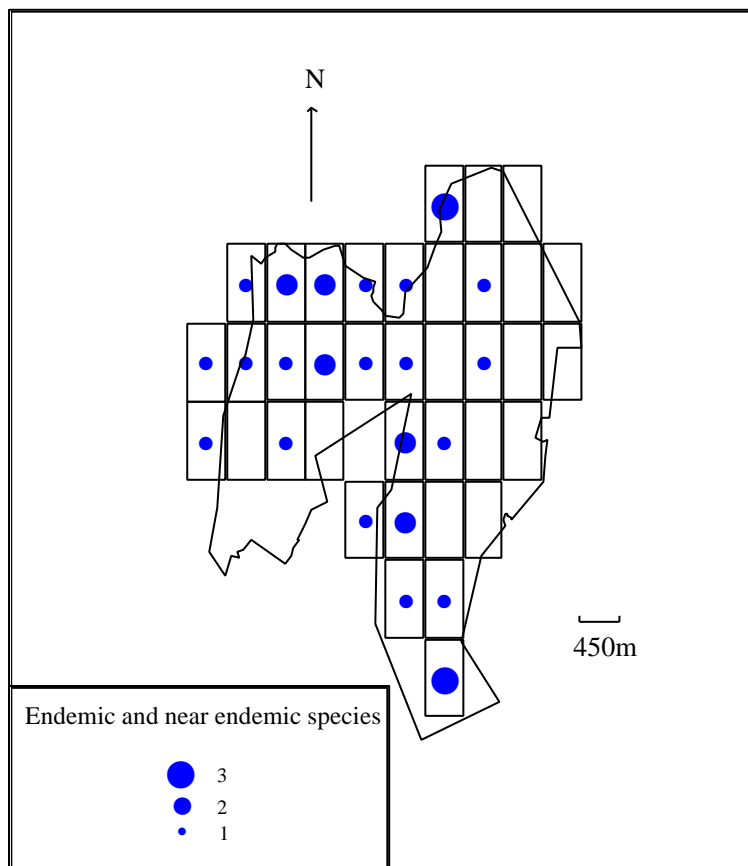


Figure 8 Distribution of endemic and near endemic tree and shrub species in Mgambo FR.

4.3.1.5 Ecological type

Just 29 individuals representing 5 species (5% of total) recorded within vegetation plots were forest dependent (Table 7). However, the majority individuals recorded were from species that were forest dwelling (Table 7). Figures 9 and 10 shows the distribution of forest dependent individuals and species. The south-western section of the reserve contained the most forest dependent species.

Non-forest individuals and species were found widely distributed throughout the forest reserve (Figures 11 and 12). This widespread distribution resulted in the majority of the forest reserve being woodland and grassland habitat and this reflects the significant disturbance pressure the forest reserve is under.

Table 7 Summary of ecological type of tree and shrub species recorded in the 50m x 20m vegetation plots (based on Table 4).

Ecological Type	Number of species	% of total species	Number of individuals	% of total individuals
Forest dependent (F)	5	5.0	29	3.4
Forest dwelling (f)	62	61.4	437	50.9
Other (O)	27	26.7	374	43.6
Unknown (?)	7	6.9	18	2.1
Total	101	100	858	100

4.3.1.6 Habitat

Flora recorded from the vegetation plots of Mgambo FR was most commonly categorised within the lowland forest habitat type. A total of 39 (38.6%) species and 363 (42.3%) individuals were categorised as lowland forest species. There were only 4 species, *Acacia mellifera*, *Acacia nilotica*, *Grewia bicolor* and *Sterculia africana*, that were categorised as sub-montane species and 1 species, *Strychnos innocua*, categorised as a montane species (Figure 13 and 14). Despite the habitat categories of these species, they were all found in woodland lowland areas. Many other species (48 in total) were categorised as combinations of lowland with submontane and/or without montane forest habitats.

Table 8 Summary of habitat type for tree and shrub species recorded in the 50m x 20m vegetation plots (based on Table 4).

Habitat	No. of species	% of total species	No. of individuals	% of total individuals
Montane (M)	1	1.0	2	0.2
Submontane & montane (S&M)	5	5.0	15	1.7
Submontane (S)	4	4.0	71	8.3
Lowland, submontane & montane (L&S&M)	18	17.8	185	21.7
Lowland & submontane (L&S)	25	24.8	201	23.4
Lowland (L)	39	38.6	365	42.5
Unknown (?)	7	6.9	19	2.2
Total	101	100	858	100

Table 9 Submontane and/or montane species and the altitudinal ranges at which they were recorded in Mgambo FR.

Family	Species	Altitudinal range (masl)
BALANITACEAE	<i>Balanites aegyptica</i>	420-505
FLACOURTIACEAE	<i>Caloncoba welwitschii</i>	505
LEGUMINOSAE	<i>Acacia mellifera</i>	400
LEGUMINOSAE	<i>Acacia nilotica</i>	510
LEGUMINOSAE	<i>Milletia dura</i>	540-570
LOGANIACEAE	<i>Strychnos innocua</i>	360-430
SAPINDACEAE	<i>Allophylus melliodorus</i>	480

SAPINDACEAE	<i>Deinbollia kilimandscharica</i>	530
STERCULIACEAE	<i>Sterculia africana</i>	505-520
TILIACEAE	<i>Grewia bicolor</i>	400-800

Altitude (masl): metres above sea level
Bold Type: Montane Forest species

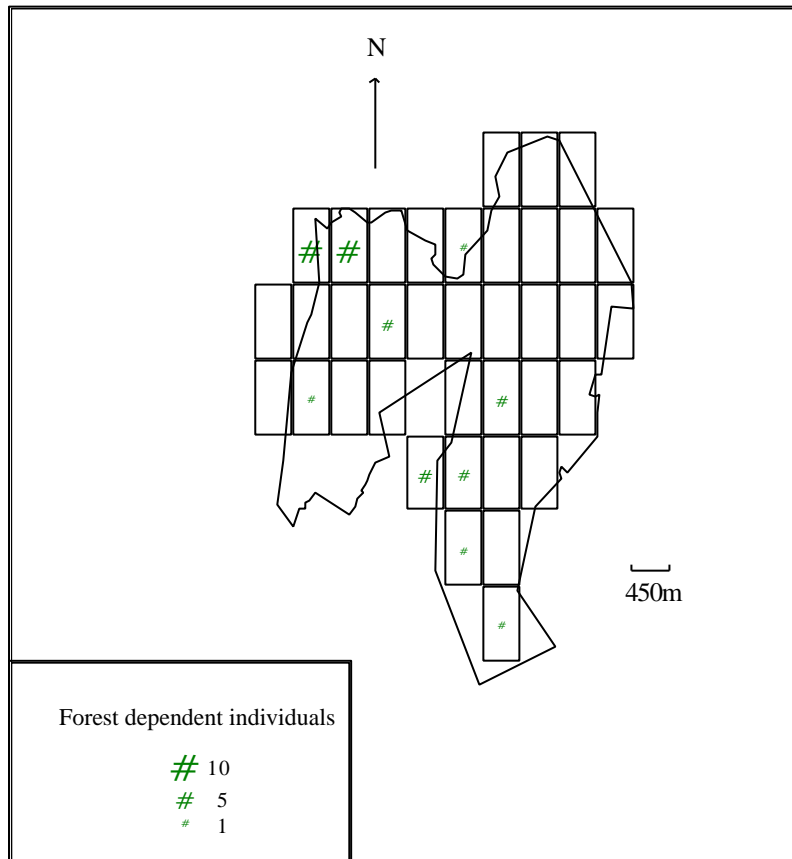


Figure 9 Distribution of forest dependent tree and shrub individuals in Mgambo FR.

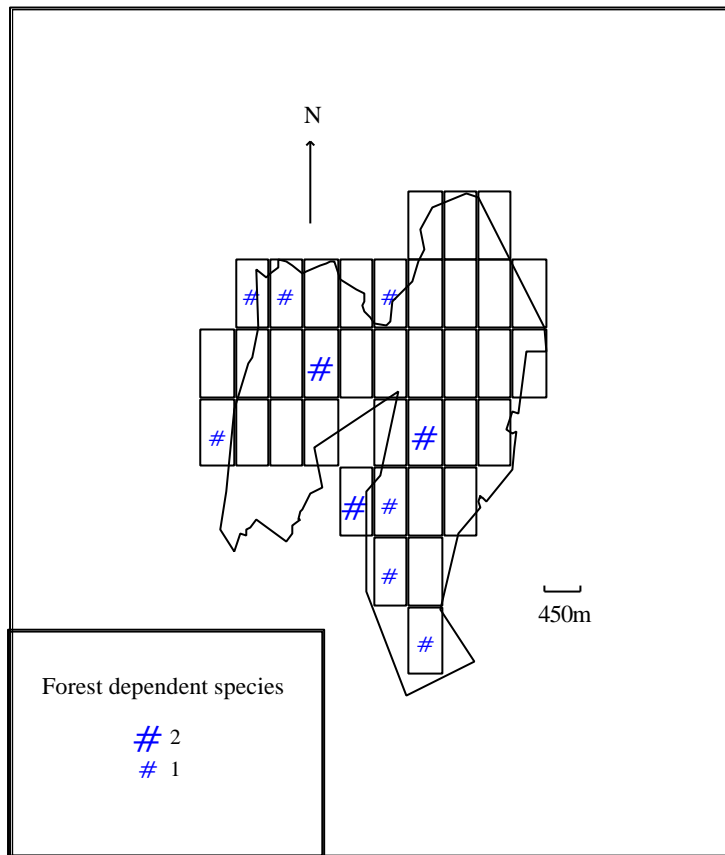


Figure 10 Distribution of forest dependent tree and shrub species in Mgambo FR.

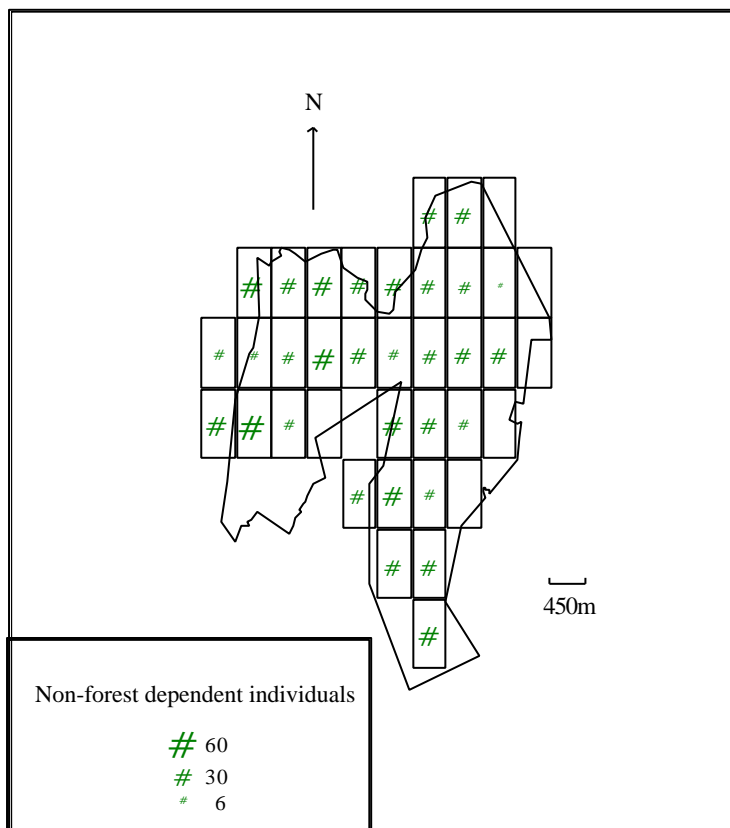


Figure 11 Distribution of non-forest dependent tree and shrub individuals in Mgambo FR.

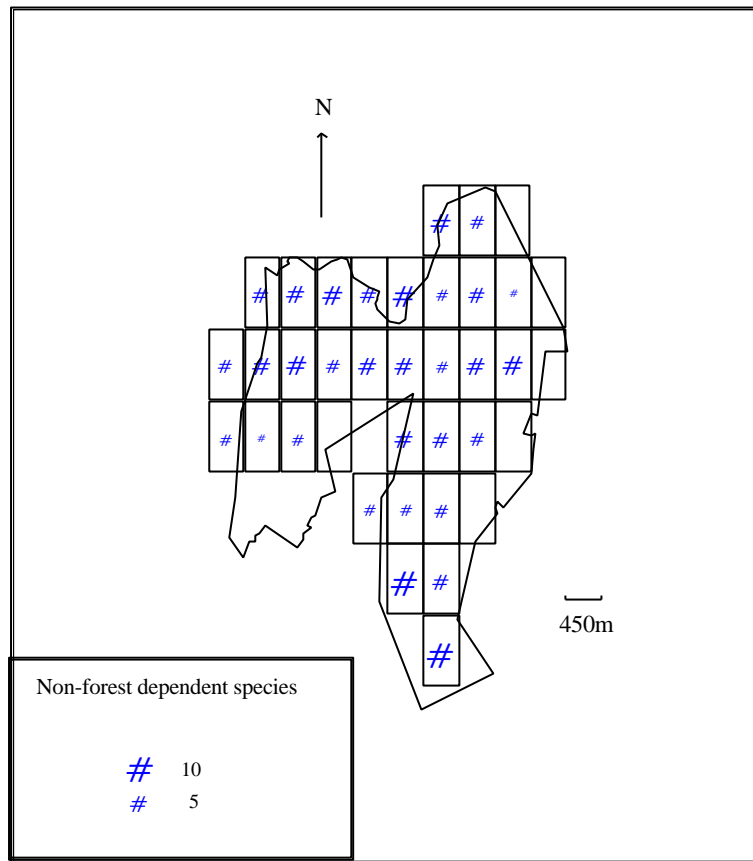


Figure 12 Distribution of non-forest tree and shrub species in Mgambo FR.

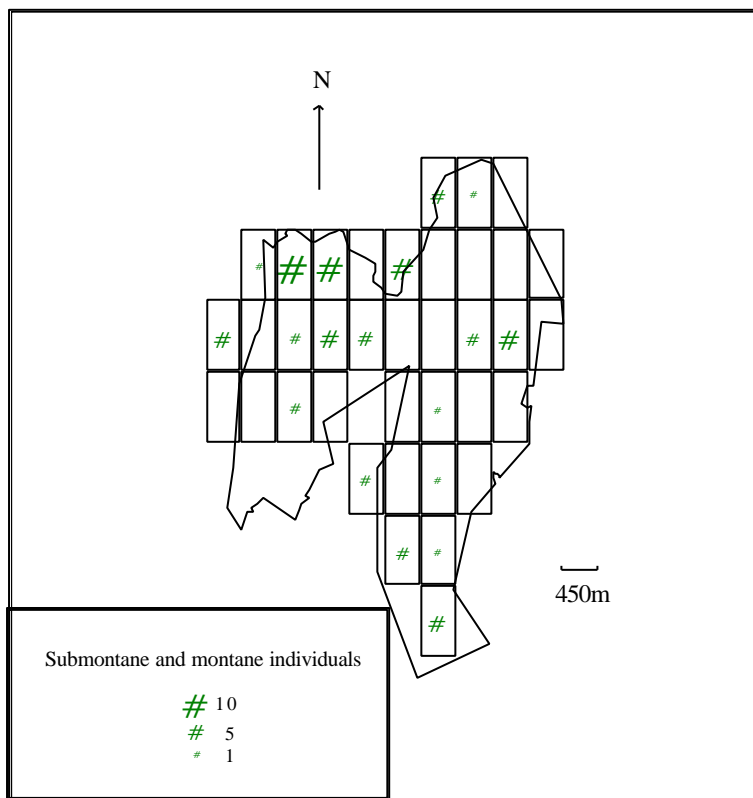


Figure 13 Distribution of submontane and montane tree and shrub individuals in Mgambo FR.

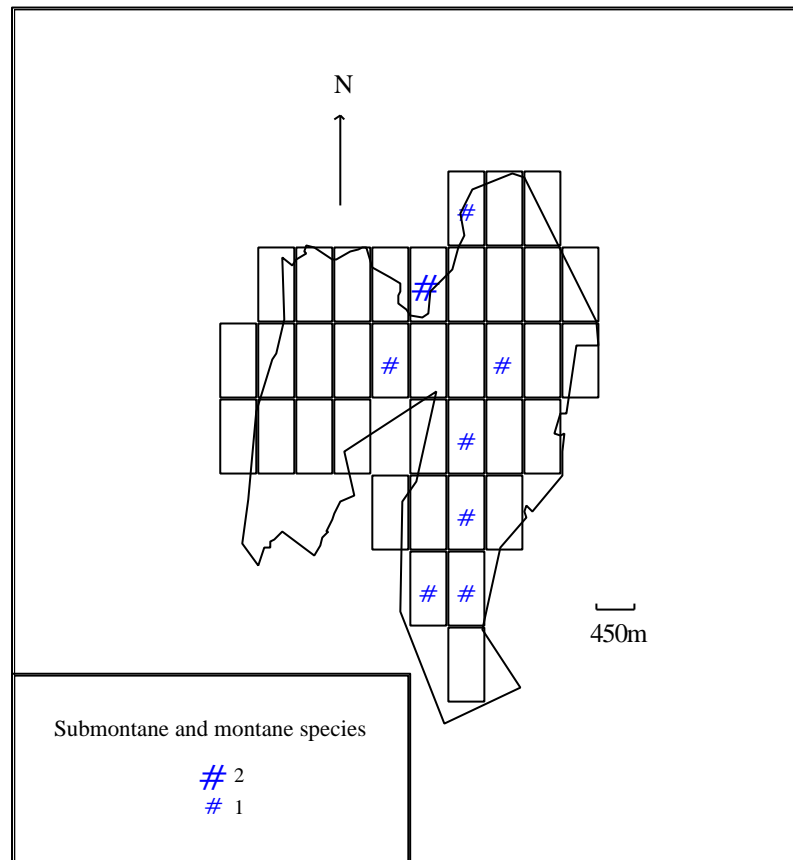


Figure 14 Distribution of submontane and montane tree and shrub species in Mgambo FR.

4.3.1.7 Range extensions

In 1986 and 1987, botanical surveys were conducted in a number of reserves in the East Usambara Mountains (Ruffo et al. 1989). 33 species recorded in vegetation plots in Mgambo FR were also recorded by Ruffo et al. (1989) within these surveys. The remaining 71 species were not recorded at all by Ruffo et al. (1989). Table 10 lists those species not previously recorded by Ruffo et al (1989).

Despite more than seven years systematic and opportunistic vegetation survey work by the EUBS team throughout the majority of the East Usambara Forest Reserves, 8 new species were found in the vegetation plots in Mgambo FR that were new to the East Usambara Biodiversity Database. These species are listed in Table 11 and Appendix 4.

Table 10 Tree and shrub species found within Mgambo FR not listed by Ruffo *et al.*, 1989.

Species	Species
ANACARDIACEAE <i>Lannea schweinfurthii</i> <i>Lannea schweinfurthii</i> var. <i>stuhlmannii</i> <i>Ozoroa insignis</i> <i>Sclerocarya birrea</i>	LEGUMINOSAE subfamily: MIMOSOIDEAE cont. <i>Acacia nilotica</i> <i>Acacia polyacantha</i> <i>Albizia anthelmintica</i> <i>Albizia versicolor</i>
ANNONACEAE <i>Asteranthe asterias</i> <i>Annona senegalensis</i>	<i>Dichrostachys cinerea</i> <i>Julbernardia globiflora</i> <i>Tamarindus indica</i>
ARALIACEAE <i>Cussonia arborea</i>	LEGUMINOSAE subfamily: PAPILIONOIDEAE <i>Dalbergia melanoxylon</i>
BALANITACEAE <i>Balanites aegyptica</i>	<i>Erythrina abycaffra</i> <i>Xeroderris stuhlmannii</i>
BIGNONIACEAE <i>Stereospermum kunthianum</i>	LOGANIACEAE <i>Strychnos innocua</i>
BORAGINACEAE <i>Cordia ovalis</i> <i>Ehretia amoena</i>	<i>Strychnos spinosa</i> MELIACEAE <i>Trichilia emetica</i>
BURSERACEAE <i>Commiphora africana</i> <i>Maerua kirkii</i>	MORACEAE <i>Artocarpus heterophyllus</i> <i>Ficus ottoniifolia</i>
CELASTRACEAE <i>Mystroxydon aethiopicum</i>	OLACACEAE <i>Ximemia americana</i>
COMBRETACEAE <i>Combretum exalatum</i> <i>Combretum molle</i> <i>Combretum zeyheri</i> <i>Pteleopsis myrtifolia</i> <i>Terminalia prunioides</i>	RUBIACEAE <i>Canthium mombazense</i> <i>Rutidea fuscenscens</i> <i>Vangueria tomentosa</i>
COMPOSITAE <i>Brachylaena huillensis</i>	RUTACEAE <i>Vepris amaniensis</i> <i>Vepris trichocarpa</i>
EBENACEAE <i>Euclea natalensis</i>	SAPINDACEAE <i>Allophylus calophyllus</i> <i>Allophylus ferrugineus</i>
EUPHORBIACEAE <i>Bridelia cathartica</i> <i>Euphorbia candelabrum</i> <i>Spirostachys africana</i>	<i>Deinbollia kilimandscharica</i> <i>Haplocoelum inopleum</i> <i>Haplocoelum foliolosum</i>
FLACOURTIACEAE <i>Dovyalis hispidula</i>	SAPOTACEAE <i>Manilkara sulcata</i>
LEGUMINOSAE subfamily: CAESALPINOIDEAE <i>Brachystegia spiciformis</i> <i>Cassia abbreviata</i> <i>Piliostigma thonningii</i>	STERCULIACEAE <i>Dombeya kirkii</i> <i>Sterculia africana</i>
LEGUMINOSAE subfamily: MIMOSOIDEAE <i>Acacia hockii</i> <i>Acacia mellifera</i>	TILIACEAE <i>Grewia bicolor</i> <i>Grewia goetzeana</i> <i>Grewia microcarpa</i>

Table 11 Tree and shrub species found in Mgambo FR but new to the East Usambara Plant Biodiversity Database (Pohjonen, 2001).

Species	
ANACARDIACEAE <i>Lannea schweinfurthii</i> var. <i>stuhlmannii</i>	FLACOURTIACEAE <i>Dovyalis hispidula</i>
<i>Ozoroa insignis</i>	LEGUMINOSAE <i>Cassia abbreviata</i>
<i>Sclerocarya birrea</i>	<i>Erythrina abyssinica</i>
COMBRETACEAE <i>Combretum exelatum</i>	
EUPHORBIACEAE <i>Spirostachys africana</i>	

4.3.1.8 Timber species

Small scale extraction of timber for local and commercial use over the years within most East Usambara forest reserves is suspected to have been significant. The most commonly extracted trees within Tanzania (Ruffo, 1989) are listed in Table 12 to present an indication of the remaining populations of these species within Mgambo FR.

A total of five tree species recorded within the vegetation plots were listed by Ruffo (1989) as useful for timber or plywood use. Four of these species (34 individuals) were recorded as 'timber only' (species that are regarded by the Forestry Division as timber trees, although may not necessarily have been used in the East Usambaras) and one species (2 individuals) were listed as 'plywood only' (information based on Sikh Saw Mills (T) Ltd of Tanga).

Table 12 The abundance of selected timber and plywood species.

Family	Species	Ruffo, (1989) category	No. of Individuals	Present in n plots
COMBRETACEAE	<i>Combretum schumannii</i> .	Timber only	6	2
COMBRETACEAE	<i>Terminalia sambesiaca</i>	Timber only	3	2
LEGUMINOSAE	<i>Albizia gummifera</i>	Timber only	24	9
MORACEAE	<i>Milicia excelsa</i>	Timber only	1	1
BOMBACEAE	<i>Rhodognaphalon schumannianum</i>	Plywood only	2	2
Total			36	16

Bold Type – species that are listed by Ruffo (1989) as one of four preferred species utilised by pitsawyers.

Timber only – regarded as timber trees by the Forestry Division but have not necessarily been used in the East Usambaras.

Plywood only and Plywood & Timber – lists of species provided by Sikh Saw Mills (T) Ltd of Tanga.

Appendices 5 and 6 provide further lists of useful plant species found within Mgambo FR (including fuelwood, building poles and medicinal plants).

4.3.1.10 Regeneration

An additional five species were recorded solely in the regeneration layer within the 3 x 3m sample plots. None of these species was classified as forest dependent, although most were forest dwelling (Table 13).

Only two species, *Cola clavata* and *Ochna* sp. were previously recorded in the survey by Ruffo *et al.* (1989). All of the species are present in the East Usambara Plant Biodiversity Database (Pohjonen, 2001). *Cola clavata* is also listed as a useful species for providing building poles (Ruffo, 1989).

Herbaceous vegetation dominated the ground layer in plots, with grasses predominant. Soils were a mixture of loamy clay, sandy clay, sandy loam. Regeneration, in general was poor with an

average of 2.1 species regenerating within each 3 x 3m plot. A more detailed summary of regeneration plot information is shown in Appendix 7.

Table 13 Species recorded exclusively in the regeneration layer.

	Ecol. Type	Habitat	Endemic Status
APOCYNACEAE			
<i>Carissa tetramera</i>	f	?	W
CAPPARIDACEAE			
<i>Boscia salicifolia</i>	O	?	W
CELASTRACEAE			
<i>Maytenus hetelophylla.</i>	f	?	W
OCHNACEAE			
<i>Ochna sp.</i>	?	?	?
STERCULIACEAE			
<i>Cola clavata</i>	?	?	?

KEY TO ABBREVIATIONS FOR TABLE 13

Ecological type: (based on Iversen, 1991b)

- F - Forest dependent species: Species previously recorded as restricted to primary or closed canopy forest only, e.g. wet evergreen forest, dry evergreen forest and/or riverine forest;
- f - Forest dwelling but not forest dependent: Species previously recorded in primary or closed canopy forest as defined above and/or in forest edge, clearings, secondary forest, deciduous forest and woodland, and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge (e.g. species that have been recorded in bushland, heathland, thicket, secondary scrub, grassland, rocky outcrops, swamps, wastelands and cultivation).

Habitat: (based on Hamilton, 1989)

- L - Lowland: Species occurring at altitudes less than 850m above sea level;
- S - Submontane: Species occurring at altitudes greater than 850m above sea level.
- M - Montane Species occurring at altitudes greater than 1,250m above sea level.

If species occur in more than one habitat range, this has been recorded (e.g. L&S – this species has been recorded at altitudes between 0 and 850m above sea level).

Endemic status: (based on Iversen, 1991b):

- E - Endemic: Occurring only in the Usambara mountains, EU - Range limited to the East Usambara Mountains, WU - Range limited to the West Usambara Mountains;
- N - Near endemic: Species with limited ranges in the Eastern Arc mountains and/or the East African lowland forests;
- W - Widespread distribution.

4.3.1.12 Opportunistic plant collection and observation

A total of 34 species of dicotyledons were opportunistically recorded within Mgambo FR. These represented 22 families. An additional one near endemic and one forest dependent species were recorded during opportunistic collection.

Eight species from the opportunistic checklist (Table 14) are new species records for the East Usambara Biodiversity Database. These species are summarised in Appendix 4.

Table 14 Checklist of opportunistic plant collection and observation

Species	Lifeform	Ecol. Type	Habitat	Endemic Status
Angiospermae – Dicotyledonae				
ACANTHACEAE				
<i>Acanthaspermum hispidum</i> DC	Herb	?	?	?
ASCELEPIDACEAE				
<i>Secamore</i> sp.	Climber	?	?	?
BORAGINACEAE				
<i>Cordia goetzei</i> Guerke (basonym <i>Gerascanthus goetzei</i> (Guerke) A. Borhidi)	Shrub	f	L&S&M ¹	W ¹
CAPPARIDACEAE				
<i>Maerua triphylla</i> A. Rich	Shrub	f	L&S	W
CELASTRACEAE				
<i>Mystroxyloa aethiopicum</i> (Thunb.) Loes	Shrub	f	L&S&M ¹	W ¹
COMBRETACEAE				
<i>Combretum zeyheri</i> Sond	Tree	O	L&S&M ¹	W ¹
EBENACEAE				
<i>Diospyros squarrosa</i> Klotzsch	Shrub	f	L&S&M	W
EUPHORBIACEAE				
<i>Acalypha psilostachya</i> Hochst	Herb	?	S&M ¹	W ¹
<i>Bridelia cathartica</i> Bertol. f 1854	Shrub	O	L&S&M ¹	W
FLACOURTIACEAE				
<i>Dovyalis hispidula</i> Wild.	Shrub	f	L	W
ICACINACEAE				
<i>Pyranacantha</i> sp.	Climber	?	?	?
LABIATAE				
<i>Becium kirkii</i> Bak	Shrub	?	?	?
<i>Orthosiphon rubicondus</i> (D.Don) Benth	Herb	?	M ¹	W ¹
<i>Tinneo aethiopica</i> Kotschy ex. Hook.f.	Shrub	?	?	?
LEGUMINOSAE: MIMOSACEAE				
<i>Acacia polyacantha</i> Willd.	Tree	f	L&S	W
LOGANIACEAE				
<i>Strychnos henningsii</i> Gilg	Tree	f	L&S&M ¹	W ¹
MELIACEAE				
<i>Turraea holstii</i> Guerke 1894	Tree	F	S&M ¹	W
MORACEAE				
<i>Dorstenia tayloriana</i> Rendle 1915	Herb	?	L ¹	W ¹
<i>Ficus cyathistipula</i> Warb	Tree		L&S&M ¹	W ¹
<i>Ficus ottoniifolia</i> (Mildbr. & Burret) C.C.Berg	Tree	f	L	N
OLACACEAE				
<i>Ximenia caffra</i> Sond.	Tree	f	L&S&M	W
RHAMNACEAE				
<i>Ziziphus mucronata</i> Willd. 1809	Shrub	f	L&S&M ²	W
ROSACEAE				
<i>Abrus schimperi</i> Bak	Climber	?	?	?
RUBIACEAE				
<i>Canthium mombazense</i> Baill 1878	Shrub	f	L&S	W
<i>Heinsia crinita</i> (Afzel) G. Taylor 1944	Shrub		L	W
<i>Pavetta crebrifolia</i> Hiern	Shrub		L&S&M ¹	W ¹
<i>Polysphaeria lanceolata</i> Hiern	Shrub		L&S ¹	W
<i>Psychotria ambonia</i> K. Schum 1894	Shrub	?	?	?
<i>Psychotria lauracea</i> (K. Schum) E. Petit 1964	Shrub		L	?
<i>Rutidea fuscenscens</i> Hiern	Shrub	f	L	W
TILIACEAE				
<i>Triumfetta rhomboidea</i> Jacq.	Shrub	f	L&S&M ¹	W
VERBENACEAE				
<i>Lantana trifolia</i> L.	Shrub	f ¹	L&S&M ¹	W ¹
VITACEAE				
<i>Cissus quadrangularis</i> L.	Climber	f	L&S	W
<i>Rhoicissus revoli</i> Planch 1887	Climber	O	L&S&M ¹	W ¹

¹ Information is based on FTEA

² Information is based on LEAP (Knox, 2000)

KEY TO ABBREVIATIONS FOR TABLE 14

Ecological type: (based on Iversen, 1991b)

- F - Forest dependent species: Species previously recorded as restricted to primary or closed canopy forest only, e.g. wet evergreen forest, dry evergreen forest and/or riverine forest;
- f - Forest dwelling but not forest dependent: Species previously recorded in primary or closed canopy forest as defined above and/or in forest edge, clearings, secondary forest, deciduous forest and woodland, and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge (e.g. species that have been recorded in bushland, heathland, thicket, secondary scrub, grassland, rocky outcrops, swamps, wastelands and cultivation).

Habitat: (based on Hamilton, 1989)

- L - Lowland: Species occurring at altitudes less than 850m above sea level;
- S - Submontane: Species occurring at altitudes greater than 850m above sea level.
- M - Montane Species occurring at altitudes greater than 1,250m above sea level.

If species occur in more than one habitat range, this has been recorded (e.g. L&S – this species has been recorded at altitudes between 0 and 850m above sea level).

Endemic status: (based on Iversen, 1991b):

- E - Endemic: Occurring only in the Usambara mountains, EU - Range limited to the East Usambara Mountains, WU - Range limited to the West Usambara Mountains;
- N - Near endemic: Species with limited ranges in the Eastern Arc mountains and/or the East African lowland forests;
- W - Widespread distribution.

4.3.2 Disturbance transects

A total area of 13.635 ha was assessed for signs of disturbance. Disturbance categories were recorded for all 50m sections along each transect line. Every self standing tree (not creepers or lianas) above 5cm diameter at breast height (dbh) was measured within a distance of 5m either side of each transect line. Each plant was recorded under one of four categories: live, old cut, new cut or naturally fallen. Old cut was identified by darkening and rotting of a cut stump, and was assumed to have been cut more than 6 months prior to sampling. New cut was identified by fresh cream or green cut stumps and assumed to have been cut less than six months prior to sampling. Within these categories a distinction was made between poles and timbers. Poles were classified as having a dbh between 5 and 15cm and a minimum 3m relatively straight trunk. Timber was classified as having a dbh greater than 15cm with a minimum of 3m relatively straight trunk. These divisions are based on differences in use. Timber and pole cutting data are presented as an average per hectare.

All other forms of anthropogenic disturbance within a distance of 5m either side of each transect were also recorded for every 50m section.

Other forms of disturbance were defined as follows:

Fire damage - an area affected by fire, evidence included burnt trees and ground vegetation.

Pitsaw site - an area cleared for pitsaw activities, with pitsaw platform, or remains of such.

Timber/planks/poles - cut wood on ground abandoned or ready for transportation.

Trapping - animal traps of all varieties whether set or sprung or unused.

Cultivation - evidence of crop cultivation (past or present).

Grazing - direct evidence or remains of cattle grazing.

Roads/tracks - including all human used footpaths.

Old Settlement - well-established clearings as a consequence of past human settlement.

The topography of Mgambo FR was generally not difficult and, consequently, only one 50m section was found to be inaccessible. A total of 10949 live stems were sampled throughout the reserve, giving a mean total of 613.7 poles per hectare and 189.3 timbers per hectare, 76% and 24% respectively.

4.3.2.1 Pole and Timber extraction

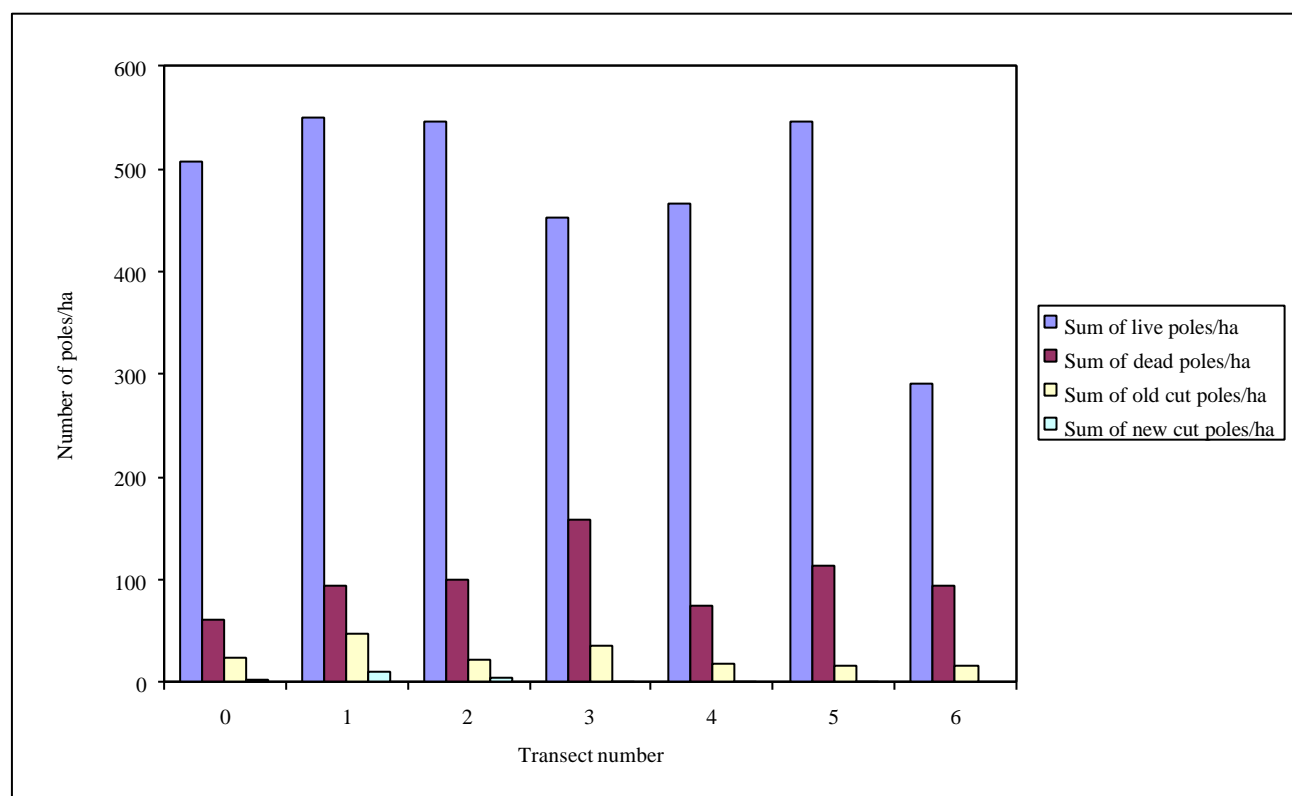
Pole and timber extraction was found along all seven transects, however, new extraction was only observed at a low intensity within the reserve.

Rates of pole extraction are summarised in Table 15 and Figures 11 and 13. An average total of 3359 poles per hectare were alive, 695 dead and 198 cut, representing 79%, 17% and 4% of all poles sampled respectively (Table 15). None of the transects had a significantly higher rate of extraction than the others. (Figure 11). A significant proportion of the poles sampled were dead, particularly along transects 0 and 1 (Figure 13). Live poles were least abundant along transect 6 with 291 poles per hectare compared with all of the other transects with figures over 450 poles per hectare. (Table 15 and Figure 11).

Pole cutting was most intensive along reserve border areas (Figure 15). A high level of extraction was observed within proximity to Daluni and Bwiti villages to the south of both halves of the reserve (see Figure 3 for positioning of villages).

Table 15 Disturbance transect results showing total pole counts and average pole counts per hectare.

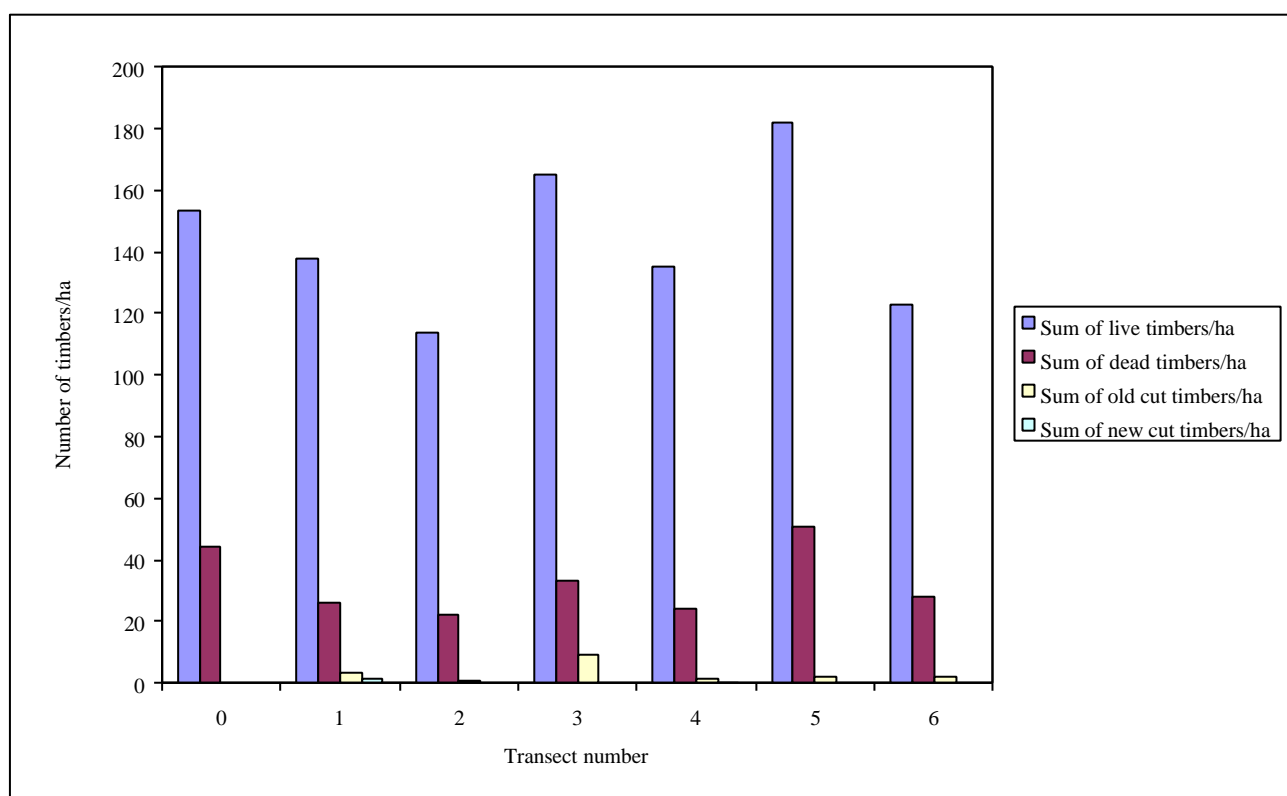
Transect number	Transect length (m)	Total no. poles sampled	Live Poles	Average Live Poles/ha	Dead Poles	Average Dead Poles/ha	Old Cut Poles	Old Cut Poles /ha	New Cut Poles	New Cut Poles /ha
0	450	267	228	507	27	60	11	24	1	2
1	850	596	467	549	80	94	40	47	9	11
2	1200	807	656	547	120	100	26	22	5	4
3	2535	1639	1146	452	402	159	90	36	1	0
4	3550	1987	1655	466	265	75	63	18	4	1
5	3800	2572	2077	547	428	113	63	17	4	1
6	1250	500	364	291	117	94	19	15	0	0
Total	13635	8368	6593	3359	1439	695	312	179	24	19

**Figure 11** The relative abundance of live, dead and cut poles in Mgambo FR.

Rates of timber extraction are summarised in Table 16 and Figures 12 and 14. A total of 1011 timbers per hectare were alive, 229 dead and 21 cut, representing 80%, 18% and 2% of all timbers sampled respectively (Table 16). Transect 3 showed greatest evidence of timber cutting with 9 cut timbers per hectare representing 5% of all timber sampled along this transect line. (Table 16 and Figure 12). The incidence of live and dead timbers was fairly evenly distributed through the reserve with no particular transects showing significantly higher concentrations of timbers than others. (Table 16 and Figure 14). As with pole-extraction, the highest levels of timber extraction was found to be within proximity of Daluni and Bwiti villages (see Figure 16, and refer to Figure 3 for positioning of villages).

Table 16 Disturbance transect results showing total timber counts and average timber counts per hectare.

Transect number	Transect length (m)	Total no. timber sampled	Live Timbers	Live Timbers/ha	Dead Timbers	Dead Timbers/ha	Old Cut Timbers	Old Cut Timbers /ha	New Cut Timbers	New Cut Poles /ha
0	450	89	69	153	20	44	0	0	0	0
1	850	143	117	138	22	26	3	4	1	1
2	1200	165	137	114	27	23	1	1	0	0
3	2535	527	419	165	84	33	24	9	0	0
4	3550	571	480	135	85	24	5	1	1	0
5	3800	894	692	182	194	51	8	2	0	0
6	1250	192	154	123	35	28	3	2	0	0
Total	136350	2581	2068	1011	467	229	44	20	2	1

**Figure 12** The relative abundance of live, dead and cut timbers in Mgambo FR.

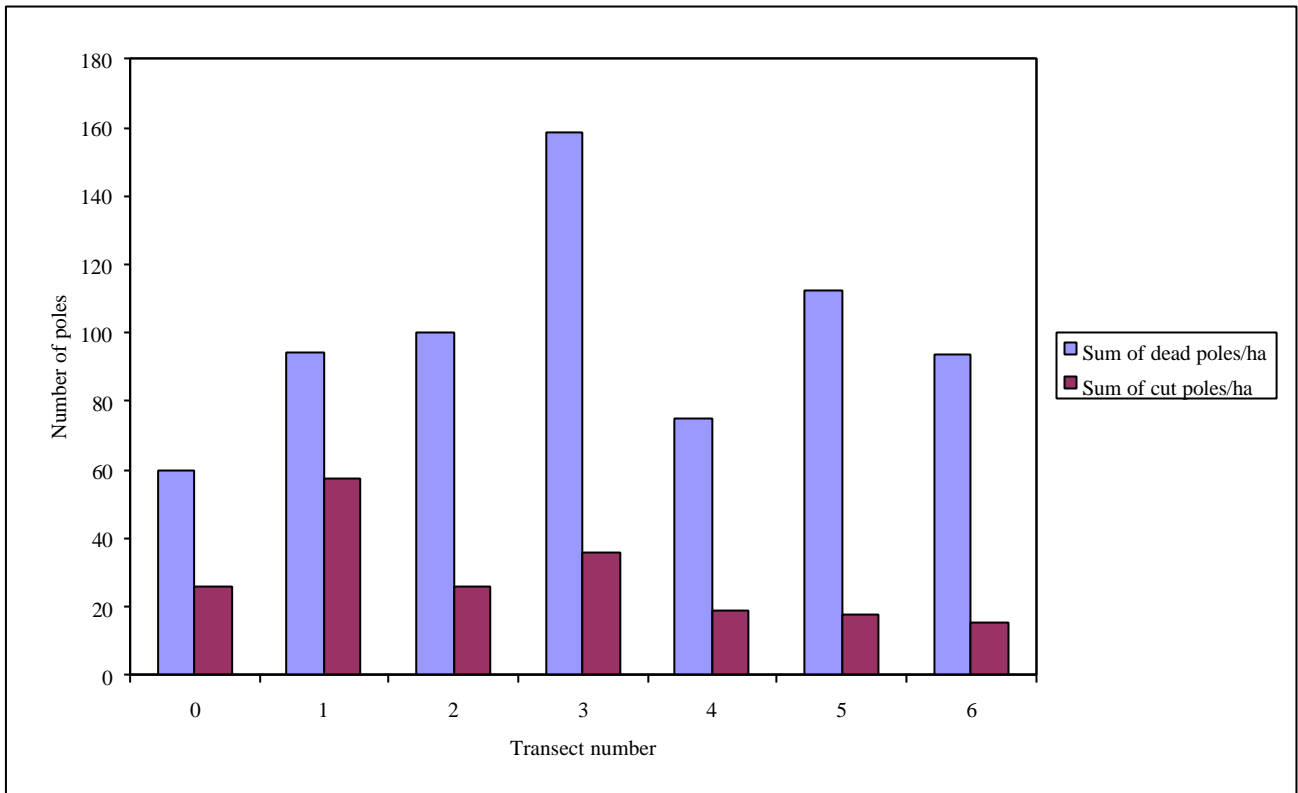


Figure 13 Comparison of cut poles to dead poles per hectare in Mgambo FR.

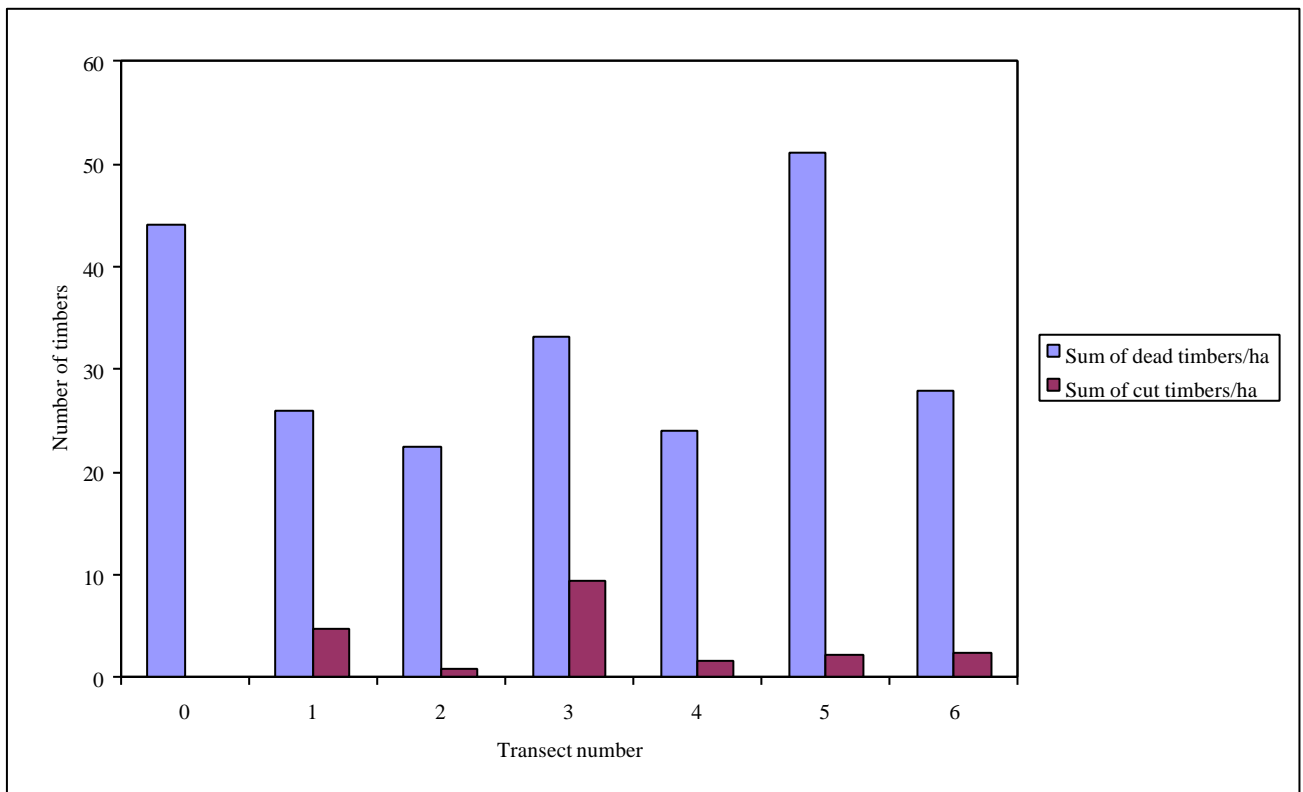


Figure 14 Comparison of cut timbers to dead timbers per hectare in Mgambo FR.

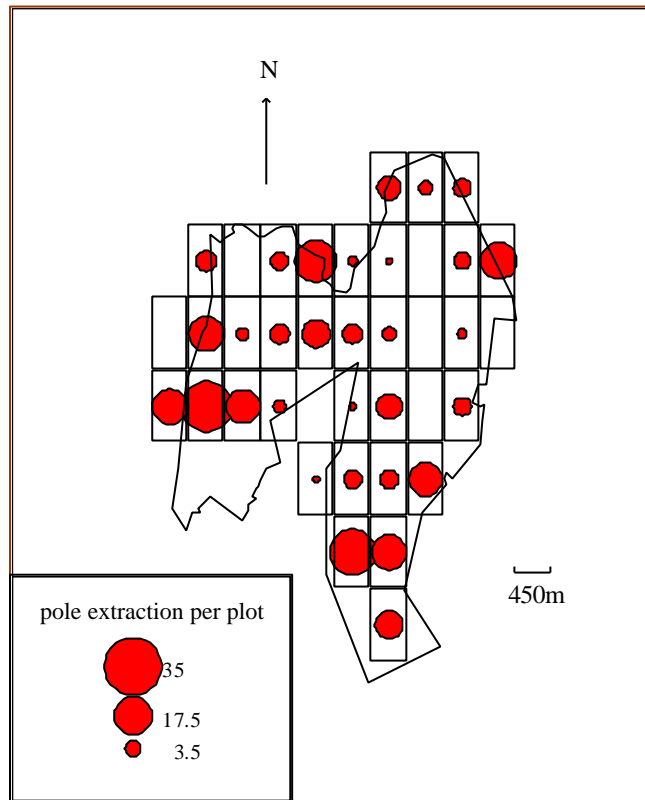


Figure 15 Actual pole extraction values per transect length along plot in Mgambo FR.

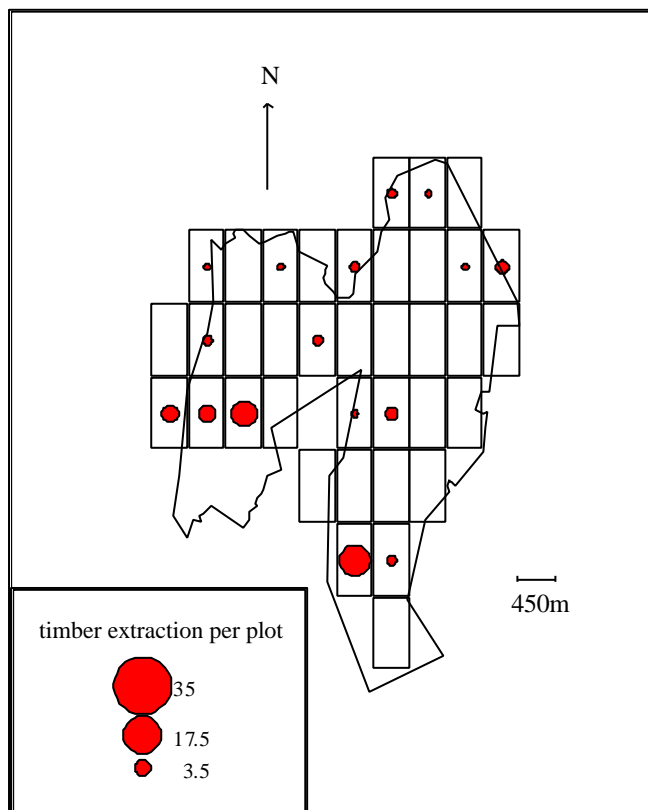


Figure 16 Actual timber extraction values per transect length along plot in Mgambo FR.

4.3.2.2 Other signs of disturbance

Fire

The most common form of disturbance was fire disturbance, present within 62% of all 50 metre sections sampled (Table 17). Deliberate fires, started to create grazing land, represent the most significant threat to Mgambo FR. Fire incidence was most intense in the eastern side of the reserve, although was common throughout (Figure 17). A large burnt area was in grid sections 6, 10 and 11, which had been burnt around October 2001.

Grazing

Grazing pressure on Mgambo FR was very evident throughout the survey period. A total of 23% of all 50 metre sections sampled contained signs of grazing, and animals and herdsman were sighted on a number of occasions. (Figure 18).

Footpaths

There were some well-used livestock and human paths within the reserve, and so this form of disturbance ranked third within Mgambo FR.

Pitsawing

There was evidence of three fairly recent pitsawing sites and one old site. Two of the recent sites were close together near to the western border of transect 3, not far from Daluni village. The other recent site was at the zoological trap site 3, close to the path heading north towards Mgambo village. Two piles of old cut poles were seen along transect 5 and one pile along transect 4 close to human paths. (Table 17)

Trapping

Only two animal traps were seen (Table 17). These were set up with a brush-fence corridor probably to catch small duiker. One trap was sprung and contained a live Banded Mongoose (*Mungos mungo*) which was later released. Both traps were found close to Mgambo village along transect 6.

Table 17 The incidence of various types of disturbance shown as percentage and rank (calculated as presence (1) or absence (0) every 50m transect section)

	Fire	Grazing	Paths	Pitsawing	Trapping	Planks/Poles
Incidence Tally	170	64	17	2	2	2
Percentage (%)	62	23	6	<0.1	<0.1	<0.1
Rank	1	2	3	4	4	4

DEFINITIONS FOR TABLE 17

Fire refers to an area affected by fire, evidence including burnt trees and ground flora.

Grazing refers to cattle or goat grazing.

Paths refer to all human used footpaths.

Pitsaw refers to any site with the remains of pitsaw activity past or present.

Trapping refers to any form of animal trapping.

Planks/Poles refers to cut timber and poles laying on the ground ready for transportation.

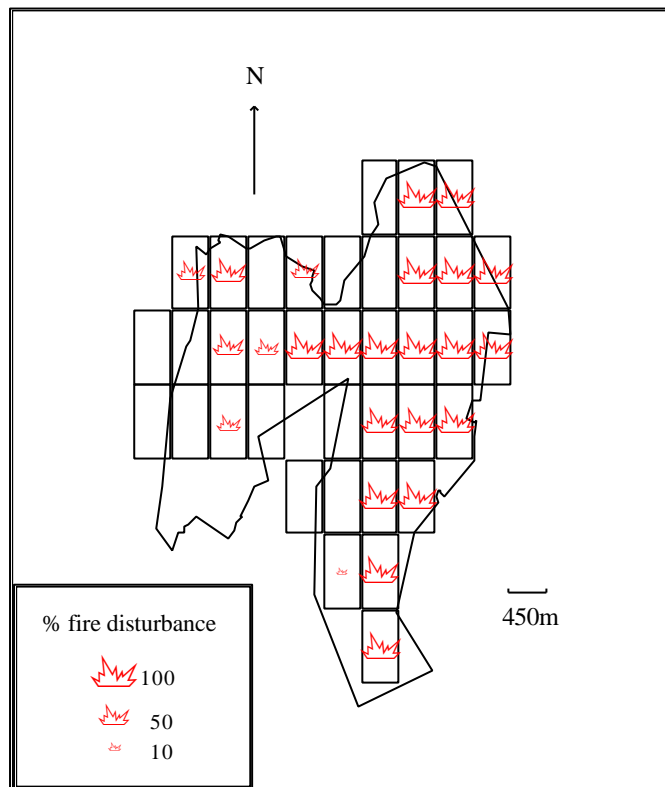


Figure 17 Incidence of fire as percentage of sections evidence was found in, for Mgambo FR.

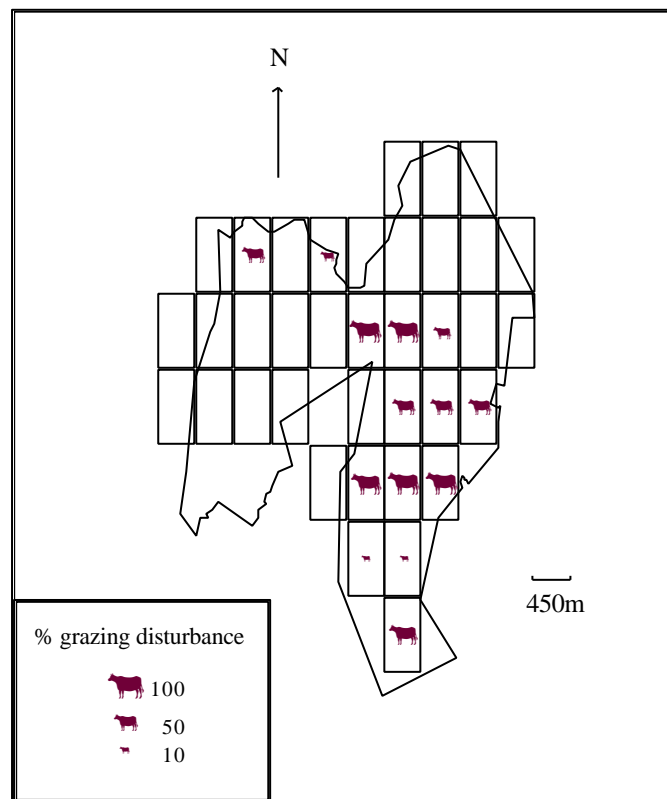


Figure 18 Incidence of grazing as percentage of sections evidence was found in, for Mgambo FR.

4.3.2.3 Areas of greatest disturbance

The most disturbed areas within Mgambo were located on the eastern half of the reserve. These areas were grids that contained evidence of fire and grazing within each 50m transect section. Some endemic, near endemic and forest dependent vegetation was in these most disturbed grid areas; most notably, grid 26 to the far south of the reserve where *Cassia abbreviata* (endemic), *Dombeya shupangae* (near endemic) and *zanthoxylum deremense* (near endemic and forest dependant). (Figures 19 and 20).

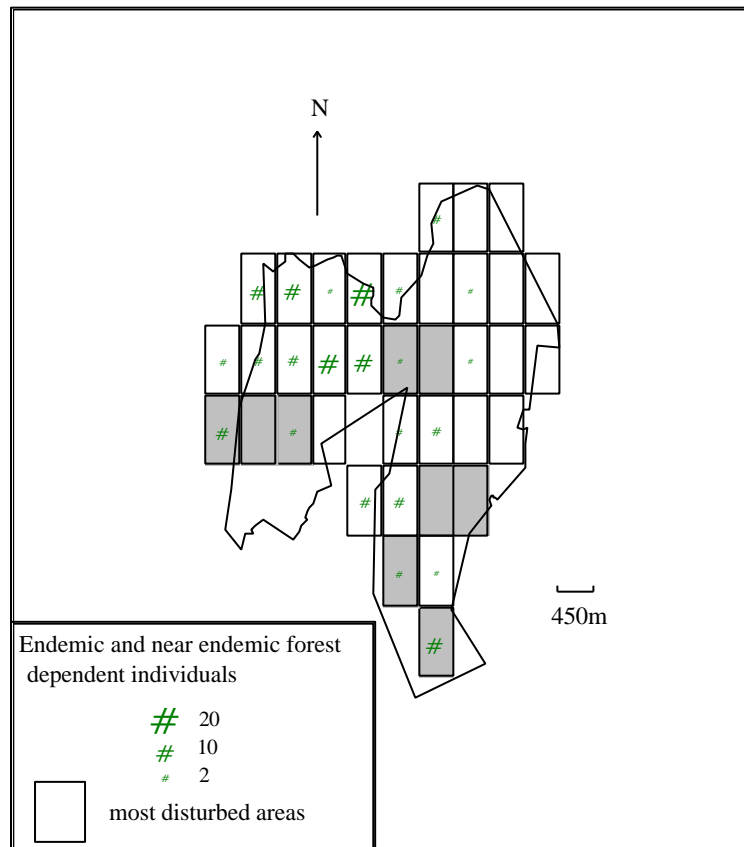


Figure 19 Distribution of forest dependent, endemic and near endemic tree and shrub individuals in relation to areas of highest disturbance in Mgambo FR.

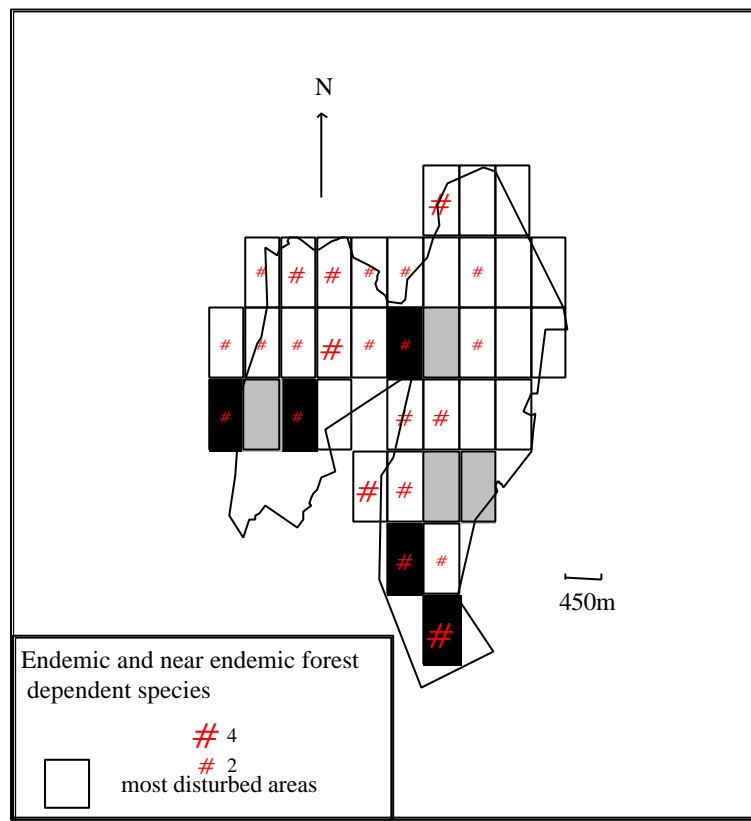


Figure 20 Distribution of forest dependent, endemic and near endemic plant species in relation to areas of highest disturbance in Mgambo FR.

4.4 Discussion

Mgambo FR covers an area of 13.46 km² (1346 ha) with an altitude range of 300m to 800m above sea level. Topography is, at times, fairly steep but not extreme and the landscape generally a mix of open woodland, scrub and grassland. Mgambo FR only contained small patches of lowland forest and riverine forest habitat.

Habitat

Of the 31 vegetation plots surveyed systematically, 20 were open woodland (65% of plots), 5 were lowland forest (16% of plots) and 6 were scrub/grassland/previously disturbed (19% of plots). Mgambo FR had previously been recorded as 96% poorly stocked lowland forest by Johannson and Sandy (1996). The large proportion of open woodland actually recorded suggests increased disturbance in recent years. None of the vegetation plots was recorded with an average canopy height of over 20m. Approximately two-thirds of vegetation plots had been affected by fire.

Species richness

In the systematic vegetation plots 858 trees and shrubs were surveyed, representing 101 species from 31 families. An additional five species were recorded in the regeneration plots. Opportunistic observations and collections recorded an additional 22 plant species from 14 families. In total 128 plant species from 39 families were recorded.

Relative to other forest reserves surveyed in the East Usambara Mountains the botanical diversity of Mgambo FR was low, largely as a result of the high level of fire and grazing disturbance.

The most abundant species in vegetation plots, representing 9.0% of individuals was the woodland species *Combretum zeyheri*. Other commonly encountered species in vegetation plots were *Dombeya shupangae*, *Brachystegia spiciformis*, *Acacia nilotica*, *Grewia bicolor*, *Cordia ovalis* and *Maytenus undata*. All of these species were seen to be resilient to disturbance and at competitive advantage in disturbed areas.

Endemic Status

The majority of species recorded in vegetation plots (87%) had widespread distributions. Only the species *Cassia abbreviata* was recorded as endemic to the Usambara Mountains and 12 species were recorded as near endemic. The most commonly recorded near-endemic tree species in the reserve was *Dombeya shupangae* (55 individuals), then was *Scorodophloeus fischeri* (15 individuals) and *Canthium mombazense* (10 individuals). Endemic and near endemic species were fairly evenly distributed in the reserve, but tended to be more frequently found in the western half of the reserve.

Only two near endemic species recorded in vegetation plots were forest dependent, namely *Deinbollia kilimandscharica* and *Zanthoxylum deremense*. Three near endemic species, *Dombeya shupangae*, *Scorodophloeus fischeri* and *Monodora grandidieri* are non-forest species.

Ecological Type

Only five species (5.0%) recorded in vegetation plots were classified as forest dependent defined as 'limited to primary or closed canopy forest only'. These species were *Deinbollia kilimandscharica*, *Commiphora eminii*, *Zanthoxylum deremense*, *Turraea holstii* and *Rothmannia manganjae*. The most commonly recorded forest dependent tree species was *Turraea holstii* represented by 22 individuals in 7 plots in a selection of scrub, woodland and lowland forest habitats.

Sixty two species (61.4%) were recorded in vegetation plots as forest dwelling and 27 species (26.7%) non-forest dwelling. *Brachystegia spiciformis* was the most abundant forest dwelling species represented by 77 individuals in just 3 open woodland plots. *Combretum zeyheri*, represented by 33 individuals in 3 plots, was the most abundant non-forest species present in disturbed open woodland habitats.

Habitat

Flora recorded from the vegetation plots of Mgambo FR was most commonly categorised within the lowland forest habitat type. A total of 39 (38.6%) species and 363 (42.3%) individuals were categorised as lowland forest species. There were only 4 species, *Acacia mellifera*, *Acacia nilotica*, *Grewia bicolor* and *Sterculia africana*, that were categorised as sub-montane species and 1 species, *Strychnos innocua*, categorised as a montane species (although it was found in woodland in lowland areas). Many other species (48 in total) were categorised as combinations of lowland with submontane and/or without montane forest habitats.

Of the tree species surveyed with known altitudinal preferences, 38.6% were considered to be solely typical of lowland forest, 4.0% of submontane forest and 1.0% of montane forest. The remainder (47.5%) were considered to be typical of a combination of habitats.

Range Extensions

The vegetation plot data generated a total of 71 new species records for Mgambo FR, when compared to the study by Ruffo *et al.* (1989). Eight of these species were also new to the East Usambara Plant Biodiversity Database, Pohjonen (2001).

Regeneration

An additional 5 species were also recorded from the regeneration plots. Three of these species were not present in the study by Ruffo *et al.* (1989). None of these species were endemic, near endemic or forest dependent.

Disturbance

Evidence of disturbance was found throughout Mgambo FR, notably around the forest areas close to Bwiti and Daluni villages.

The most significant disturbance category recorded in Mgambo FR was fire disturbance. Evidence of fire was noted in 62% of all disturbance transect sections and 21 vegetation plots (68% of the total). Fire disturbance was particularly intense in eastern areas although was fairly common throughout the forest reserve. Most of the reserve had poor canopy cover (with no canopy recorded over 20m) and fire disturbed areas were generally open wooded grassland habitats. Very few forest dependent, or endemic species were recorded in Mgambo, and it is likely that fire has played a significant role in the impoverishment of Mgambo's forest habitats and has resulted in limited regeneration prospects.

A second major disturbance category affecting Mgambo FR is grazing pressure. This was noted in 23% of all disturbance transect sections and 6 vegetation plots (19.4% of the total). It is likely that

these two disturbances are linked as herdsmen light fires to obtain new grasses for their animals to graze on. During the course of the survey, stock, and evidence of stock, was frequently observed in the reserve. This high level of disturbance must result in substantial detrimental effects on floral diversity.

Pole cutting was more concentrated around forest borders with an average of cut poles at 4% of the total per hectare. Timber extraction was fairly low and also tended to occur near forest borders around Daluni and Bwiti villages. The intensity of pole and timber extraction was, along all transects, much less than the number of dead poles and timber.

A total of 17% of poles and 18% of all timber sampled were dead. This was a high figure, compared with other East Usambara forest reserves and is likely to be directly influenced by the high levels of fire disturbance in the reserve.

There was virtually no signs of old cultivation except for one old shamba area which had only recently been designated as inside the reserve.

There was some recent and some old pitsawing evidence. As pitsawing is largely confined to the riverine and lowland forest habitats where the few larger trees remain, this may be of some concern to Mgambo's small relatively undisturbed areas.

Only one area in Mgambo FR was seen to have animal traps, this was a disturbed scrub habitat close to Mgambo village. The traps were likely set to target duiker species. The lack of large mammal sightings and signs, and local knowledge suggests that hunting activity was substantial in recent times.

5.0 FAUNA

Authors: Bracebridge, C.E., Oliver, S.A. and Hall, S. pp. 43-72

5.1 Introduction

The fauna of Mgambo Forest Reserve (FR) was studied to assess diversity within specific taxonomic groups. Inventories were compiled of mammal, reptile, amphibian, butterfly, mollusc and millipede species. Practicalities of capture methods, identification techniques and potential information that could be extracted from the data, influenced the taxonomic groups chosen for the study. The results of the inventories were analysed to assess the relative biodiversity value of the reserve's fauna.

5.2 Methods

Within Mgambo FR, target groups of fauna were surveyed using a combination of standardised, repeatable methods at 'zoological trappingsites'. Transect surveys of dung and other animal signs, and the opportunistic collection and observation of all animals were also implemented. Brief descriptions of the methods employed and trappingsite locations follow. A more detailed methodology of survey techniques can be found in the FT FRP *Methodology Report* (SEE, 1998).

5.2.1 Bucket pitfall traps

Small mammals, amphibians and reptiles were sampled using bucket pitfall traps. Three 50m linear transects were created at a zoological trappingsite location whereby eleven 10 litre plastic buckets were sunk into the ground with their rims flush to ground level. Buckets contained small holes to allow rainwater to drain from them and each bucket was positioned 5m apart. A sheet of vertical plastic (approximately 0.5m high, and no less than 0.2m) was run along the bucket line crossing the centre of each bucket to form a 'drift fence'. A 10-15cm lip of plastic sheeting was left flat on the ground onto which soil and leaf litter was placed to prevent any gap in the drift fence at ground level. Animals moving into the area from either side would be channelled along the plastic towards the bucket traps.

Each line was placed no more than 50m apart, but was located to encompass a range of micro-habitats. Brief habitat notes were taken for each bucket position. Traps were checked early each morning for the duration of the trappingsite period and data recorded on standardised data sheets regarding the identification of each animal captured.

5.2.2 Sherman traps

Small rodents and insectivores were sampled using 100 Sherman traps (standard size) baited with toasted coconut and peanut butter. Traps were placed at least 2m apart, forming a wide loop around the bucket pitfall trap lines; 33 around two of the lines and 34 around the third. Traps were baited each evening (16.00hr or later) for the duration of the trappingsite and checked early the following morning (08.00hr or earlier). Traps were closed during each day of the trappingsite.

Data were recorded on standardised sheets regarding the identification, sex, breeding status and biometrics of each animal captured, as well as habitat notes. Specimens were retained when species level could not be ascertained and in cases where sexed specimens were required; these specimens were subsequently sent to international taxonomic experts (refer to Appendix 1).

In the case of small rodents, individuals to be released were each given a distinct mark-code made by trimming small patches of fur in a given pattern. 'Recaptured' individuals were then able to be identified.

5.2.3 Bat mist-netting

Bats were sampled using varying combinations and configurations of mist-nets within 4 trapping sites. Up to four mist-nets of varying sizes (3m x 3.5m, 6m x 3.5m, 9m x 3.5m) were utilised at any one time. Nets were placed across assumed 'flight corridors' such as rivers and paths. Nets were opened at dusk (approximately 18.30hr) and checked every 10 to 15 minutes for the duration of the netting session.

Data were recorded on standardised data sheets regarding the identification, sex, breeding status, weight and biometrics of each bat captured. Detailed habitat notes were taken for each mist-netting location and the number of net-metre hours calculated for each session.

5.2.4 Butterfly sweep-netting

Low-flying butterflies were sampled using hand-held sweep-nets. Two man-hours were spent netting along the bucket pitfall lines each day for the duration of the trapsite.

5.2.5 Butterfly canopy traps

Five Blendon-style canopy traps were set up at the trapsites, one trap close to one bucket pitfall line, and two traps on each of the remaining two lines. Traps were baited with fermented banana in the mornings (usually around 08.00hr). Traps were checked morning and late afternoon. One individual of each species captured was taken; any 'repeat species' butterflies were identified, recorded and released.

5.2.6 Mollusc plots

Molluscs were sampled in three 1m x 1m quadrats per trapsite; whereby quadrats were established close to each of the bucket pitfall trap lines and located in order to encompass a range of microhabitats. Two man-hours were spent searching the leaf litter, to a depth of 5cm within each quadrat. All molluscs encountered were collected and preserved.

5.2.7 Millipede plots

Millipedes were sampled in three 3m x 3m quadrats per trapsite; again, one established close to each of the bucket pitfall trap lines and located in order to encompass a range of microhabitats. Four man-hours were spent searching the leaf litter, to a depth of 5cm within each quadrat. All millipedes encountered were collected and preserved.

5.2.8 Dung and sign surveys

Spoor and other signs of animal presence were assessed along every established transect line through the Forest Reserve (Figure 5). A 2m strip either side of each transect line was assessed for animal dung, tracks and paths, as well as other signs such as burrows, diggings, feathers etc. All animal signs were recorded along with brief geographical and habitat details. To determine identification of indirect evidences, the knowledge of experienced field assistants was utilised, in conjunction with a Reference Dung Collection and Walker (1996).

5.2.9 Opportunistic collection and observations

All taxa were also collected and observed on a casual basis throughout the survey period. Opportunistic collections of amphibians, reptiles, molluscs and millipedes were taken and direct and indirect observations of birds and larger mammals were recorded to determine the presence of species otherwise omitted in the standardised techniques.

5.3 Trapping sites and sampling intensity

Zoological trapsites were established at four different locations in Mgambo FR. Non-systematic trapping also occurred in 2 additional areas for two nights each. Trapsites were strategically positioned to incorporate a range of habitats reflective of the reserve. The location of trapsites within Mgambo FR are shown in Figure 21.

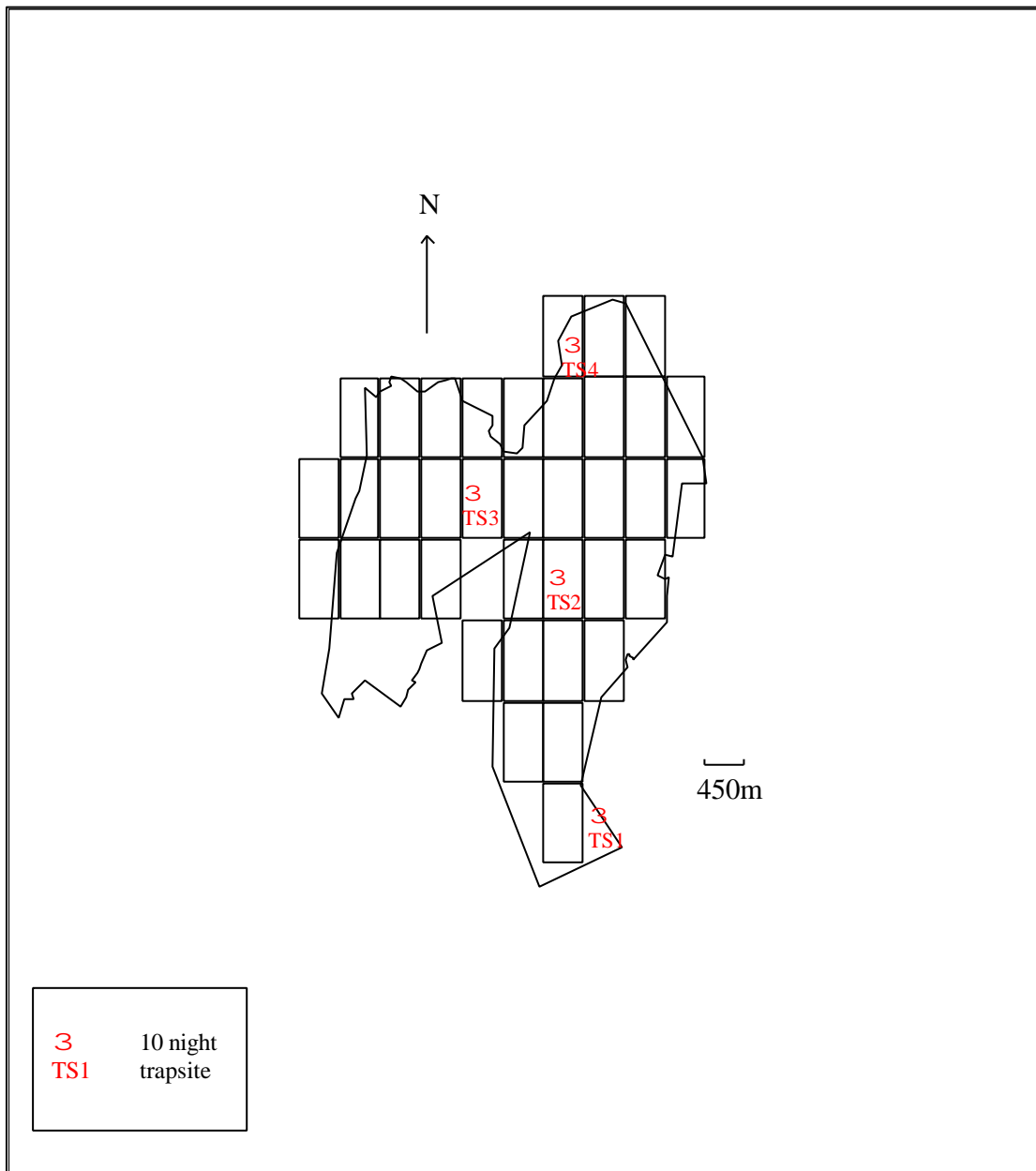


Figure 21 Location of zoological trapsites in Mgambo FR.

Table 18 provides brief descriptions of the trapping sites. Table 19 summarises the sampling intensity for each site and each trapping method. Table 20 briefly describes bat mist-netting sites.

Table 18 Descriptions and locations of zoological trapsites in Mgambo FR.

Trapsite Number	Duration (nights)	Vegetation type	Altitude (masl)	Topography	Co-ordinates
1	10	Lowland Riverine Forest and Lowland Forest	300-320	Gentle Lower to Upper Slope	S 04° 47' 31.2" E 038° 48' 46.7"
2	10	Grazed Miombo Woodland	560	Gentle Upper Slope to Hill Top	S 04° 46' 03.5" E 038° 48' 39.5"
3	10	Dry Lowland Forest / Lowland Riverine Forest	470	Gentle Lower Slope	S 04° 45' 40.5" E 038° 47' 58.6"
4	10	Lowland Scrub / Disturbed Scrubby Woodland	410	Gentle Mid Slope	S 04° 44' 52.7" E 038° 48' 34.3"
Casual Site					
5	2	Lowland Forest / Disturbed Scrubby Woodland	320	Lowland Plain	S 04° 47' 08.1" E 038° 48' 40.1"
6	2	Lowland Forest	380	Gentle Lower Slope	S 04° 47' 11.8" E 038° 48' 33.5"

Table 19 Zoological sampling intensities in Mgambo FR.

Trapsite Number	Trapsite Duration (dates)	Sherman traps x trap nights	Bucket traps x trap nights	Butterfly traps x trap days	Butterfly sweepnetting hours	Mollusc plots per trapsite	Millipede plots per trapsite
1	17/04/02-27/04/02	998	330	50	20	3	3
2	30/04/02-10/05/02	989	330	50	20	3	3
3	13/05/02-23/05/02	997	330	50	20	3	3
4	26/05/02-05/06/02	997	330	50	20	3	3
Casual Site							
5	04/06/02-05/06/02	29	0	0	0	0	0
6	10/06/02-11/06/02	100	0	0	0	0	0
TOTAL		4110	1320	200	80	12	12

Table 20 Bat mist-netting sites and sampling intensities in Mgambo FR.

Net site number	Site location	Site description	Co-ordinates	Altitude (m)	Sampling intensity (square metres of net x no. of hours)
1	Zoological Trapsite 1	Stream in Riverine Forest. Gentle lower slope. 10-20m canopy height.	S 04° 47' 31.2" E 038° 48' 46.7"	300	57.2
2	Near Basecamp	Stream in Riverine Forest, 250m upstream from basecamp. Gully. 10-20m canopy height.	S 04° 47' 34.5" E 038° 48' 39.4"	240	416
3	Zoological Trapsite 3 Near (Vegetation Plot 13)	Dry stream in Riverine Forest and Dry Lowland Forest. Gentle lower slope. 10-20m canopy height.	S 04° 45' 40.5" E 038° 47' 58.6"	380	684.8
4	East border of forest reserve / shamba (Near to Transect line 1).	Lowland forest and scrub forest just inside the reserve border and on the border line of Cassia trees. Cultivated land up to border.	S 04° 47' 09.2" E 038° 48' 42.2"	240	390
				TOTAL	1548

5.4 Results

5.4.1 Mammals

5.4.1.1 *Small mammals (not including bats)*

A total of 39 small mammals were captured during 4110 sherman trapping nights and 1320 bucket-pitfall nights in Mgambo FR and, of these, 18 specimens were retained for taxonomic purposes. Identifications in this report remain tentative while awaiting taxonomic verifications from Frankfurt Zoological Museum (refer to Appendix 1). The specimens collected represent at least 9 species from 3 families. A summary of trapping data is shown in Appendix 8 and, species list of captured small mammals with their corresponding ecological, endemic and threat status is presented in Table 21.

Ecological type, endemic status and threat status for the mammal tables 21, 22, 23 and 24 were compiled using the National Biodiversity Database (UDSM, 1997), IUCN (Hilton-Taylor, 2000), Kingdon (1974 and 1997) and CITES listings (2001). Nomenclature follows Kingdon (1997).

Table 21 Summary of captured small mammals from Mgambo FR.

Species	Ecol. type	End. status	Threat status			Total nos. captured	No. of specimens taken
			IUCN 2000	UDSM 1997	CITES 2001		
SORICIDAE							
<i>Crocidura cf. bicolor</i>		White-toothed Shrew	f	W		1	1
<i>Crocidura cf. elongius</i>		White-toothed Shrew	f	N	VU	6	5
<i>Crocidura cf. hirta/xantippe</i>		White-toothed Shrew	f	W		2	2
<i>Crocidura cf. hildegardae</i>		White-toothed Shrew	f	W		1	1
<i>Crocidura sp.</i>		White-toothed Shrew	?	?		3	3
MURIDAE							
<i>Acomys spinosissimus</i>		Spiny Mouse	f	W		23	3
<i>Grammomys sp.</i>		Narrow-footed Woodland Mouse	O	W		1	1
<i>Mastomys natalensis</i>		Multimammate rat	O	W		1	1
MYOXIDAE							
<i>Graphiurus sp.</i>		Dormouse	f	W		1	1
TOTAL						39	18

KEY TO ABBREVIATIONS FOR TABLES 21 and 22Ecological (Ecol.) type:

- F – Forest dependent species: Species confined to primary forest only; not including forest edge or secondary forest.
 f – Forest dwelling but not forest dependent species: Species occurring in primary forest, forest edge or secondary forest.
 O – Non-forest species: Species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:

- E – Endemic: Species only found in the Usambara Mountains.
 N – Near endemic: Species with limited ranges usually only including coastal forest and/or East African lowland forests.
 W – Widely distributed species.

IUCN status:

- EN – Endangered
 VU – Vulnerable
 LR/NT – Lower Risk/Near Threatened
 DD – Data Deficient

CITES listings:

- I – Appendix One listed species
 II – Appendix Two listed species
 (Appendix Three species not included in Table)

Of most interest was the *Graphiurus sp.* (Dormouse) captured in dry lowland forest, one of the few patches of undisturbed forest within the reserve. It is a species that has been captured in small numbers in Amani Nature Reserve and Nilo Forest Reserve in previous surveys (2 individuals within each reserve within a time frame of one year and six months respectively). *Graphiurus* prefers dense woodland / forest habitats. (Table 21).

5.4.1.2 Dung survey

Dung from 9 mammal species was recorded, 2 of which were domesticated goats and cows commonly found illegally grazing throughout the reserve. Apart from livestock, evidence of baboons were most commonly collected along the transect lines. The most interesting species was that of the Giant elephant shrew, most likely to be the *Rhynchocyon petersi* (Zanj elephant shrew), which is considered forest-dependent, near endemic and endangered (IUCN 2000). (Table 22).

Table 22 Summary of dung survey in Mgambo FR.

Species	Ecol. type	End. status	Threat Status			No. of occurrences	Altitude of dung findings
			IUCN 2000	UDSM 1997	CITES 2001		
CERCOPITHECIDAE							
<i>Papio cynocephalus</i> Yellow Baboon	f	W			II	11	420-670
HERPESTIDAE							
Unknown sp. Mongoose	?	?				1	550
THRYONOMYIDAE							
<i>Thryonomys</i> sp. Cane-Rat	?	?				10	350-685
VIVERRIDAE							
<i>Civettictis civetta</i> African Civet	O	W				1	360
<i>Genetta genetta</i> Common Genet	O	W				3	410-520
ANTILOPINAE							
<i>Cephalophus</i> sp. Duiker sp.	f	W				1	680
<i>Madoqua</i> sp. Dik Dik	?	?				3	450-500
<i>Capra hircus</i> Domestic Goat sp.	O	W				3	450-620
RHYNCHOCYONINAE							
<i>Rhynchocyon</i> sp. Giant Elephant Shrew sp.	?	?				1	620
BOVIDAE							
Domestic cow sp	O	W				9	370-720

For key to abbreviations, see Table 21.

5.4.1.3 Mammal observations

A total of 22 species from 14 families were observed directly and indirectly but not retained for taxonomic purposes. This included species detected from the presence of tracks, paths, diggings and feeding sites, but not those detected through the dung survey. All mammal observations are summarised in Table 23. As many observations were made by indirect means, positive identification was not always possible to a species level. An 'identification confidence' column clarifies the reliability of each sighting. Identification is ranked as follows: Certain, Near Certain, Probable, Possible.

Of particular interest was the sighting of the *Rhynchocyon petersi* (Zanj elephant shrew) which is forest-dependent, near endemic and endangered (IUCN 2000). (Table 23). Observations were made of up to six different groups of forest dependent *Colobus angolensis palliatus* (Black and white colobus monkey) in patches of lowland and riverine forest throughout the reserve. These primates, although considered widespread, seem to be limited to rapidly decreasing areas of lowland forest and must be at risk from local extinction due to limitations to disperse and interbreed. Also of interest was the sighting of the vulnerable (IUCN 2000) *Paraxerus palliatus* (Red bellied coastal squirrel).

Five nocturnal species were seen and/or heard at trap site 3, an area of good lowland and riverine forest. These were the *Dendrohyrax validus* (Eastern tree hyrax), which is near endemic and vulnerable (IUCN 2000); *Galagoides zanzibaricus* (Zanzibar galago), a forest-dependent species;

Otolemur garnetti (Small eared galago), which was also seen and heard frequently around basecamp in an area of riverine forest on the reserve border; *Otolemur crassicaudatus* (Greater galago), a species typically known to inhabit open Miombo-type woodland, indicating its presence on the Miombo ridge tops of Mgambo FR and, lastly, *Pterodromus tetradactylus* (Four-toed elephant shrew). All of the nocturnal species identifications were verified by Andy Perkins, a visiting *Galago* expert, with an extensive knowledge on other nocturnal species.

There was also much evidence of grazing by domestic livestock, goats and cattle. This is a problem within the reserve.

Table 23 Summary of mammal observations in Mgambo FR.

Species	Common Name	Ecol. type	End. status	Threat Status			Identification confidence	Evidence
				IUCN 2000	UDSM 1997	CITES 2001		
COLOBIDAE								
<i>Colobus angolensis palliatus</i>	Angola Pied Colobus	F	W	DD		II	Certain	obs, voc
CERCOPITHECIDAE								
<i>Papio anubis</i>	Olive Baboon	O	W			II	Possible	obs
<i>Papio cynocephalus</i>	Yellow Baboon	f	W			II	Certain	obs, voc, pa, sp, sk, tr, fed
<i>Cercopithecus (n.) mitis</i>	Gentle Monkey	f	W			II	Certain	obs, voc, fed
GALAGONIDAE								
<i>Otolemur crassicaudatus</i>	Greater Galago	f	W			II	Certain	obs, voc
<i>Otolemur garnettii</i>	Small-eared Galago	f	W			II	Certain	voc
<i>Galagoides zanzibaricus</i>	Zanzibar Galago	F	W	LR/NT		II	Certain	obs, voc
MACROSCOLIDAE								
<i>Pterodromus tetradactylus</i>	Four-toed Elephant Shrew	f	W				Certain	obs, voc
<i>Rhynchocyon petersi</i>	Zanj Elephant Shrew	F	N	EN	NT		Certain	obs, voc, pa, dig
ANTILOPINAE								
<i>Cephalophus sp.</i>	Duiker sp.	f	W				Probable	tr, sk, pa
<i>Capra hircus</i>	Domestic Goat	O	W				Certain	obs, tr, pa
SCIURIDAE								
<i>Heliosciurus undulatus</i>	Zanj Sun Squirrel	f	W			LR/NT	Certain	obs
<i>Paraxerus palliatus</i>	Red-Bellied Coastal Squirrel	F	W	VU			Near Certain	obs
CRICETOMYINAE								
<i>Cricetomys sp.</i>	Giant Pouched Rat	O	W				Possible	obs
MURIDAE								
<i>Praomys sp.</i>	Soft Furred Rat	f	W				Possible	obs
HYSTRICIDAE								
<i>Hystrix sp.</i>	Porcupine sp.	O	W				Certain	hair
THRYONOMYIDAE								
<i>Thryonomys sp.</i>	Cane Rat	-	-				Near Certain	fed
PROCAVIDAE								
<i>Dendrohyrax validus</i>	Eastern Tree Hyrax	f	N	VU	EN		Certain	voc

Table 23 continued Summary of mammal observations in Mgambo FR.

Species	Common Name	Ecol. type	End. status	Threat Status			Identification confidence	Evidence
				IUCN 2000	UDSM 1997	CITES 2001		
SUIDAE								
<i>Potamochoerus larvatus</i>	Bush Pig	f	W				Certain	tr, dig, pa
BOVIDAE								
Unknown sp. .	Domestic Cow	O	W				Certain	obs, tr, pa, fed

KEY TO ABBREVIATIONS FOR TABLE 23Ecological (Ecol.) type:

- F – Forest dependent species: Species confined to primary forest only; not including forest edge or secondary forest.
 f – Forest dwelling but not forest dependent species: Species occurring in primary forest, forest edge or secondary forest.
 O – Non-forest species: Species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:

- E – Endemic: Species only found in the Usambara Mountains.
 N – Near endemic: Species with limited ranges usually only including coastal forest and/or East African lowland forests.
 W – Widely distributed species.

IUCN status:

- EN – Endangered
 VU – Vulnerable
 LR/NT – Lower Risk/Near Threatened
 DD – Data Deficient

CITES listings:

- I – Appendix One listed species
 II – Appendix Two listed species
 (Appendix Three species not included in Table)

Evidence:

- voc - vocalisations heard tr - track fed - remains of feedings sk - skull found sp - spoor
 obs - observed dig - diggings hair - fur/hair found bns - bones found pa - path

5.4.1.4 Bats

A total of 45 individuals were caught during 1548 net-metre-hours of trapping in Mgambo FR. These individuals represented potentially 10 species from 4 families. Seventeen individuals were retained for taxonomic purposes. A summary of trapping data is shown in Appendix 8 and a species list presented in Table 24. Identifications remain tentative while awaiting taxonomic verification from Frankfurt Zoological Museum (refer to Appendix 1).

**Figure 20** Leaf-nosed bat (*Hipposideros* sp.)

It is interesting to note that most of the bat species caught were those that live in a mosaic of habitats, including open woodland and are non-forest dependent. This probably reflects the level of disturbance throughout the reserve and loss of pristine forest habitat. Those species that live in forest or on forest edges (ecological type = f) were caught in areas of either dry lowland forest and/or riverine forest. At trap site 1, a large number of bats were caught, suggesting a roost close to the positioning of the mist nets. These were situated in riverine forest on the edge of the reserve border, close to shambas. Most bats were *Rhinolophus* species and it is possible that they flew out of the forest into drier open areas to feed.

Table 24 Summary of bat records in Mgambo FR

Species	Common name	Ecol. type	End. status	Threat Status			Total nos. captured	No. of specimens taken
				IUCN 2000	UDSM 1997	CITES 2001		
NYCTERIDAE								
<i>Nycteris</i> sp.	Slit-faced Bat	?	?				1	1
<i>Nycteris grandis</i>	Large Slit-faced Bat	f	W				1	1
PTEROPODIDAE								
<i>Epomorphus wahlbergi</i>	Epauletted Fruit Bat	f	W				3	1
RHINOLOPHIDAE								
<i>Hipposideros caffer / ruber</i>	Leaf-nosed Bat	?	W				2	1
<i>Rhinolophus clivosus</i>	Horseshoe Bat	O	W				18	5
<i>Rhinolophus hildebrandti</i>	Horseshoe Bat	O	W				5	2
<i>Rhinolophus landeri</i>	Horseshoe Bat	O	W				1	1
VESPERTILIONIDAE								
<i>Glauconycteris argentata / variegata</i>	Butterfly Bat	f	W				7	2
<i>Nyctecius shlieffeni</i>	Twilight Bat	O	W				1	1
<i>Scotoecus</i> sp.	Evening Bat	O	W				6	2
TOTAL							45	17

KEY TO ABBREVIATIONS FOR TABLE 24

Ecological (Ecol.) type:

- F – Forest dependent species: Species confined to primary forest only; not including forest edge or secondary forest.
 f – Forest dwelling but not forest dependent species: Species occurring in primary forest, forest edge or secondary forest.
 O – Non-forest species: Species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:

- E – Endemic: Species only found in the Usambara Mountains.
 N – Near endemic: Species with limited ranges usually only including coastal forest and/or East African lowland forests.
 W – Widely distributed species.

IUCN status:

- EN – Endangered
 VU – Vulnerable
 LR/NT – Lower Risk/Near Threatened
 DD – Data Deficient

CITES listings:

- I – Appendix One listed species
 II – Appendix Two listed species
 (Appendix Three species not included in Table)

5.4.2 Birds

A total of 52 species from 30 families were recorded. As no systematic survey of bird fauna was undertaken, the findings do not represent a complete inventory (Table 25). An 'identification confidence' column is presented in Table 25 to clarify the reliability of each sighting. Identification is ranked as follows: Certain, Near Certain, Probable and Possible.

Where possible Mlingwa *et al.* (2000) and Stuart (1989) was used to determine ecological type and Stattersfield *et al.* (1998) used to define endemic status. When this was not possible, ecological type, endemic status and threat status were compiled using the National Biodiversity Database (UDSM, 1997), IUCN (Hamilton, 2000), CITES (2001) and Zimmerman *et al.* (1996).

Table 25 Summary of birds observed opportunistically in Mgambo FR.

Species	Common name	Ecol. type	End. status	Threat Status			Identification confidence
				IUCN 2000	UDSM 1997	CITES 2001	
ACCIPITRIDAE							
<i>Aquila rapax</i>	Tawny Eagle	f	W		LR	II	Probable
<i>Buteo augur</i>	Augur Buzzard	f	W		LR	II	Certain
<i>Buteo buteo vulpinus</i>	Common Buzzard	f	W		LR	II	Certain
<i>Gypohierax angolensis</i>	Palm-nut Vulture	f	W		LR	II	Certain
<i>Polyboroides typus</i>	African Harrier Hawk	f	W			II	Certain
<i>Stephanoaetus coronatus</i>	African Crowned Eagle	FF2	W		NT	II	Certain
<i>Terathopius ecaudatus</i>	Bateleur	f	W		LR	II	Certain
ALCEDINIDAE							
<i>Ispinina picta natalensis</i>	African Pygmy Kingfisher	f1	W				Certain
<i>Halcyon senegalensis</i>	Woodland Kingfisher	f	W				Certain
APODIDAE							
<i>Apus affinis</i>	Little Swift	f	W				Possible
BUCEROTIDAE							
<i>Bycanistes brevis</i>	Silvery Cheeked Hornbill	F2	W				Probable
<i>Bycanistes bucinator</i>	Trumpeter Hornbill	F2	W				Certain
<i>Tokus alboterminatus</i>	Crowned Hornbill	f1	W				Certain
CAMPEPHAGIDAE							
<i>Campephaga flava</i>	Black Cuckoo Shrike	f1	W				Certain
CAPITONIDAE							
<i>Pogoniulus bilineatus</i>	Yellow Rumped Tinker Bird	f	W				Certain
COLIIDAE							
<i>Urocolius macrourus</i>	Blue-Naped Mousebird	f	W				Probable
COLUMBIDAE							
<i>Treron calva</i>	African Green Pigeon	F	W				Certain
<i>Streptopelia capicola</i>	Ring-necked Dove	f	W				Certain
<i>Streptopelia semitorquata</i>	Red-eyed Dove	f	W				Certain
<i>Streptopelia senegalensis</i>	Laughing Dove	f	W				Certain
CORACIIDAE							
<i>Eurystomus glaucurus</i>	Broad-billed Roller	f	W				Certain
CUCULIDAE							
<i>Centropus superciliosus</i>	White-browed Coucal	f	W				Certain

Table 25 continued Summary of birds observed opportunistically in Mgambo FR.

Species	Common name	Ecol. type	End. status	Threat Status			Identification confidence
				IUCN 2000	UDSM 1997	CITES 2001	
CAPITONIDAE							
<i>Stactolaema leucotis kilimensis</i>	White-eared Barbet	F1	W				Certain
DICRURIDAE							
<i>Dicrurus adsimilis</i>	Common Drongo	f	W				Certain
<i>Dicrurus ludwigii</i>	Square-tailed Drongo	F3	W				Certain
ESTRILDIDAE							
<i>Hypargos niveoguttatus</i>	Peter's Twinspot	F1	W				Near Certain
<i>Lonchura fringilloides</i>	Magpie Mannikin	f	W				Possible
MALACONOTIDAE							
<i>Laniarius aethiopicus</i>	Tropical Boubou	f	W				Certain
MEROPIDAE							
<i>Merops n. nubicus</i>	Northern Carmine Bee-eater	f	W				Near Certain
<i>Merops pusillus</i>	Little Bee-eater		W				Certain
MONARCHIDAE							
<i>Terpsiphone viridis</i>	African Paradise Fly-catcher	f1	W				Certain
MUSOPHAGIDAE							
<i>Tauraco fischeri</i>	Fisher's Turaco	F2	N			II	Certain
<i>Tauraco porphyreolophus chlorochlamys</i>	Purple Crested Turaco	F	W		LR/NT	II	Possible
NECTARINIIDAE							
<i>Anthreptes</i> sp.	Sunbird	?	?				Possible
<i>Cyanomitra olivacea</i>	Olive Sunbird	FF1	W				Certain
<i>Hedydipna collaris</i>	Collared Sunbird	F1	W				Certain
NUMIDIDAE							
<i>Numida meleagris</i>	Helmeted Guineafowl	f	W				Certain
ORIOOLIDAE							
<i>Oriolus</i> sp.	Oriole	?	?				Certain
<i>Oriolus chlorocephalus</i>	Green Headed Oriole	F2	W				Certain
PICIDAE							
<i>Campethera mombassica</i>	Mombasa Woodpecker	F	N*		LR		Probable
PLATYSTEIRIDAE							
<i>Platysteira p. peltata</i>	Black-Throated Wattle-eye	F	W				Certain
PRIONOPIDAE							
<i>Prionops retzii</i>	Retz's Helmet Shrike	f1	W				Certain
PYCNONOTIDAE							
<i>Andropadus milanjensis</i>	Stripe-Cheeked Greenbul	FF2	W				Certain
<i>Andropadus virens</i>	Little Greenbul	F2	W				Certain
<i>Pycnonotus barbatus</i>	Common Bulbul	f	W				Certain
STRIGIDAE							
<i>Strix woodfardii nigricantoir</i>	African Wood Owl	F2	W		LR	II	Certain
STURNIDAE							
<i>Onychognathus morio</i>	Red-winged Starling	f	W				Near Certain

Table 25 continued Summary of birds observed opportunistically in Mgambo FR.

Species	Common name	Ecol. type	End. status	Threat Status			Identification confidence
				IUCN 2000	UDSM 1997	CITES 2001	
TROGONIDAE							
<i>Apaloderma narina</i>	Narina's Trogon	f3	W				Certain
TURDIDAE							
<i>Cossypha natalensis</i>	Red-capped Robin-chat	F1	W				Certain
<i>Pogonocichla stellata</i>	White-starred Robin	F2	W				Certain
TYTONIDAE							
<i>Tyto alba affinis</i>	Barn Owl	f	W		LR	II	Certain
UPUPIDAE							
<i>Phoeniculus purpureus</i>	Green Wood-hoopoe	F1	W				Certain
<i>Rhinopomastus cyanomelas</i>	Common Scimitarbill	f	W				Certain

*Endemic status determined using Stattersfield *et al* (1998)

Bold text Ecological type determined using Mlingwa *et al.* (2000)

KEY TO ABBREVIATIONS FOR TABLE 25

Forest dependence Mlingwa *et al.* (2000):

Forest specialist (FF): Species that are typical of forest interior and likely to disappear when the forest is modified to any extent.

Forest generalist (F): Species that can occur in undisturbed forest but which are able to exist (and may even be numerous) at the forest edge or in modified/ fragmented forests. However, these generalists continue to depend upon forests for some of their resources, such as nesting sites.

Non-forest birds (f): Forest visitors

Forest dependence Stuart (1989) categories:

1. those which live in forest but are not dependent upon it for their survival
2. those which live in forest and 'overspill' into adjacent habitats, but are dependent upon forest for their survival
3. those that can only survive in forest and hardly 'overspill' into adjacent habitats.

Endemic (End.) status:

E - Endemic: Species only found in the Usambara Mountains.

N - Near endemic: Species with limited ranges usually only including coastal forest and/or E. African lowland forests.

W - Widely distributed species

IUCN status:

EN - Endangered

VU - Vulnerable

LR/NT - Low Risk/Near Threatened

DD - Data Deficient

CITES listings:

I - Appendix One listed species

II - Appendix Two listed species

(Appendix Three not included in Table)

A total of 60% of bird species (31 species) recorded in Mgambo FR were non-forest species (Mlingwa *et al.*, 2000), with 6% (3 species) forest specialists and 31% (16 species) forest generalists. Forest specialists are summarised in Table 26.

Table 26 Summary of forest dependant birds with corresponding threat status categories.

Species name	Common name	Ecol. type	End. status	Threat status		
				IUCN 2000	UDSM 1997	CITES 2001
<i>Andropadus milanjensis</i>	Stripe-cheeked Greenbul	FF	W			
<i>Cyanomitra olivacea</i>	Olive Sunbird	FF	W			
<i>Stephanoaetus cornatus</i>	African Crowned Eagle	FF2	W		NT	II

*Endemic status determined using Stattersfield *et al* (1998)

Two bird species observed in Mgambo FR were of restricted range and are summarised in Table 27.

Table 27 Restricted ranges of near endemic birds
(1° source: Statterfield *et al* (1998), 2° Mlingwa *et al.* 2000), 3°: source: UDSM (1997).)

Species name	Common name	Range
<i>Campethera mombassica</i>	Mombasa Woodpecker	East Usambara Mountains and Coastal forests north of Tanga from Shimba NP to Boni Forest.
<i>Tauraco fischeri</i>	Fischer's Tauraco	Endemic to Tanzania, Kenya, Coastal forest endemic.

Apart from those birds that are of obvious importance in terms of threat status and restricted range, such as *Tauraco fischeri* (Fischer's tauraco) which has been used to define one of the Birdlife International Endemic Bird Areas, there were a number of birds that were interesting because they are locally common and have a restricted and patchy distribution in East Africa. These include: *Lonchura fringilloides* (Magpie mannikin), commonly known from Amani; *Tauraco porphyreolophus chlorochlamys* (Purple-crested turaco), with no recent records in north Tanzania (Zimmerman *et al* 1996); and *Onychognathus morio* (Red-winged starling), known to be rare in the Usambara foothills.

Bycanistes brevis (Silvery cheeked hornbill), *Bycanistes bucinator* (Trumpeter hornbill) and *Stactolamema leucotis kilimensis* (White-eared barbet) are common but fairly restricted to North Eastern Tanzania and Southern Kenya.

Also of interest was *Ispiniina picta natalensis* (African pygmy kingfisher), a non-breeding migrant species from South Africa, present in Coastal forests from April to September, and *Cossypha natalensis* (Red-capped Robin-chat), an Afrotropical migrant.

It is also important to consider the birds species that have not been found in Mgambo forest reserve, such as the lowland species: Sokoke scops owl, *Otus ireneae*; the endemic Usambara eagle owl, *Bubo vosseleri*; Swynnerton's robin, *Swynnertonia swynnertonii*; East coast akalat, *Sheppardia gunningi*; Amani sunbird, *Anthreptes pallidigaster* the Banded green sunbird, *Anthreptes rubritorques* and the near-threatened Southern banded snake eagle (*Circaetus fasciolatus*). Forest dependent species, such as Burr-spotted fluff tail (*Sarothrura elegans*), Barred long-tailed cuckoo (*Cercococcyx montanus*) and the Forest batis (*Batis mixta*), are known from wetter and more intact lowland forest areas of the East Usambaras. Therefore, this preliminary bird species list may suggest that Mgambo is too dry and fragmented for many typical lowland coastal forest species.

5.4.3 Reptiles

A total of 45 reptile individuals representing 20 species and 9 families were captured in Mgambo FR during 1320 pitfall trapping nights and opportunistic collection. These species are summarised in Table 28. At least one individual representing each species were taken as specimens for taxonomic purposes and await formal identification. Nomenclature follows Spawls *et al* (2002).

Table 28 Summary of reptile pitfall and opportunistic captures in Mgambo FR.

Family	Ecol. type	End. status	Threat Status			No. of individuals captured		
			IUCN 2000	UDSM 1997	CITES 2001	Trap sites	Additional Locations	Total
CHAMAELEONIDAE								
<i>Rhampholeon k. kerstenii</i> Kenyan Pygmy Chameleon	O	N		LR/NT		-	1	1
COLUBRIDAE								
<i>Natriciteres olivacea</i> Olive Marsh Snake	O	W				-	2	2
<i>Philothamnus</i> sp. Green Snake	?	?				-	1	1
<i>Psammophis sudanensis</i> Northern Stripe-bellied Sand Snake	O	W				-	2	2
<i>Scaphiophus albopunctatus</i> Hook-nosed Snake	O	W				5	-	5
Unknown genus	?	?				1	-	1
ELAPIDAE								
<i>Dendroaspis angusticeps</i> Eastern Green Mamba	f	W				-	1	1
<i>Naja</i> sp. Cobra sp.	?	W				1	-	1
GEKKONIDAE								
<i>Cnemaspis africana</i> Usambara Forest Gecko	F	W		NT		2	-	2
<i>Hemidactylus</i> sp. Tropical Gecko	?	?				-	1	1
<i>Hemidactylus platycephalus</i> Tree Gecko	O	W				2	-	2
<i>Pachydactylus</i> sp. Thick-toed Gecko	O	W				-	1	1
GERRHOSAURIDAE								
<i>Gerrhosaurus flavigularis</i> Yellow-throated Plated Lizard	O	W				11	-	11
<i>Gerrhosaurus</i> sp. Plated Lizard	O	W				-	1	1
LACERTIDAE								
<i>Heliobolus speckii speckii</i> Speke's Sand Lizard	O	W		LR/NT		2	1	3
<i>Holaspis guentheri laevis</i> Blue-tailed Gliding Lizard	F	W		LR/NT		-	1	1
<i>Latastia longicaudata</i> Southern Long-tailed Lizard	O	W				2	-	2
LEPTOTYPHLOPIDAE								
<i>Leptotyphlops</i> sp. Worm Snake	?	?				1	1	2
SCINCIDAE								
<i>Mabuya maculilabris</i> Speckle-lipped Skink	O	W				1	1	2
<i>Lygosoma</i> sp. Writhing Skink	O	?				-	1	1
VIPERIDAE								
<i>Bitis arietans</i> Puff Adder	O	W				1	1	2
TOTAL						29	16	45

KEY TO ABBREVIATIONS FOR TABLE 28Ecological (Ecol.) type:

- F – Forest dependent species: Species confined to primary forest only; not including forest edge or secondary forest.
 f – Forest dwelling but not forest dependent species: Species occurring in primary forest, forest edge or secondary forest.
 O – Non-forest species: Species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:

- E – Endemic: Species only found in the Usambara Mountains.
 N – Near endemic: Species with limited ranges usually only including coastal forest and/or East African lowland forests.
 W – Widely distributed species.

IUCN status:

- EN – Endangered
 VU – Vulnerable
 LR/NT – Lower Risk/Near Threatened
 DD – Data Deficient

CITES listings:

- I – Appendix One listed species
 II – Appendix Two listed species
 (Appendix Three species not included in Table)

Appendix 9 summarises reptile trapping data, 35% of individuals were captured opportunistically. Ecological type, endemic status and threat status were compiled from the National Biodiversity Database (UDSM, 1997), IUCN (Hilton-Taylor, 2000) and Spawls *et al* (2002).

Two species captured were categorised as forest dependent, *Holaspis guentheri laevis* (Speke's Sand Lizard) and *Cnemaspis africana* (Usambara forest gecko) with one near endemic, *Rhampholeon k. kerstenii* (Kenyan pygmy chameleon). None were listed as vulnerable or endangered (IUCN 2000).

Five additional species were recorded in Mgambo FR as observations. These are listed in Table 29. An 'identification confidence' column has been presented to clarify the reliability of each sighting. Identification is ranked as follows: Certain, Near Certain, Probable, Possible.

Table 29 Summary of reptile observations in Mgambo FR.

Species	Common Name	Ecol. type	End. status	Threat Status			Identification confidence
				IUCN 2000	UDSM 1997	CITES 2001	
COLUBRIDAE							
<i>Philothamnus battersbyi</i>	Battersby Green Snake	O	W				Probable
<i>Thelotornis capensis</i>	Vine Snake	O	W				Certain
GEKKONIDAE							
<i>Lygodactylus luteopicturatus</i>	Yellow-headed Dwarf Gecko	O	N		LR		Certain
TESTUDINIDAE							
<i>Kinixys belliana</i>	Bell's Hinged Tortoise	O	W			II	Certain
VARANIDAE							
<i>Varanus niloticus</i>	Nile Monitor Lizard	O	W			II	Certain

KEY TO ABBREVIATIONS FOR TABLE 29Ecological (Ecol.) type:

- F – Forest dependent species: Species confined to primary forest only; not including forest edge or secondary forest.
 f – Forest dwelling but not forest dependent species: Species occurring in primary forest, forest edge or secondary forest.
 O – Non-forest species: Species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:

- E – Endemic: Species only found in the Usambara Mountains.
 N – Near endemic: Species with limited ranges usually only including coastal forest and/or East African lowland forests.
 W – Widely distributed species.

IUCN status:

- EN – Endangered
 VU – Vulnerable
 LR/NT – Lower Risk/Near Threatened
 DD – Data Deficient

CITES listings:

- I – Appendix One listed species
 II – Appendix Two listed species
 (Appendix Three species not included in Table)

An additional one near endemic reptile species was recorded through observation, *Lygodactylus luteopicturatus* (Yellow-headed dwarf gecko).

Additionally, two species of Chameleon were observed just outside of the forest reserve, *Chameleo dilepsis* (Flap-necked chameleon), a widespread forest dwelling species, and *Chameleo melleri* (Giant one-horned chameleon), mostly distributed along the coast in well-wooded savannah and woodland.

Many of the species found in Mgambo predominantly range in the Eastern coastal forests with some patchy distribution in other more central parts of east and central Africa. Therefore, although they cannot be categorised as 'near endemic' based on the definition given in this report, they are of limited distribution. For example, *Dendroaspis angusticeps* (Green mamba, see Figure 22), *Heliobolus spekii spekii* (Speke's sand lizard), *Holaspis guentheri laevis* (Blue-tailed lizard) and *Cnemaspis africana* (Usambara forest gecko).

Both the forest dependent reptiles were captured in good quality patchily distributed riverine forest. The presence or absence of *Holaspis guentheri laevis* may be a good future indicator of the levels of deforestation to the remaining areas of lowland forest.

Of interest was the capture of 5 juvenile *Scaphiophus albopunctatus* (Hook-nosed snake) at trap site 4, an area of scrub forest. This species is not currently on the East Usambara database (available from EUCAMP). The East African population of this genus seems to be isolated (Spawls *et al* 2002). Also interesting was the sighting of an adult *Varanus niloticus* (Nile monitor lizard).

Most of the reptiles species captured and observed seemed to be indicative of the disturbance seen throughout the reserve, reflecting a tendency for dry habitat, open woodland / savannah species to dominate, such as *Latastia longicaudata* (Southern long-tailed lizard), *Pachydactylus* sp. (Thick-toed gecko) and *Natriciteres olivecea* (Olive marsh snake). Even the near endemic *Rhampholeon k. kerstenii* (Kenyan pygmy chameleon) prefers a dry habitat.



Figure 22 Green mamba (*Dendroaspis angusticeps*), found in riverine forest. This individual was approximately 2m in length.

5.4.4 Amphibians

A total of 184 amphibians were captured during 1320 pitfall trapping nights. An additional 18 individuals were captured opportunistically. These individuals represented 14 species and 7 families. Twenty-four individuals were retained for taxonomic purposes. A summary of trapping data is presented in Appendix 10. A species list is shown in Table 30. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997), IUCN (Hilton-Taylor, 2000) and Poynton & Broadley (1991). Identifications remain tentative while awaiting taxonomic verifications from the University of Dar es Salaam and the British Natural History Museum (refer to Appendix 1). Common names are from Passmore and Carruthers (1995).

Table 30 Summary of pitfall and opportunistic amphibian captures in Mgambo FR.

Species	Common name	Ecol. type	End. status	Threat status			No. of individuals captured
				IUCN 2000	UDSM 1997	CITES 2001	
ARTHROLEPTIDAE							
<i>Arthroleptis stenodactylus</i>	Shovel footed Squeaker	f	W				78
<i>Arthroleptis xenodactyloides</i>	Shovel nosed Squeaker	f	W				71
BUFONIDAE							
<i>Bufo brauni</i>	Dead leaf Toad	F	N		VU		7
<i>Bufo gutturalis</i>	Square-marked Toad	O	W				1
<i>Bufo maculatus</i>	Flat Backed Toad	O	W				10
<i>Bufo</i> sp.		?	?				1
<i>Mertensophryne micranotis</i>	Dwarf Toad	F	N		EN		1
HEMISOTIDAE							
<i>Hemisus marmoratus</i>	Mottled Shovel Nosed Frog	O	W				16
HYPEROLIIDAE							
<i>Leptopelis barbouri</i>	Tree Frog	F	N		VU		5
PIPIDAE							
<i>Xenopus muelleri</i>	Tropical Platanna	O	W				1
RHACOPHORIDAE							
<i>Chiromantis xerampelina</i>	Foam Nest Frog	O	W				1
RANIDAE							
<i>Arthroleptides martiensseni</i>	Usambara Montane Torrent Frog	F	N		VU		1
<i>Phrynobatrachus</i> sp.	Puddle Frog	?	?				1
<i>Rana angolensis</i>	Common River Frog	O	W				7
GYMNOPHONIA							
SCOLECOMORPHIDAE							
<i>Scolecophorus vittatus</i>	Caecilian	F	N		VU		1
TOTAL							201

KEY TO ABBREVIATIONS FOR TABLE 30Ecological (Ecol.) type:

- F – Forest dependent species: Species confined to primary forest only; not including forest edge or secondary forest.
 f – Forest dwelling but not forest dependent species: Species occurring in primary forest, forest edge or secondary forest.
 O – Non-forest species: Species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:

- E – Endemic: Species only found in the Usambara Mountains.
 N – Near endemic: Species with limited ranges usually only including coastal forest and/or East African lowland forests.
 W – Widely distributed species.

IUCN status:

- EN – Endangered
 VU – Vulnerable
 LR/NT – Lower Risk/Near Threatened
 DD – Data Deficient

CITES listings:

- I – Appendix One listed species
 II – Appendix Two listed species
 (Appendix Three species not included in Table)

By far the most commonly captured genus in pitfalls was *Arthroleptis*, or Squeakers, which dwell in leaf litter (Table 30). Interestingly, their life history involves direct development of frogs in the leaf litter without a freeswimming stage. This makes at least a partially covered wooded area to create leaf litter an essential habitat requirement. Individuals in this genera are particularly difficult to identify to species level and, particular care must be taken with this group to treat identifications as tentative until taxonomic confirmation is obtained.

An interesting capture was that of *Mertensophryne micranotis* (Dwarf toad), as it is most commonly known to be an Eastern Arc and coastal endemic.

In addition to these captures, one further species was observed casually but not retained (Table 31).

Table 31 Amphibians observed casually in Mgambo FR.

Species	Common name	Ecol. type	End. status	Threat Status			Certainty of identification
				IUCN 2000	UDSM 1997	CITES 2001	
RANIDAE							
<i>Ptychadena anchietae</i>	Plain Grass Frog	f	W				Certain



Figure 23 Plain grass frog (*Ptychadena anchietae*).

Five forest dependent amphibian species were captured and observed in Mgambo FR, all of which were also categorised as near endemic (UDSM 1997). Four are classified as Vulnerable and one species Endangered (*Mertensophryne micranotis*) (UDSM 1997) (Table 30). Five amphibian species have restricted ranges (UDSM, 1997), these are summarised in Table 32.

Table 32 Restricted ranges for near-endemic amphibians (UDSM, 1997).

Species	Common name	Range
<i>Bufo brauni</i>	Dead leaf Toad	Usambara; Uluguru and Udzungwa Mountains.
<i>Mertensophryne micranotis</i>	Dwarf Toad	Coastal forests and East Usambaras (Kilulu Hill), and Sokoke, Kenya.
<i>Leptopelis barbouri</i>	Tree Frog	Usambara and Udzungwa Mountains
<i>Scolecormorphus vittatus</i>	Caecilian	Usambara, Uluguru, North Pare Mountains, Magrotto and lowlands near Usambaras.
<i>Arthroleptides martiensseni</i>	Usambara Montane Torrent Frog	Usambara, Magarotto, Uluguru, Nguru and Udzungwa Mountains.

Of particular interest was the capture of the caecilian *Scolecormorphus vittatus*, a leg-less worm-like amphibian of the order Gymnophonia, in lowland forest at trap site 1. Although locally common, they are not commonly captured, especially in the smaller forest reserves. They are sometimes known as ‘Queen of the Ants’ because they can be observed at the front of a trail of ants. They are thought to feed on earth worms and other invertebrates – little else is known of their ecology.

5.4.5 Invertebrates

5.4.5.1 Butterflies

A total of 138 species of butterfly were captured in Mgambo FR, using sweepnets and canopy traps. These species represented 5 families (taxonomic classification is taken from Larsen (1996), where Nymphalidae is one large family incorporating genera, such as *Acraea*, *Bicyclus*, *Charaxes*, *Danaus*, *Hypolimnas*, *Salamis*, etc. This is in contrast to Kielland (1990), where there are 5 families under the superfamily of Nymphaloidea, thereby splitting the above genera into different families). One hundred and ninety one specimens were retained for taxonomic purposes. Official taxonomic identifications have yet to be obtained. Ecological type and endemic status were compiled using Kielland (1990) and Larsen (1996).

The butterfly species list for Mgambo FR is presented to subspecies level in Table 33. This table also indicates whether butterflies have previously been recorded in the East Usambara Mountains, using an East Usambara butterfly species list up to April 2000 and specimens collected by EUBS and listed in reports from 2000 onwards. Capture data for trapsites is summarised in Appendix 11.

Eighty percent of all butterfly species captured in Mgambo FR were widespread in distribution with eleven species of near endemic status. Seventeen percent of butterfly species were forest dependent, 39% forest dwelling, 8% non-forest species, and 12% unknown. If identifications are accurate (to be confirmed) at least five species records represent range extensions and ten represent those of uncommon, localised or rare species.

A large number of butterfly species were caught, possibly because Mgambo FR has a variety of different habitats, reflecting changes through overgrazing and fire disturbance. The majority of the butterfly species were non-forest species, possibly indicating the predominance of open habitat types, such as open and Miombo woodland.

Table 33 Summary of butterflies captured in Mgambo FR.

Species	Ecol. type	End. status	Other information	Existing EU Record (Y / N)
HESPERIIDAE				
<i>Coeliades anchises anchises</i>	O	W		N
LYCAENIDAE				
<i>Aslauga purpurascens</i>	f	W		N
<i>Axiocerses amanga</i>	O	W		N
<i>Axiocerses harpax</i>	O	W		Y
<i>Axiocerses punicea</i>	f	W	Not common in Usambaras	N
<i>Axiocerses tjoane</i>	O	W		Y
<i>Baliochila hildegarda</i>	f	W		Y
<i>Baliochila</i> sp.	?	?		?
<i>Leptotes adamsoni</i>	f	N		N
<i>Ornipholidotos peucetia peucetia</i>	F	W	Expect 800-1200m	Y
<i>Pentila tropicalis</i>	f	W		Y
<i>Spindasis mozambica</i>	f	W		N
<i>Teriomina subpunctata</i>	F	N	Coastal lowland forest	Y
<i>Zizeeria knysna</i>	O	W		N
NYMPHALIDAE				
Unknown sp.	?	?		?
<i>Acraea</i> sp. ¹	?	?		?
<i>Acraea</i> sp. ²	?	?		?
<i>Acraea acrita</i>	O	W		N
<i>Acraea anemosa</i>	f	W		Y
<i>Acraea eponina eponina</i>	f	W		Y
<i>Acraea cf. macarista</i>	?	?		N
<i>Acraea cf. matuapa</i>	F	N	Not common in East Usambaras	N
<i>Acraea natalica natalica</i>	O	W		Y
<i>Acraea rabbaiae mombasae</i>	f	W	Not common in Usambaras	N
<i>Amauris niavius niavius</i>	F	W		Y
<i>Amauris ochlea ochlea</i>	f	W		Y
<i>Apaturopsis cleochares schulzei</i>	f	W	Very local and uncommon	Y
<i>Bicyclus campinus ocelligerus</i>	F	W		Y
<i>Bicyclus ena</i>	O	W		Y
<i>Bicyclus safitza safitza</i>	O	W		Y
<i>Byblia anvatara acheloia</i>	O	W		Y
<i>Byblia ilithyia</i>	O	W		Y
<i>Charaxes</i> sp. ¹	?	?		?
<i>Charaxes</i> sp. ²	?	?		?
<i>Charaxes</i> sp. ³	?	?		?
<i>Charaxes</i> sp. ⁴	?	?		?
<i>Charaxes achaemenes</i>	O	W		Y
<i>Charaxes aubyni ecketti</i>	f	W		Y
<i>Charaxes bohemani</i>	O	W		Y
<i>Charaxes brutus</i>	f	W		Y
<i>Charaxes candiope candiope</i>	f	W		Y
<i>Charaxes castor castor</i>	f	W		Y
<i>Charaxes cithaeron nairobicus</i>	F	W		Y

Table 33 continued Summary of butterflies captured in Mgambo FR.

Species	Ecol. type	End. status	Other information	Existing EU Record (Y / N)
NYMPHALIDAE continued				
<i>Charaxes contrarius</i>	f	N	Coastal forests	Y
<i>Charaxes etesipe gordani</i>	f	W		Y
<i>Charaxes ethalion kikuyensis</i>	f	W		Y
<i>Charaxes cf. etheocles evansi</i>	f	W		Y
<i>Charaxes fionae</i>	O	W		Y
<i>Charaxes fulvescens</i>	f	W	Usually found in West Tanzania	N
<i>Charaxes guderiana rabaiensis</i>	f	W		N
<i>Charaxes cf. hansali baringana</i>	O	W		Y
<i>Charaxes cf. howarthi</i>	O	W	Usually found in West Tanzania	
<i>Charaxes jahluca kenyensis</i>	f	W	Uncommon, local race	Y
<i>Charaxes kirki kirki</i>	O	W	Locally common	Y
<i>Charaxes lasti kimbozae</i>	F	W	Not common to East Usambaras	Y
<i>Charaxes lasti lasti</i>	f	N		Y
<i>Charaxes pleione oriens</i>	f	W		Y
<i>Charaxes protoclea azota</i>	f	W		Y
<i>Charaxes pythodoris nesaea</i>	F	N	Uncommon, very local	N
<i>Charaxes saturnus</i>	O	W		N
<i>Charaxes varanes vologese</i>	O	W		Y
<i>Charaxes violetta maritimus</i>	f	W		Y
<i>Charaxes zoolina zoolina</i>	f	W		Y
<i>Danaus sp.</i>	?	?		
<i>Euphaedra neophron littoralis</i>	F	N	Usambaras, South Pare Mts	Y
<i>Euptera kinugnana</i>	F	W		Y
<i>Euryphura achlys</i>	F	W		Y
<i>Eurytela dryope angulata</i>	f	W		Y
<i>Euxanthe tiberius</i>	F	N	Coastal forest	Y
<i>Euxanthe wakefieldi</i>	F	W	Lowland forest	Y
<i>Hamanumida daedalus</i>	O	W		Y
<i>Henotesia perspicua</i>	O	W		Y
<i>Henotesia sp.</i>	?	?		?
<i>Hypolimnas anhedon</i>	F	W		Y
<i>Hypolimnas deceptor deceptor</i>	f	W		Y
<i>Hypolimnas cf. deceptor</i>	f	W		Y
<i>Hypolimnas misippus</i>	O	W		Y
<i>Hypolimnas usambara</i>	F	N	Rare, coastal primary forest	Y
<i>Junonia cf. hierta</i>	O	W		Y
<i>Junonia natalica natalica</i>	f	W		Y
<i>Junonia oenone oenone</i>	O	W		Y
<i>Libythea labdaca laius</i>	f	W		Y
<i>Melantis leda</i>	O	W		Y
<i>Neptidopsis fulgurata platyptera</i>	f	W		Y
<i>Neptis carcassoni</i>	F	W	Lowland forest	Y
<i>Neptis goochi</i>	F	W		Y
<i>Neptis saclava marpessa</i>	f	W		Y
<i>Phalanta phalantha aethipicus</i>	O	W		Y
<i>Physcaeneura leda</i>	O	N	Coastal N.E. Tanzania and Kenya	Y
<i>Pseudacraea eurytus condraati</i>	F	W		Y
<i>Pseudacraea lucretia expansa</i>	f	W		Y
<i>Pseudacraea lucretia protracta</i>	f	W		Y

Table 33 continued Summary of butterflies captured in Mgambo FR.

Species	Ecol. type	End. status	Other information	Existing EU Record (Y / N)
NYMPHALIDAE continued				
<i>Salamis cf. anacardii</i>	f	W		Y
<i>Salamis cacta</i>	F	W		Y
<i>Sallya garega garega</i>	f	W	West Tanzania	N
<i>Sallya natalensis</i>	f	W		Y
<i>Sallya sp.</i>	?	?		?
<i>Tirumala petiverana</i>	f	W		N
PAPILIONIDAE				
<i>Graphium sp.</i>	?	?		?
<i>Graphium angolanus angolanus</i>	O	W		N
<i>Graphium antheus</i>	f	W		Y
<i>Graphium colonna</i>	f	W		Y
<i>Graphium leonides leonides</i>	O	W	More common in West Tanzania	Y
<i>Graphium policeses</i>	F	W		Y
<i>Graphium porthaon mackie</i>	f	W		Y
<i>Papilio bromius</i>	F	W	West Tanzania	Y
<i>Papilio constantinus</i>	f	W		Y
<i>Papilio dardanus polytrophus</i>	f	W		Y
<i>Papilio demodacus demodacus</i>	O	W		Y
<i>Papilio hornimani</i>	F	N	E & W Usambaras, S. Pare Mts	Y
<i>Papilio nireus lyaeus</i>	f	W		Y
<i>Papilio ophidicephalus ophidicephalus</i>	f	W		Y
PIERIDAE				
<i>Unknown sp.</i>	?	?		?
<i>Appias epaphia orbona</i>	f	W		N
<i>Appias lasti lasti</i>	f	W	Coastal and Masagati	Y
<i>Appias sabina phoebe</i>	f	W		Y
<i>Belenois creona severina</i>	O	W		Y
<i>Belenois thysa thysa</i>	f	W		Y
<i>Belenois subeida</i>	O	W		Y
<i>Colotis sp.¹</i>	?	?		?
<i>Colotis sp.²</i>	?	?		?
<i>Colotis aurigineus</i>	f	W		Y
<i>Colotis auxo incretus</i>	O	W		Y
<i>Colotis danae</i>	O	W		Y
<i>Colotis cf. दौरा jacksoni</i>	O	W	Comparatively rare in Tanzania	Y
<i>Colotis euippe omphale</i>	f	W		Y
<i>Colotis evagore antigone</i>	O	W		Y
<i>Colotis ione</i>	O	W		Y
<i>Colotis regina</i>	O	W		Y
<i>Colotis vesta</i>	O	W		N
<i>Dixeia doxo</i>	O	W		N
<i>Eronia leda</i>	O	W		Y
<i>Eurema brigatta brigatta</i>	O	W		Y
<i>Eurema floricola</i>	F	W	Confined to lowland forest	Y
<i>Eurema regularis</i>	O	W		Y
<i>Mylothris agathina</i>	O	W		N
<i>Mylothris similis</i>	F	W		N
<i>Nepheronia argia argia</i>	f	W		Y

Existing EU record: Yes (Y) or No (N). This column only considers specimens to species level.

KEY TO ABBREVIATIONS FOR TABLE 33Ecological (Ecol.) type:

- F – Forest dependent species: Species confined to primary forest only; not including forest edge or secondary forest.
f – Forest dwelling but not forest dependent species: Species occurring in primary forest, forest edge or secondary forest.
O – Non-forest species: Species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:

- E – Endemic: Species only found in the Usambara Mountains.
N – Near endemic: Species with limited ranges usually only including coastal forest and/or East African lowland forests.
W – Widely distributed species.

Other Information obtained from:

Larsen (1996); Kielland (1990)

5.4.5.2 Molluscs

A total of 153 molluscs were collected in zoological trapsites and opportunistically. Taxonomic determinations were not available at the time of publication. Specimens were deposited at the Zoological Museum of Copenhagen (refer to Appendix 1).

5.4.5.3 Millipedes

A total of 392 millipedes were collected in zoological trapsites and opportunistically. Taxonomic determinations were not available at the time of publication. Specimens were deposited at the Zoological Museum of Copenhagen (refer to Appendix 1).

5.4.6 Distribution of endemic and forest dependent species

Almost all near endemic and forest dependent fauna were captured or observed outside the 9 most disturbed areas (Figure 24). Fire and grazing were the two most significant forms of disturbance in Mgambo FR (refer to Figures 17 and 18 and disturbance discussion, page 36 of report) and it is likely that illegal grazing poses the greatest threat to endemic and forest dependant fauna within the reserve as the forest patches are further encroached.

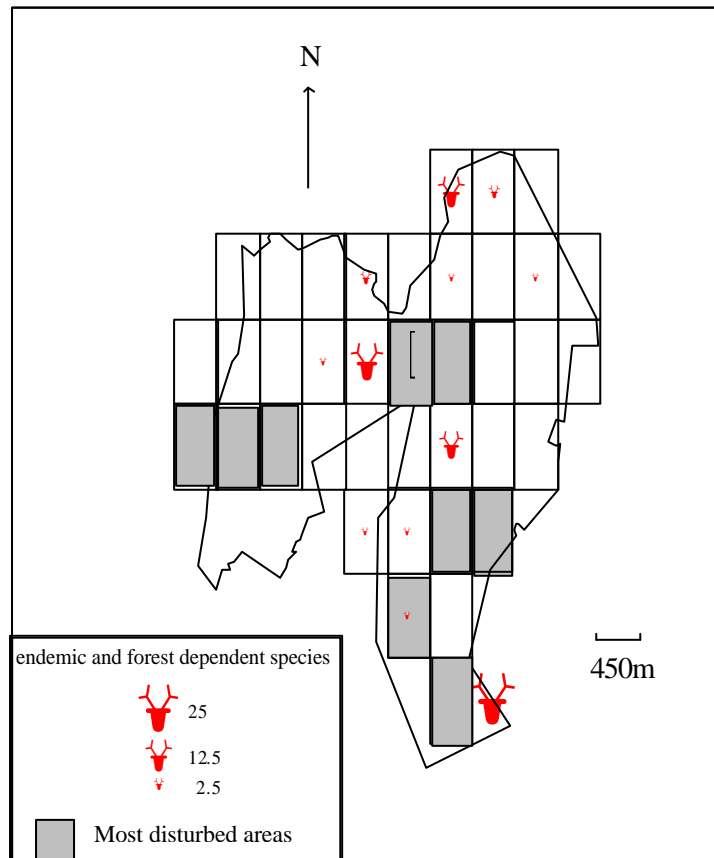


Figure 24 Distribution of forest dependent and near endemic fauna in comparison with the most disturbed areas in Mgambo FR

5.4 Discussion

5.5.1 Introduction

Mgambo FR is 1,346ha and despite its relatively small size, the number of animal species recorded was comparable to those found in nearby forest reserves, such as Bombo East I and II and Mtai FRs (refer to Frontier Tanzania, 1999, Frontier Tanzania 2002c and Frontier Tanzania 2002d) (although the number of mammal species captured was lower than expected). Amani Nature Reserve, for comparison, is almost 6 times the area but, when surveyed, was found to contain approximately 25% more species (refer to Frontier Tanzania, 2001).

Table 34 Summary of faunal families and species (identified to date) and inclusive of casual observations, dung surveys etc.

Taxon	Number of families	Number of species
Mammals (not including bats)	18	35
Bats	4	10
Birds	30	52
Reptiles	9	20
Amphibians	7	14
Butterflies	5	138

5.5.2 Species Abundance and Importance

To provide a concept of species abundance, the frequency of species-capture was investigated. This makes the assumption that the frequency with which an animal is recorded reflects its general abundance and it must be highlighted that abundance of highly cryptic species may not be reflected accurately. Also, it does not give a good measure of species distribution within the reserve.

5.5.2.1 Mammals

The most commonly captured mammal species was *Acomys spinosissimus* (Spiny mouse, 23 individuals captured, 10 of which were recaptures). Most of these captures were from trap site 2, an area of Miombo woodland. The other species frequently recorded were those of the genus *Crocidura* (White-toothed shrew, 13 individuals captured). All of the identifications to species level are tentative, but of those, *Crocidura cf. elongius* was the most frequently captured, mostly in trap site 2.

Other species recorded in low abundance, at a frequency of one individual per species, were *Grammomys* sp. (Narrow-footed woodland mouse), *Mastomys* sp. (Multi-mammate rat) and *Graphiurus* sp. (Dormouse)

Of the larger mammals, there were at least 7 separate sightings of *Cercopithecus (n.) mitis* (Gentle/blue monkey) in the forested areas (not including basecamp, where one group was seen almost daily) and *Papio cynocephalus* (Yellow baboon) was seen on a number of occasions in and near the forest borders. *Colobus angolensis palliatus* (Angola pied colobus) was observed on over eleven different occasions and heard a number of times, although these may represent approximately six different groups in patchily distributed lowland forest.

Frequent aural records of *Dendrohryax validus* (Eastern tree hyrax), *Otolemur garnetti* (Small-eared galago) *Otolemur crassicaudatus* (Greater galago) and *Galagoides zanzibaricus* (Zanzibar galago) were heard nightly at trap site 3, an area of lowland and riverine forest.

Species recorded indirectly through spoor on many occasions were *Thryonomys gregorianus* (Cane rat), *Papio cynocephalus* (Yellow baboon) and *Cephalophus* sp. (Duiker sp.). Unfortunately, the frequency of domestic cattle and goat spoor was also very high within the reserve, particularly in open woodland areas.

The most commonly caught bat species was *Rhinolophus clivosus* (Horseshoe bat, 18 individuals captured), most of which were from trap site 1, where there was thought to be a roost, possibly a cave, nearby. Also frequently captured were *Glauconycteris argentata/variegata* (Butterfly bat, 7 individuals captured) and *Scotoecus* sp. (Evening bat, 6 individuals captured), mainly from trap site 3.

5.5.2.2 Birds

Bird species frequently observed in the reserve in a number of locations are as follows, *Tokus alboterminatus* (Crowned hornbill), *Bycanistes bucinator* (Trumpeter hornbill) and *Buteo augur* (Augur buzzard), although the latter may have been the same pair on several of those occasions. The 2 owl species *Strix woodfordii nigricantior* (African wood owl) and *Tyto alba affinis* (Barn owl) were frequently heard at trap site 3 and in riverine forest near to base camp.

The bird list for Mgambo has not been compared with an East Usambara species list in the same way as for other taxa. However, if the *Tauraco porphyreolophus chlorochlamysi* (Purple-crested turaco) sightings were correct, this is currently a species with no recent records in north Tanzania (Zimmerman *et al*, 1996). Similarly, *Onychognathus morio* (Red-winged starling) is known to be rare in the Usambara foothills and *Lonchura fringilloides* (Magpie mannikin), is commonly known from Amani, (Zimmerman *et al* 1996).

5.5.2.3 Reptiles

Two species caught relatively frequently were: *Gerrhosaurus flavigularis* (Yellow-throated lizard, 11 individuals captured), mostly at trap site 2, and *Scaphiophus albopunctatus* (Hook-nosed snake, 5 individuals captured). The latter were juveniles caught at trap site 4, an area of scrub forest. This species is not currently on the East Usambara database (available from EUCAMP website) and the East African population of this genus seems to be isolated (Spawls *et al* 2002).

Other species not commonly recorded, if at all, in the EUBS database (from EUCAMP website), but captured in small numbers in Mgambo were: *Pachydactylus* sp. (Thick-toed gecko, one individual captured), *Latastia longicaudata* (Southern long-tailed lizard, two individuals captured) and *Heliobolus speckii speckii* (Speke's sand lizard, three individuals captured). These are important findings in that these species prefer drier habitats. This may be indicative of the increasing levels of disturbance within the forest reserve and a change of species type, abundance and distribution.

Mabuza maculilabris (Speckle-lipped skink) was frequently seen throughout the reserve, although it was not often captured.

5.5.2.4 Amphibians

By far the most abundant amphibian genus was *Arthroleptis* (Squeakers). Captures of *Arthroleptis stenodactylus* (78 individuals) and *Arthroleptis xenodactyloides* (71 individuals), were recorded from trap sites 1 and 3, although field identification of these species may not be very accurate. Also caught with relative abundance were *Hemisus marmoratus* (Mottled shovel-nosed frog, 16 individuals captured) and *Bufo maculatus* (Flat backed toad, 10 individuals captured). Again these were from trap sites 1 and 3, areas of riverine and lowland forest.

5.5.2.5 Invertebrates

Relative abundance for molluscs and millipedes was not determined.

Butterflies caught 10 or more times are listed in descending order, with the numbers caught in brackets, as follows:

Charaxes brutus (78), *Charaxes candiope candiope* (77), *Belenois creona severina* (53), *Melanitis leda* (49), *Charaxes violetta maritimus* (43), *Charaxes zoolina zoolina* (42), *Charaxes cithaeron nairobiicus* (36), *Bicyclus safitza safitza* (34), *Charaxes contrarius* (33), *Charaxes jahlusa kenyensis* (30), *Byblia anvataracheloia* (26), *Eurytela dryope angulata* (21), *Byblia ilithyia* (20), *Acraea rabbaiae mombasae* (18), *Charaxes castor castor* (18), *Papilio dardanus polytrphus* (17), *Charaxes varanes vologeses* (15), *Euphaedra neophron littoralis* (14), *Euptera kinugnana* (14), *Charaxes ethalion kikuyensis* (11).

With provisional identifications, 23 (17%) of Mgambo's butterfly species caught have not previously been recorded on the East Usambara Mountains biodiversity database (Pohjonen, 2001).

5.5.2.6 Endemics and near-endemics

Most of the near endemic species found during the four 10 day trappings were at trappingsite 1, in riverine forest, and trappingsite 3, lowland forest (Figure 25). Of those species found at trappingsite 2 (Miombo woodland) and trappingsite 4 (scrub forest), most were butterfly species. Casual findings outside of the trappingsites were predominantly found in riverine forest.

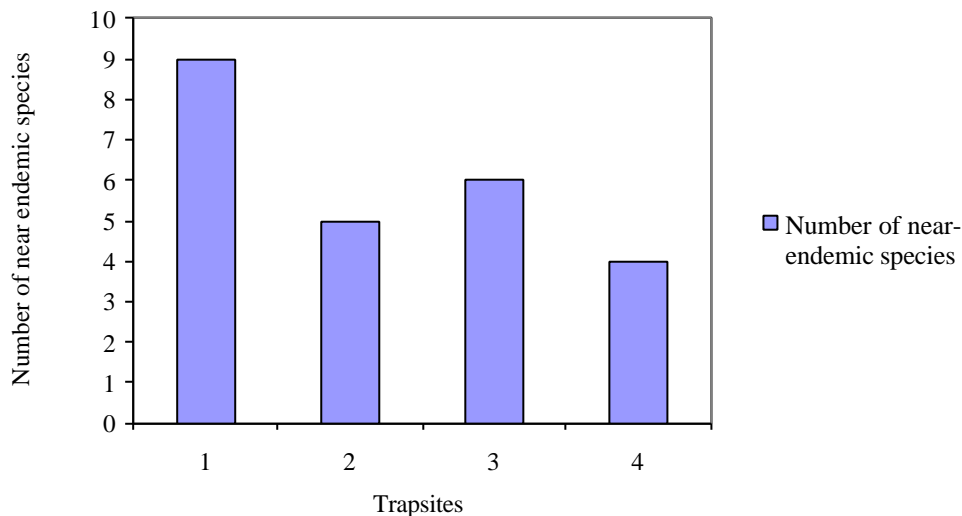


Figure 25 Distribution of near endemic species found at trappingsites 1-4

Of the 12 mammal, bird, reptile and amphibian species, which are near-endemic to the Usambara Mountains and were recorded during this survey, only the following were recorded frequently, *Bufo brauni* (Deal leaf toad) and *Lygodactylus lutecpicturatus* (Yellow-headed dwarf gecko).

5.5.2.7 Forest dependent species

The concentration of forest dependant species was highest for trappingsite 1 (Figure 26), which was a riverine forest habitat. Most of the forest dependant species found there were butterflies and amphibians. Of approximately equal concentration were forest dependent species found at trappingsites 3 and 4, lowland forest and scrub forest respectively. Most species at trappingsite 3 were mammals and birds.

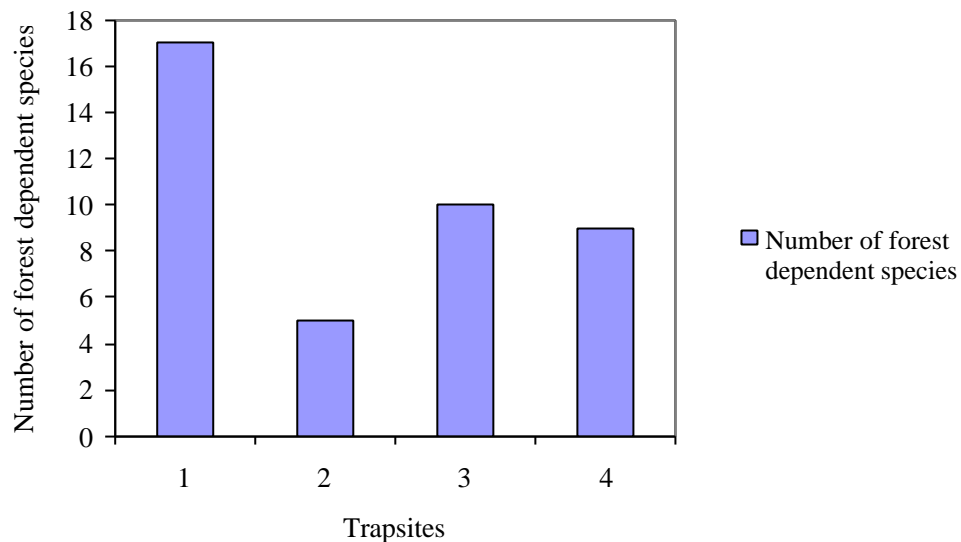


Figure 26 Distribution of forest dependent species found at trapsites 1-4

Of the 14 mammal, bird, reptile and amphibian species which are dependant on primary forest, only the following were recorded frequently during this survey, *Colobus angolensis palliatus* (Angola Pied Colobus), *Galagoides zanzibaricus* (Zanzibar galago) and *Bufo brauni* (Dead leaf toad).

Of the 24 (17%) forest dependant butterfly species, only three species were caught frequently during the survey. These were *Charaxes cithaeron nairobicus*, *Euphaedra neophron littoralis* and *Euptera kinugnana*.

5.5.2.8 High risk species

With the assumption that species observed rarely may have a low abundance, species of conservation concern in Mgambo can be determined. Cryptic species, such as chameleons have not been included in the following list. The species that were observed infrequently and are both forest dependent and near-endemic are as follows, *Rhynchocyon petersi* (Zanj elephant shrew), *Mertensophryne micranotis* (Dwarf toad), *Leptopelis barbouri* (Tree frog), *Athroleptides martiensseni* (Usambara montane torrent frog), *Scolecormorphus vittatus* (Caecilian). Butterfly species include: *Teriominia subpunctata*, *Acraea* cf. *matuapa*, *Charaxes pythodoris nesaea*, *Euxanthe tiberius*, *Hypolimnas usambara* and *Papilio hornimani*.

Specific research would be essential before any further comments were to be made on the conservation status of specific taxa.

5.5.3 Ecological Type

Of all the faunal species found, 38 are forest dependant species; 4 of these are mammals, 3 are birds, 2 are reptiles, 5 are amphibians and 24 are butterflies.

Table 35 Summary of ecological type of mammal, bird, reptile, amphibian and butterfly species.

Ecological type	No. of species	% of total species recorded
Forest dependent	38	14
Forest dwelling but not forest dependent	96	35
Non-forest species	111	40
Unknown	31	11
TOTAL:	276	100

5.5.4 Endemic Status

A total of 23 faunal species recorded are near-endemics; of these 3 are mammals, 2 are birds, 2 are reptiles, 5 are amphibians and 11 are butterflies.

Table 36 Summary of endemic status of mammal, bird, reptile, amphibian and butterfly species.

Endemic status	No. of species	% of total species recorded
Endemic to the Usambara Mountains	0	0
Near-Endemic: ranges in restricted locations	23	8
Widespread	223	81
Unknown	30	11
Total:	276	100

5.5.5 IUCN Status

Only one species are listed as endangered (IUCN, 2000). This are *Rhynchocyon petersi* (Zanj elephant shrew).

Species listed as vulnerable (IUCN, 2000) are *Crocidura cf. elongius* (White-toothed shrew), *Dendrohyrax validus* (Eastern tree hyrax), *Paraxerus palliatus* (Red-bellied coastal squirrel).

For the purpose of this study, the National Biodiversity Database has also been taken into consideration to establish threat status (UDSM, 1997). This is because certain Tanzanian species, in particular reptile and amphibian species, have been omitted from the IUCN 2000, listings despite their situation not having improved since the previous IUCN listings in 1994. The National Biodiversity Database, therefore, currently utilises the 1994 IUCN list to reflect current situations more closely. Species recorded as endangered under this classification are, *Dendrohyrax validus* (Eastern tree hyrax) and *Mertensophryne micranotis* (Dwarf toad).

Those present on the UDSM, 1997 list as vulnerable are, *Crocidura cf. elongius* (White-toothed shrew), *Bufo brauni* (Dead leaf toad), *Leptopelis barbouri* (Tree frog), *Arthroleptides martiensseni* (Usambara montane torrent frog) and *Scolecophorus vittatus* (Caecilian).

6.0 CONCLUSIONS

Authors: Bracebridge, C.E. and Oliver, S.A. pp. 73-74

This report presents the data collected during the baseline biodiversity survey of Mgambo Forest Reserve. The report presents preliminary checklists of flora and fauna groups and categorises the ecological type and endemic status of species. These two factors provide an indication of three aspects of biodiversity and conservation:

1. the relationship between forest dependency and endemism;
2. the extent to which non-forest species are established in the reserve; and
3. the relationship between disturbance and areas of biological value.

Mgambo Forest Reserve was gazetted in July 1998. The gazetted reserve covers an area of 1,346ha, with an altitudinal range of 320m - 820m. The forest reserve has altered significantly in recent years as a consequence of intensive overgrazing and fire damage. It is presently made up of a mixture of riverine forest, lowland forest, scrub forest, *Miombo* woodland and open woodland, all subject to a variety of different levels of disturbance.

6.1 Disturbance

Fire was the most significant threat to both flora and fauna in Mgambo FR, and was recorded in just over two thirds of all vegetation plots sampled. There were no vegetation plots surveyed with canopy heights greater than 20m. Open grass/bushland and woodland habitats were dominant in burnt areas, increasing the susceptibility of the reserve to future fire disturbance.

One of the causes of deliberate fire was to provide fresh grazing for livestock, and, indeed, another major disturbance category for Mgambo was grazing. This was also predominantly found on the eastern side of the reserve. Other forms of disturbance, such as pole and timber extraction, trapping, cultivation and pitsawing, were relatively low in Mgambo FR.

6.2 Species Richness

Mgambo FR was found to contain a minimum of 101 species of plant, 34 mammal, 10 bat, 52 bird, 25 reptile, 14 amphibian and 138 butterfly species (figures for molluscs and millipedes have yet to be determined). The number of faunal species found in Mgambo FR was fewer than the number found within nearby forest reserves, (refer to Frontier Tanzania, 2002c and 2002d, and Frontier Tanzania, 1999). Relative to the other thirteen forest reserves surveyed by Frontier-Tanzania Mgambo FR had a below average species richness for plants, and a below average species richness of mammals, an average species richness for reptiles and amphibians and a high species richness for butterflies. Species richness was likely to be associated with forest reserve size and the degree of patchiness and/or isolation of forested areas. Mgambo FR is relatively small in size with patchy distribution of forest habitats that are isolated as a consequence of grazing and fire disturbance.

6.3 Flora

Only one tree species recorded in the vegetation plots was endemic to the Usambara Mountains. Twelve species were found to have ranges restricted to the Eastern Arc and/or East African lowland forests. Five species were dependent on primary forest and 62 were forest dwelling.

Twenty-seven non-forest tree and shrub species were established within the reserve boundaries.

6.4 Fauna

Twenty three species were listed as near endemic to the Usambara Mountains. Thirty eight fauna species were forest dependant, many of which were butterflies.

Three species recorded in Mgambo FR have endangered status (either listed by IUCN, 2000 or UDSM, 1997) - one mammal, one reptile and one amphibian species.

6.5 Conservation

The forests of the East Usambara Mountains are recognised as being part of a Biodiversity Hotspot (Mittermeier, 1999), an Endemic Bird Area (ICBP, 1992), a Centre of Plant Diversity (WWF and IUCN) and a Globally Important Ecoregion (WWF). They are a conservation priority due to their floral and faunal diversity and to the high number of endemic species. The forests also have a direct value to surrounding communities as a principle water catchment area and as a source of fuel-wood and medicinal plants.

The forests of the East Usambara Mountains have been reduced to fragments within a matrix of agricultural land. Little forest remains outside of the gazetted forest reserves. For those species that are forest dependent, the forest reserves now provide almost the only available habitat.

There are differences in the perceived value of the forests between the villagers and the Forest and Beekeeping Division. Alternative sources of building material and fuel are required in order to meet the needs of surrounding villages while ensuring the protection of the forests.

The impact of illegal fire damage and overgrazing is of serious concern throughout Mgambo Forest Reserve and increased protection is required to prevent future disturbance destroying the patches of forest that remain. Further degradation of forest habitats in Mgambo FR will lead to local population extinctions, particularly of those species identified as being at high risk. The loss of forested areas in Mgambo will also reduce the reliability of the water supply to neighbouring communities.

It is likely that past hunting has seriously depleted large mammal populations. Present data supports this. Little can presently be done to reverse this problem unless the need for forest meat disappears.

Mgambo FR, as one of the smaller forest blocks in the East Usambara Mountains, has a particularly high risk of flora and faunal population extinctions compared to larger forest reserves. There is a need for older generations and forestry managers, jointly, to reinitiate a sense of responsibility amongst younger and less knowledgeable generations, to insure the importance of the remaining forest is known. This will go some way towards helping the sustainable management of their forest reserve. Small scale environmental education activities during the present survey went some way to promote such an idea (refer to Frontier Tanzania, 2002a and Frontier, 2002b), but much work remains. Mgambo FR is thought to be a very suitable location for the implementation of Joint Forest Management activities. Surrounding communities have well organised and active village and environmental committees.

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8.0 APPENDICES

Appendix 1: Taxonomic Verification

BOTANY

Albert Ntemi Sallu EUCAMP P.O. Box 5869, Tanga, Tanzania.
usambara@twiga.com

ZOOLOGY

Mammals:

Prof. Kim Howell UDSM Department of Zoology University of Dar es Salaam,
P.O. Box 35064, Dar es Salaam,
Tanzania
khowell@twiga.com

Dr. Dieter Kock Frankfurt Zoological Museum Saugetiere III, Senckenberg,
Senckenberganlage 25, 60325
Frankfurt am Main, Germany
dkock@sng.uni-frankfurt.de

Amphibians:

Prof. Kim Howell UDSM Department of Zoology University of Dar es Salaam,
P.O. Box 35064, Dar es Salaam,
Tanzania
khowell@twiga.com

Prof. J. Poynton British Natural History Museum Cromwell Road, South Kensington,
London, UK.

Reptiles:

Prof. Kim Howell UDSM Department of Zoology University of Dar es Salaam,
P.O. Box 35064, Dar es Salaam,
Tanzania
khowell@twiga.com

Dr. Don Broadley Natural History Museum, Zimbabwe P.O. Box 240,
Bulawayo, Zimbabwe
bfa@coldfire.dnet.co.zw

Molluscs:

C/O Dr N. Scharff Zoological Museum University of Copenhagen,
Universitetsparken 15, DK-2100,
Copenhagen, Denmark

Millipedes:

C/O Dr N. Scharff Zoological Museum University of Copenhagen,
Universitetsparken 15, DK-2100,
Copenhagen, Denmark

Butterflies

C/O Dr N. Scharff Zoological Museum University of Copenhagen,
Universitetsparken 15, DK-2100,
Copenhagen, Denmark

Appendix 2: GPS Co-ordinates of vegetation plots

Summary of GPS Coordinates of vegetation plots in Mgambo FR.

Vegetation Plot	Longitude	Latitude	Grid Ref. 37M	Grid Ref. UTM
1	E 038°48'39.9"	S 04°47'21.0"	0479052	9470687
2	E 038°48'25.2"	S 04°47'23.0"	0478598	9470626
3	E 038°48'40.0"	S 04°46'52.0"	0479052	9471578
4	E 038°48'25.5"	S 04°46'52.8"	0478607	9471554
5	E 038°48'10.0"	S 04°46'52.4"	0478130	9471563
6	E 038°48'54.6"	S 04°46'23.1"	0479503	9472465
7	E 038°48'40.6"	S 04°46'22.6"	0479072	9472479
8	E 038°48'26.1"	S 04°46'24.0"	0478624	9472437
9	E 038°49'09.3"	S 04°45'51.7"	0479956	9473429
10	E 038°48'55.2"	S 04°45'52.5"	0479523	973405
11	E 038°48'40.9"	S 04°45'52.7"	0479080	9473397
12	E 038°48'27.3"	S 04°45'54.7"	0478662	9473336
13	E 038°48'12.3"	S 04°45'55.0"	0478199	9473328
14	E 038°47'58.0"	S 04°45'55.4"	0477760	9473317
15	E 038°47'43.6"	S 04°45'56.3"	0477315	9473287
16	E 038°47'29.4"	S 04°45'57.3"	0476878	9473254
17	E 038°47'15.2"	S 04°45'58.2"	0476440	9473228
18	E 038°49'09.3"	S 04°45'22.3"	0479956	9474330
19	E 038°48'54.6"	S 04°45'23.2"	0479501	9474304
20	E 038°48'39.7"	S 04°45'24.3"	0479045	9474271
21	E 038°48'26.2"	S 04°45'25.0"	0478629	9474249
22	E 038°48'26.3"	S 04°45'24.5"	0477765	9474208
23	E 038°47'58.0"	S 04°45'28.5"	0477757	9474200
24	E 038°47'58.0"	S 04°45'26.5"	0477330	9474166
25	E 038°47'29.5"	S 04°45'29.4"	0476882	9474113
26	E 038°48'42.4"	S 04°47'50.4"	0479127	9469784
27	E 038°48'54.7"	S 04°44'53.1"	0479505	9475228
28	E 038°48'40.1"	S 04°44'53.9"	0479055	9475202
29	E 038°47'43.8"	S 04°46'25.8"	0477322	9472382
30	E 038°47'28.9"	S 04°46'26.9"	0476863	9472347
31	E 038°47'16.2"	S 04°46'26.3"	0476473	9472365

Appendix 3: General vegetation plot descriptions

Summary of vegetation plot descriptions in Mgambo FR.

Plot No.	Topography	Altitude (masl)	Slope (degrees)	Vegetation Condition	Canopy Height (m)	Disturbance Category	Features of Interest	No. species	No. indivs	Dominant sp.
1	GLS	360	6	Open woodland	<10	Fire	Roads/Tracks	10	27	<i>Combretum zeyheri</i>
2	GMS	510	6	Scrub/Thicket/Bush	<10	Cutting/Fire	Clearings	14	32	
3	SLS	430	24	Open woodland	<10	Cutting/Fire	None	8	15	
4	SLS	460	27	Open woodland	10-20	Fire	Rock outcrops	16	37	
5	SUS	570	32	Lowland Forest	10-20	Fire	None	15	27	
6	GMS	420	5	Open woodland	<10	Cutting/Fire	None	4	13	<i>Combretum zeyheri</i>
7	SLS	530	35	Open woodland	<10	Fire	None	18	30	
8	SLS	340	30	Lowland Forest	10-20	Cutting/Fire/Grazing	None	18	42	<i>Maytenus undata</i>
9	GMS	400	7	Open woodland	<10	Fire	None	9	28	<i>Combretum zeyheri</i>
10	GMS	480	22	Open woodland	<10	Fire	Rock outcrops	9	26	<i>Acacia hockii</i>
11	GMS	600	34	Open woodland	10-20	Fire/Grazing	Footpaths	7	22	<i>Brachystegia spiciformis</i>
12	SLS	640	30	Open woodland	10-20	Cutting/Fire/Grazing	Rock outcrops	7	23	<i>Stereospermum kunthianum</i>
13	GLS	420	15	Open woodland	<10	Cutting	Roads/Paths	8	30	<i>Dombeya shupangae</i>
14	GMS	960	29	Lowland Forest	10-20	Fire	Path/Rock outcrops	16	46	
15	SMS	635	36	Open woodland	<10	Fire	None	9	18	
16	GUS	600	20	Scrub/Thicket/Bush	<10	Fire	None	7	12	
17	GLS	510	8	Scrub/Thicket/Bush	10-20	Fire	Roads/Tracks	5	12	<i>Acacia nilotica</i>
18	GLS	440	6	Open woodland	<10	Cutting/Fire	None	3	3	
19	GMS	500	13	Open woodland	<10	Cutting/Fire	None	6	16	<i>Combretum zeyheri</i>
20	GUS	610	30	Open woodland	10-20	Fire	None	4	24	<i>Brachystegia spiciformis</i>
21	GMS	505	21	Scrub/Thicket/Bush	<10	None	None	13	32	
22	GLS	440	7	Open woodland	<10	None	None	10	28	<i>Dombeya shupangae</i>
23	GMS	440	26	Scrub/Thicket/Bush	<10	None	None	16	38	<i>Grewia bicolor</i>
24	GUS	520	30	Open woodland	<10	None	None	15	35	<i>Grewia bicolor/Cordia ovalis</i>
25	GMS	560	5	Scrub/Thicket/Bush	<10	Cutting	None	17	58	
26	GMS	450	16	Open woodland	<10	Cutting/Fire	Roads/Tracks	17	42	
27	GLS	400	11	Open woodland	<10	Fire	None	5	30	<i>Combretumzeyhyri</i>
28	GUS	470	25	Lowland Forest	<10	Cutting	None	22	33	.
29	SUS	800	35	Open woodland	10-20	Cutting/Grazing	None	7	13	
30	SUS	780	30	Open woodland	10-20	Fire	None	5	12	
31	GMS	560	17	Lowland Forest	10-20	Cutting	Rock outcrops	13	41	

KEY Topography: GLS – Gentle lower slope, GMS – Gentle mid-slope, GUS – Gentle upper slope, SLS – Steep lower slope, SMS – Steep mid slope

Appendix 4: New flora for the East Usambara plant biodiversity database

Summary of new flora records for the East Usambara Plant Biodiversity Database (Pohjonen, 2001) from vegetation plots and opportunistic collection, Mgambo FR.

VEGETATION PLOT TREES AND SHRUBS

ANACARDIACEAE	<i>Ozoroa insignis</i>
ANACARDIACEAE	<i>Sclerocarya birrea</i>
COMBRETACEAE	<i>Combretum exalatum</i>
EUPHORBIACEAE	<i>Spirostachys africana</i>
FLACOURTIACEAE	<i>Dovyalis hispidula</i>
LEGUMINOSAE	<i>Cassia abbreviata</i>
LEGUMINOSAE	<i>Erythrina abyssinica</i>

OPPORTUNISTIC COLLECTION AND OBSERVATION (MLINGA)

Angiospermae – Dichotyledonae

ACANTHACEAE	<i>Acanthaspermum hispidum</i>
BORAGINACEAE	<i>Cordia goetzei</i>
FLACOURTIACEAE	<i>Dovyalis hispidula</i>
LABIATAE	<i>Orthosiphon rubicondus</i>
RUBIACEAE	<i>Polysphaeria lanceolata</i>
RUBIACEAE	<i>Psychotria ambonian</i>
ICACINACEAE	<i>Pyranacantha</i> sp.
ASCELPIDACEAE	<i>Secamone</i> sp.
OLACACEAE	<i>Ximenia caffra</i>

* Species recorded in regeneration layer as well as vegetation plots

Appendix 5: Useful plants

A summary of useful plants sampled systematically in vegetation plots in Mgambo FR (based on Ruffo, 1989)

	Building Poles	Fuelwood	Tool handles	Pestles	Mortars	Ornamental	Dyes	Honey	Edible fruits	Other
ANACARDIACEAE										
<i>Sorindeia madagascariensis</i>		+	+		+				+	Wooden spoons
BOMBACEAE										
<i>Rhodognaphalon schumannianum</i>	+									
BURSERACEAE										
<i>Commiphora eminii</i> ssp. <i>zimmermannii</i>										Cups
COMBRETACEAE										
<i>Combretum schumannii</i>	+	+		+				+		
<i>Terminalia sambesiaca</i>				+				+		
EUPHORBIACEAE										
<i>Bridelia micrantha</i>	+	+	+	+			+	+		
LEGUMINOSAE subfamily: MIMOSOIDEAE										
<i>Albizia gummifera</i>		+			+			+		
LEGUMINOSAE subfamily: PAPILIONIDAE										
<i>Milletia dura</i>	+									
MELIACEAE										
<i>Turraea holstii</i>										Wooden spoons
MORACEAE										
<i>Milicia excelsa</i>					+		+			
MYRSINACEAE										
<i>Baeobotrys lanceolata</i>								+		
RUBIACEAE										
<i>Vangueria tomentosa</i>									+	
RUTACEAE										
<i>Zanthoxylum</i> sp.								+		
STERCULIACEAE										
<i>Cola clavata</i>	+		+							Wooden spoons
TILIACEAE										
<i>Grewia</i> sp.								+		

Appendix 6: Medicinal plants

Summary of Medicinal Plants recorded in Mgambo FR (Sallu A.N, (2002).

Family	Genus	species	Local name
Agavaceae	<i>Dracaena</i>	<i>steudneri</i>	Papata
Amaranthaceae	<i>Pupalia</i>	<i>atropurpurea</i>	Mamata
Ampelaceae	<i>Ampelocissus</i>	<i>grantii</i>	Tongotongo
Anacardiaceae	<i>Rhus</i>	<i>natalensis</i>	Mhunguu
Anacardiaceae	<i>Lannea</i>	<i>schweinfurthii</i>	Mumbu
Anacardiaceae	<i>Mangifera</i>	<i>indica</i>	Mwembe dodo
Annonaceae	<i>Uvaria</i>	<i>acuminata</i>	Mshofu
Araceae	<i>Culcasia</i>	<i>scandens</i>	Kiandama
Araceae	<i>Gonatopus</i>	<i>boivinii</i>	Mshunghuu
Asclepidaceae	<i>Kanahia</i>	<i>laniflora</i>	Keema nkuuka
Asteraceae	<i>Crassocephalum</i>	<i>bojeri</i>	Eza
Asteraceae	<i>Blepharispermum</i>	<i>zanguebaricum</i>	Mlenga
Asteraceae	<i>Vernaonia</i>	<i>iodocalyx</i>	Mshasha
Asteraceae	<i>Microglossa</i>	<i>oblongifolia</i>	Mshashu
Asteraceae	<i>Sonchus</i>	<i>exauricalatus</i>	Mshunga
Asteraceae	<i>Sonchus</i>	<i>oleraceus</i>	Mshunga purapura
Asteraceae	<i>Aspilia</i>	<i>mossambicensis</i>	Nyangaanyangaa
Asteraceae	<i>Loggera</i>	<i>pterodonta</i>	Tulishi
Astersceae	<i>Bidens</i>	<i>pilosa</i>	Khamachuma
Balanitaceae	<i>Balanites</i>	<i>aegyptica</i>	Mkonga
Bignoniaceae	<i>Stereospermum</i>	<i>kunthianum</i>	Mkoma
Bignoniaceae	<i>Markhamia</i>	<i>lutea</i>	Mtalawanda
Bombacaceae	<i>Adansonia</i>	<i>digitata</i>	Mbuyu
Bombacaceae	<i>Bombax</i>	<i>rhodognaphalon</i>	Msufi mwitu
Caesalpinaceae	<i>Julbernardia</i>	<i>globiflora</i>	Mhangala
Caesalpinaceae	<i>Cassia</i>	<i>sengueana</i>	Mhumba
Caesalpinaceae	<i>Afzelia</i>	<i>quanzensis</i>	Mkomba
Caesalpinaceae	<i>Isoberlinia</i>	<i>scheffleri</i>	Msuke
Capparaceae	<i>Boscia</i>	<i>salicifolia</i>	Mguluka

Medicinal Plants Table continued

Family	Genus	species	Local name
Capparaceae	<i>Maerua</i>	<i>grantii</i>	Mtunda
Chaillentaceae	<i>Tapura</i>	<i>fischeri</i>	Msonogoi
Combretaceae	<i>Combretum</i>	<i>schummanii</i>	Mkongolo
Combretaceae	<i>Combretum</i>	<i>molle</i>	Mnama
Combretaceae	<i>Combretum</i>	<i>exalatum</i>	Mwekei
Commelinaceae	<i>Commelina</i>	<i>africana</i>	Nkongo
Cucurbitaceae	<i>Melothria</i>	<i>microsperma</i>	Fuiza
Cucurbitaceae	<i>Zehneria</i>	<i>scabra</i>	Fuiza
Cyperaceae	<i>Cyperus</i>	<i>alternifolia</i>	Zira
Ebenaceae	<i>Euclea</i>	<i>fructuosa</i>	Mdaa
Ebenaceae	<i>Diospyros</i>	<i>natalensis</i>	Mtambakuzimu
Euphorbiaceae	<i>Drypetes</i>	<i>usambarica</i>	Kihambie
Euphorbiaceae	<i>Jatropha</i>	<i>curcas</i>	Mbono
Euphorbiaceae	<i>Phyllanthus</i>	<i>innflatus</i>	Mkeche
Euphorbiaceae	<i>Phyllanthus</i>	<i>inflatus</i>	Mkeche
Euphorbiaceae	<i>Sapium</i>	<i>ellipticum</i>	Mkongoo
Euphorbiaceae	<i>Macaranga</i>	<i>capensis</i>	Mkumba
Euphorbiaceae	<i>Phyllanthus</i>	<i>guincensis</i>	Mkwamba
Euphorbiaceae	<i>Spirostachys</i>	<i>africana</i>	Msharaka
Euphorbiaceae	<i>Acalypha</i>	<i>paniculata</i>	Mzindu
Euphorbiaceae	<i>Ricinus</i>	<i>communis</i>	Mzono
Euphorbiaceae	<i>Ricinodendron</i>	<i>heudelotii</i>	Toodoo
Flacourtiaceae	<i>Dasylepis</i>	<i>leptophylla</i>	Kigwande
Graminae	<i>Eleusine</i>	<i>indica</i>	Kikuse
Graminae	<i>Pennisetum</i>	<i>purpureu</i>	Ngugu
Graminae	<i>Olyra</i>	<i>latifolia</i>	Ufiha
Graminae	<i>Oplismenus</i>	<i>hirlellus</i>	Ukoka
Graminae	<i>Rotteboellia</i>	<i>axaltata</i>	Ushuki
Hamamelidaceae	<i>Trichocladus</i>	<i>allipticus</i>	Mkombechi
Icacinaceae	<i>Leptaulis</i>	<i>holstii</i>	Mkungu
Labiatae	<i>Hyptis</i>	<i>pectinata</i>	Hozandogoi

Medicinal Plants Table continued

Family	Genus	species	Local name
Labiatae	<i>Lipia</i>	<i>asperifolia</i>	Mzugwa
Labiatae	<i>Ocimum</i>	sp.	Vumba manga
Labitae	<i>Plectranthus</i>	<i>amaniensis</i>	Hozandogoi
Labitae	<i>Ocimum</i>	<i>suave</i>	Kivumbasi
Labitae	<i>Hoslundia</i>	<i>oposita</i>	Mshwee
Labitae	<i>Plectranthus</i>	<i>barbatus</i>	Mzugwa
Loganiaceae	<i>Strychnos</i>	<i>innocua</i>	Mtonga
Menispermaceae	<i>Stephania</i>	<i>abyssinica</i>	Usisi mdodo
Mimosaceae	<i>Acacia</i>	<i>mellifera</i>	Kikwata
Mimosaceae	<i>Acacia</i>	sp	Mgungamwita
Mimosaceae	<i>Acacia</i>	<i>clavigera</i>	Mkame
Mimosaceae	<i>Albizia</i>	<i>harveyi</i>	Msisimizi
Monimiaceae	<i>Xymaros</i>	<i>monospora</i>	Kidimudimu
Moraceae	<i>Ficus</i>	<i>kirkii</i>	Kinyandegé
Moraceae	<i>Ficus</i>	<i>sur</i>	Mkuyu
Moraceae	<i>Ficus</i>	<i>valis choudae</i>	Mkuyu maji
Moraceae	<i>Ficus</i>	<i>exasperata</i>	Msasa
Moraceae	<i>Ficus</i>	<i>holstii</i>	Msoso
Moraceae	<i>Ficus</i>	<i>natalensis</i>	Mvumo
Moraceae	<i>Milicia</i>	<i>excelsa</i>	Mzutwe
Musaceae	<i>Musa</i>	sp	Tindi
Myrtaceae	<i>Psidium</i>	<i>guajava</i>	Mpea
Myrtaceae	<i>Myrica</i>	<i>salicifolia</i>	Mshegheshe
Olacaceae	<i>Ximenia</i>	<i>americana</i>	Mtundwi
Onaginaceae	<i>Jussiaea</i>	sp	Kisagata
Palmae	<i>Cocos</i>	<i>nucifera</i>	Mnazi
Palmae	<i>Borassus</i>	<i>aethiopum</i>	Mvuma
Papilionaceae	<i>Cajanus</i>	<i>cajan</i>	Mbaazi
Papilionaceae	<i>Lonchocarpus</i>	<i>bussei</i>	Mfumbii
Papilionaceae	<i>Entada</i>	<i>abyssinica</i>	Mgodogodo
Papilionaceae	<i>Dalbergia</i>	<i>melanoxylon</i>	Mpingo

Medicinal Plants Table continued

Family	Genus	species	Local name
Papilionaceae	<i>Dalbergia</i>	<i>elata</i>	Msangazi
Papilionaceae	<i>Abrus</i>	<i>precatorius</i>	Ufyambo
Passifloraceae	<i>Adenia</i>	<i>cissampeloides</i>	Ghoe
Piperaceae	<i>Piper</i>	<i>capnesis</i>	Ngoko
Polygonaceae	<i>oxygonumatriplici</i>	<i>folium</i>	Mbigili
Rubiaceae	<i>Canthium</i>	sp	Mlawa
Rubiaceae	<i>Rytigynia</i>	<i>amaniensis</i>	Msonganya
Rubiaceae	<i>Vangueria</i>	<i>infausta</i>	Mvui
Rutaceae	<i>Citrus</i>	<i>aurantifolia</i>	Mdimu
Rutaceae	<i>Toddalia</i>	<i>asiatica</i>	Mdongonyezi
Rutaceae	<i>Zanthoxylum</i>	<i>eickii</i>	Mhombo
Rutaceae	<i>Citrus</i>	<i>aurantium</i>	Mshusa
Sapindaceae	<i>Alluphyllus</i>	<i>abyssinica</i>	Mbangwe
Sapindaceae	<i>Allophylus</i>	<i>calophyllus</i>	Mbangwe
Sapindaceae	<i>Deinbollia</i>	<i>borbonica</i>	Mbwakabwaka
Sapindaceae	<i>Lecaniodiscus</i>	<i>fraxinifolia</i>	Mbwewe
Sapindaceae	<i>Blighia</i>	<i>unijugata</i>	Mzinda nguuwe
sapotaceae	<i>Afrosersalsia</i>	<i>cerasifora</i>	Mohoyo
Solanaceae	<i>Solanum</i>	<i>incanum</i>	Mtua
Solanaceae	<i>Nicotiana</i>	<i>tabacum</i>	Tumbaku
Sterculiaceae	<i>Sterculia</i>	<i>appendiculata</i>	Mfune
Sterculiaceae	<i>Dombeya</i>	<i>shupangae</i>	Mkiika
Sterculiaceae	<i>Dombeya</i>	<i>rotundifolia</i>	Mkilika
Sterculiaceae	<i>Dombeya</i>	<i>guingueseta</i>	Mlwati
Tiliaceae	<i>Grewia</i>	<i>forbesii</i>	Mkongodeka
Ulmaceae	<i>Trema</i>	<i>orientalis</i>	Mshinga
Umbeliferae	<i>Steganotaenia</i>	<i>araliacea</i>	Mnyongampembe
Verbenaceae	<i>Lantana</i>	<i>camara</i>	Mvuti
Zingiberaceae	<i>Aframomum</i>	<i>angustifolium</i>	Samaka

Appendix 7: Regeneration plot descriptions

Summary of regeneration plot descriptions in Mgambo FR.

Regen. Plot	Habitat	Ground cover (%)				Dominance (%)			Soil Texture	Soil Colour	No. of inds.	No. of species
		Herbs	Bare soil	Litter	Rocks	Grasses	Forbs	Sages				
1	Open Woodland	60	20	10	10	55	10	0	sandy-loam	dark brown	9	3
2	Scrub/Thicket/Bush	50	30	20	0	40	60	0	sandy-loam	dark brown	5	2
3	Open Woodland	50	30	5	15	80	20	0	sandy-loam	dark brown	14	2
4	Open Woodland	10	20	30	40	10	90	0	loam	dark brown	1	1
5	Lowland Forest	45	40	10	5	80	20	0	loamy-clay	brown	3	2
6	Open Woodland	40	40	0	20	55	45	0	sandy-loam	dark brown	29	6
7	Open Woodland	10	30	60	0	10	90	0	loam	brown	5	3
8	Lowland Forest	5	15	80	0	2	98	0	loam	dark grey	9	5
9	Open Woodland	50	30	20	0	60	40	0	clay	brown	8	2
10	Open Woodland	70	30	0	20	90	10	0	sandy-loam	dark grey	3	1
11	Open Woodland	45	20	30	15	60	40	0	sandy-loam	brown	2	1
12	Open Woodland	50	20	30	0	80	20	0	loamy-clay	dark brown	2	1
13	Open Woodland	50	40	10	0	80	20	0	sandy-clay	dark brown	3	2
14	Lowland Forest	10	10	80	0	0	100	0	loamy-clay	dark brown	1	1
15	Open Woodland	70	10	20	0	95	5	0	loam	black	1	1
16	Scrub/Thicket/Bush	60	30	10	0	90	10	0	sandy-loam	brown	8	5
17	Scrub/Thicket/Bush	50	40	10	0	80	20	0	sandy-loam	brown	9	2
18	Open Woodland	80	20	0	0	80	20	0	loamy-clay	brown	3	2
19	Open Woodland	45	40	15	0	80	20	0	loamy-clay	dark brown	5	2
20	Open Woodland	25	0	70	5	50	40	10	sandy-loam	red brown	1	1
21	Scrub/Thicket/Bush	10	5	85	0	0	100	0	loam	brown	1	1
22	Open Woodland	60	0	40	0	60	40	0	loam	dark brown	0	0
23	Scrub/Thicket/Bush	5	20	75	0	0	100	0	sandy-loam	light grey	0	0
24	Open Woodland	40	40	20	0	10	90	0	loamy-clay	brown	4	3
25	Scrub/Thicket/Bush	10	0	90	0	0	100	0	loamy-clay	brown	28	2
26	Open Woodland	20	30	50	0	70	30	0	sandy-clay	dark brown	4	3
27	Open Woodland	60	30	10	0	95	5	0	loamy-clay	red brown	3	3
28	Lowland Forest	15	50	35	0	10	80	0	sandy-clay	brown	17	5
29	Open Woodland	85	0	15	0	90	10	0	loam	dark brown	1	1
30	Open Woodland	100	0	0	0	100	0	0	loamy-clay	dark brown	0	0
31	Lowland Forest	20	0	50	30	0	100	0	loamy-clay	dark brown	1	1
	MEAN	41.94	22.26	31.61	5.16	52.00	46.23	0.32			5.81	2.06
	Standard Deviation	25.26	14.80	28.10	9.96	35.73	36.03	1.77			7.19	1.50

Appendix 8: Mammal capture data

8a Summary of small mammal capture at zoological trapsites in Mgambo FR (refer to Tables 18 and 19 for trapsite locations, descriptions and sampling intensity).

Species	Number of individuals caught in trapsites 1-6 (sampling intensity in Sherman trap nights)						No. of individuals captured (4110)	No. of recaptures	Total specimens taken
	1 (998)	2 (989)	3 (997)	4 (997)	5 (29)	6 (100)			
SORICIDAE									
<i>Crocidura bicolor</i>	-	1	-	-	-	-	1	-	1
<i>Crocidura elongius</i>	-	5	-	1	-	-	6	-	5
<i>Crocidura hirta/xantippe</i>	-	2	-	-	-	-	2	-	2
<i>Crocidura hildegardeae</i>	1	-	-	-	-	-	1	-	1
<i>Crocidura</i> sp.	2	-	1	-	-	-	3	-	3
MURIDAE									
<i>Acomys spinosissimus</i>	1	21	-	-	1	-	23	10	3
<i>Grammomys</i> sp.	-	-	1	-	-	-	1	-	1
<i>Mastomys natalensis</i>	-	1	-	-	-	-	1	-	1
MYOXIDAE									
<i>Graphiurus</i> sp.	-	-	1	-	-	-	1	-	1
TOTAL	4	30	3	1	1	0	39	10	18

8b Summary of bat capture at bat-netting sites in Mgambo FR (refer to Table 20).

Species	Number of individuals caught in bat net sites 1-3 (sampling intensity in net square meter hours)				Total no. individuals captured (1548)	Total specimen taken
	1 (52.7)	2 (416)	3 (684.8)	4 (390)		
NYCTERIDAE						
<i>Nycteris</i> sp.	-	-	1	-	1	1
<i>Nycteris grandis</i>	-	-	1	-	1	1
PTEROPODIDAE						
<i>Epomorphus wahlbergi</i>	-	-	1	2	3	1
RHINOLOPHIDAE						
<i>Hipposideros caffer / ruber</i>	2	-	-	-	2	1
<i>Rhinolophus clivosus</i>	14	1	-	3	18	5
<i>Rhinolophus hildebrandti</i>	1	4	-	-	5	2
<i>Rhinolophus landeri</i>	-	-	1	-	1	1
VESPERTILIONIDAE						
<i>Glauconycteris argentata / variegata</i>	-	1	6	-	7	2
<i>Nyctecius shlieffeni</i>	1	-	-	-	1	1
<i>Scotoecus</i> sp.	-	-	6	-	6	2
TOTAL	18	6	16	5	45	17

Appendix 9: Reptile capture data

Summary of reptile capture at zoological trapsites and during opportunistic collection in Mgambo FR (refer to Tables 18 and 19 for trapsite locations, descriptions and sampling intensity).

Species	Number of individuals caught in traps at trapsites 1-4 (sampling intensity in trap nights)				Casual collections	Total no. individuals captured	Total specimens taken
	1 (330)	2 (330)	3 (330)	4 (330)			
CHAMAELEONIDAE							
<i>Rhampholeon k. kerstenii</i>	-	1	-	-	-	1	1
COLUBRIDAE							
<i>Natriciteres olivacea</i>	-	-	-	-	2	2	2
<i>Philothamnus</i> sp.	-	-	-	-	1	1	1
<i>Psammophis sudanensis</i>	-	-	-	-	2	2	2
<i>Scaphiophus albopunctatus</i>	-	-	-	5	-	5	1
Unknown genus	-	-	1	-	1	1	1
ELAPIDAE							
<i>Dendroaspis angusticeps</i>	-	-	-	-	1	1	1
<i>Naja</i> sp.	1	-	-	-	-	1	1
GEKKONIDAE							
<i>Cnemaspis africana</i>	1	-	1	-	-	2	2
<i>Hemidactylus</i> sp.	-	-	-	-	1	1	1
<i>Hemidactylus platycephalus</i>	-	-	2	-	-	2	1
<i>Pachydactylus</i> sp.	-	-	-	-	1	1	1
GERRHOSAURIDAE							
<i>Gerrhosaurus flavigularis</i>	1	10	-	-	-	11	2
<i>Gerrhosaurus</i> sp.	-	-	-	-	-	1	1
LACERTIDAE							
<i>Heliobolus speckii speckii</i>	-	2	-	-	1	3	1
<i>Holaspis guentheri laevis</i>	-	-	-	-	1	1	1
<i>Latastia longicaudata</i>	-	1	-	1	-	2	2
LEPTOTYPHLOPIDAE							
<i>Leptotyphlops</i> sp.	-	-	-	-	2	2	2
SCINCIDAE							
<i>Mabuya maculilabris</i>	1	-	1	-	-	2	2
<i>Lygosoma</i> sp.	-	-	-	-	1	1	1
VIPERIDAE							
<i>Bitis arientans</i>	1	-	-	-	1	2	2
TOTAL	5	14	5	6	15	45	29

Appendix 10 : Amphibian capture data

Summary of amphibian capture at zoological trapsites and during opportunistic collection in Mgambo FR (refer to Tables 18 and 19 for trapsite locations, descriptions and sampling intensity).

Species	Number of individuals caught in traps Trapsites 1-4 (sampling intensity in bucket pitfall nights)				Casual collections	Total no. individuals captured*	Total specimens taken
	1 (330)	2 (330)	3 (330)	4 (330)			
ARTHROLEPTIDAE							
<i>Arthroleptis stenodactylus</i> *	53	-	25	-	-	78	3
<i>Arthroleptis xenodactyloides</i> *	39	-	32	-	-	71	7
BUFONIDAE							
<i>Bufo brauni</i>	7	-	-	-	-	7	2
<i>Bufo gutturalis</i>	-	-	-	-	1	1	-
<i>Bufo maculatus</i>	-	-	10	-	-	10	1
<i>Bufo</i> sp.	-	-	-	-	1	1	1
<i>Mertensophryne micranotis</i>	-	-	-	-	1	1	1
HEMISOTIDAE							
<i>Hemisis marmoratus</i>	6	-	10	-	-	16	2
HYPEROLIIDAE							
<i>Leptopelis barbouri</i>	1	-	-	-	4	5	1
PIPIDAE							
<i>Xenopus muelleri</i>	-	-	-	-	1	1	1
RHACOPHORIDAE							
<i>Chiromantis xerampelina</i>	-	-	-	-	1	1	1
RANIDAE							
<i>Arthroleptides martiensseni</i>	-	-	-	-	1	1	1
<i>Phrynobatrachus</i> sp.	-	-	-	-	1	1	1
<i>Rana angolensis</i>	2	-	1	-	4	7	2
SCOLECOMORPHIDAE							
<i>Scolecophorus vittatus</i>	1	-	-	-	-	1	1
TOTAL	109	0	78	0	15	202	25

*May include recaptures

Appendix 11: Butterfly capture data

11a Summary of butterfly capture in canopy traps at zoological trapsites 1 to 4 in Mgambo FR (refer to Tables 18 and 19 for trapsite locations, descriptions and sampling intensity).

Species	Number of individuals caught in canopy traps Trapsites 1-4 (sampling intensity in butterfly trap days)				Total no. individuals captured	No. of specimens taken
	1 (50)	2 (50)	3 (50)	4 (50)		
LYCAENIDAE						
<i>Baliochila hildegarda</i>	-	1	-	-	1	1
NYMPHALIDAE						
<i>Apaturoopsis cleochares schulzei</i>	1	-	-	-	1	1
<i>Bicyclus campinus ocelligerus</i>	-	-	2	-	2	0
<i>Bicyclus safitza safitza</i>	1	1	13		15	0
<i>Byblia ilithyia</i>	-	11	4		15	0
<i>Byblia anvataracheloia</i>	-	16	2	-	18	2
<i>Charaxes</i> sp ¹ .	-	1	-	-	1	1
<i>Charaxes</i> sp ² .	-	-	-	1	1	1
<i>Charaxes</i> sp ³ .	-	-	-	1	1	1
<i>Charaxes achaemenes achaemenes</i>	-	2		-	2	1
<i>Charaxes aubyni ecketti</i>	-	-	-	2	2	2
<i>Charaxes bohemani</i>	-	2	-	-	2	2
<i>Charaxes brutus</i>	1	15	45	17	78	3
<i>Charaxes candiope candiope</i>	1	10	35	31	77	2
<i>Charaxes castor castor</i>	2	3	2	11	18	2
<i>Charaxes cithaeron nairobicus</i>	2	1	29	4	36	3
<i>Charaxes contrarius</i>	-	1	14	18	33	2
<i>Charaxes</i> cf. <i>etheocles evansi</i>	-	-	3	-	3	1
<i>Charaxes etesipe gordonii</i>	1	1	-	1	3	1
<i>Charaxes ethalion kikuyensis</i>	-	2	6	3	11	3
<i>Charaxes fionae</i>	-	1	-	-	1	1
<i>Charaxes fulvescens</i>	1	-	-	-	1	1
<i>Charaxes guderiana rabaiensis</i>	-	2	-	-	2	2
<i>Charaxes</i> cf. <i>howarthi</i>	-	2	3	-	5	2
<i>Charaxes</i> cf. <i>hansali baringana</i>	-	1	1	1	3	1
<i>Charaxes jahlusa kenyensis</i>	-	1	9	19	29	1
<i>Charaxes kirki kirki</i>	-	2	3	1	6	1
<i>Charaxes lasti kimbozae</i>	-	-	4	-	4	1
<i>Charaxes lasti lasti</i>	1	-	7	-	8	1
<i>Charaxes protoaclea azota</i>	-	-	4	5	9	0
<i>Charaxes pythodoris nesaea</i>	1	-	-	-	1	1
<i>Charaxes saturnus</i>	-	1	1	1	3	1
<i>Charaxes varanes vologeses</i>	-	-	8	6	14	0
<i>Charaxes violetta maritimus</i>	9	-	29	5	43	1
<i>Charaxes zoolina zoolina</i>	-	6	15	19	40	5
<i>Danaus</i> sp.	-	1	-	-	1	1

11a continued

Species	Number of individuals caught in canopy traps Trapsites 1-4 (sampling intensity in butterfly trap days)				Total no. individuals captured	No. of specimens taken
	1 (50)	2 (50)	3 (50)	4 (50)		
NYMPHALIDAE continued.						
<i>Euptera kinugnana</i>	11	-	-	-	11	6
<i>Euryphura achlys</i>	-	-	1	1	2	1
<i>Eurytela dryope angulata</i>	1	2	10	5	18	2
<i>Euxanthe wakefieldi</i>	-	-	-	1	1	1
<i>Hamanumida daedalus</i>	2	-	1	-	3	1
<i>Henotesia</i> sp.	-	1	-	-	1	1
<i>Henotesia perspicua</i>	-	2	-	-	2	2
<i>Hypolimnias anhedon</i>	3	-	-	3	6	1
<i>Hypolimnias deceptor deceptor</i>	1	-	-	-	1	1
<i>Hypolimnias usambara</i>	1	-	-	-	1	1
<i>Libythea labdaca laius</i>	1	-	2	4	7	1
<i>Melantis leda</i>	2	5	25	12	44	2
<i>Pseudacraea lucretia expansa</i>	1	-	-	3	4	2
<i>Pseudacraea lucretia protracta</i>	2	-	-	6	8	2
<i>Sallya garega garega</i>	-	1	-	3	4	3
<i>Sallya natalensis</i>	-	2	1	1	4	2
PIERIDAE						
<i>Belenois creona severina</i>	-	-	-	3	3	0
TOTAL	46	97	279	188	610	78

11b Summary of butterflies caught sweepnetting at zoological trapsites and casually in Mgambo FR (refer to Tables 18 and 19 for trapsite locations, descriptions and sampling intensity).

Species	Number of individuals caught in systematic sweepnetting Trapsites 1-4 (sampling intensity in sweepnet hours)				Casual sweepnet captures	Total no. individuals captured	No. of specimens taken
	1 (20)	2 (20)	3 (20)	4 (20)			
HESPERIIDAE							
<i>Coeliades anchises anchises</i>	-	-	-	-	1	1	1
LYCAENIDAE							
<i>Aslauga purpurascens</i>	-	1	-	-	-	1	1
<i>Axiocerses amanga</i>	-	1	-	-	-	1	1
<i>Axiocerses harpax</i>	-	-	-	-	2	2	1
<i>Axiocerses punicea</i>	-	1	-	-	-	1	1
<i>Axiocerses tjoane</i>	-	1	-	-	1	2	1
<i>Baliochila cf. hildegarda</i>	-	2	-	-	-	2	2
<i>Baliochila sp.</i>	-	1	-	-	-	1	1
<i>Ornipholidotos peucetia peucetia</i>	1	-	-	-	-	1	1
<i>Pentila tropicalis</i>	-	1	-	-	-	1	1
<i>Spindasis mozambica</i>	-	4	-	-	1	5	3
<i>Teriominia subpunctata</i>	-	-	1	-	-	1	1
<i>Zizeeria knysna</i>	-	1	-	-	-	1	1
NYMPHALIDAE							
Unknown sp.	-	-	-	-	1	1	1
<i>Acraea sp.</i> ¹	-	-	-	1	-	1	1
<i>Acraea sp.</i> ²	-	-	-	-	1	1	1
<i>Acraea acrita</i>	-	1	-	-	-	1	1
<i>Acraea anemosa</i>	-	5	-	-	2	7	2
<i>Acraea eponina eponina</i>	1	-	-	-	1	2	1
<i>Acraea cf. macarista</i>	1	-	-	-	-	1	1
<i>Acraea cf. matuapa</i>	-	1	-	-	-	1	1
<i>Acraea natalica natalica</i>	-	1	-	-	-	1	1
<i>Acraea rabbaiae mombasae</i>	6	8	-	4	-	18	1
<i>Amauris ochlea ochlea</i>	-	-	-	-	1	1	1
<i>Bicyclus ena</i>	-	2	-	-	-	2	2
<i>Bicyclus safitza safitza</i>	-	4	11	-	2	17	1
<i>Byblia anvatara acheloia</i>	-	7	1	-	-	8	1
<i>Byblia ilithyia</i>	-	5	-	-	-	5	0
<i>Charaxes sp.</i> ⁴	-	-	-	-	1	1	0
<i>Charaxes cf. howarthi</i>	-	-	1	-	-	1	0
<i>Charaxes juhlasa kenyensis</i>	-	1	-	-	-	1	1
<i>Charaxes pleione oriens</i>	1	-	-	-	-	1	0
<i>Charaxes protoaclea azota</i>	-	-	-	-	1	1	1
<i>Charaxes zoolina zoolina</i>	1	-	-	1	-	2	1
<i>Charaxes varanes vologeses</i>	-	1	-	-	-	1	0
<i>Danaus sp.</i>	-	2	-	-	-	2	1

11b continued

Species	Number of individuals caught in systematic sweepnetting Trapsites 1-4 (sampling intensity in sweepnet hours)				Casual sweepnet captures	Total no. individuals captured	No. of specimens taken
	1 (20)	2 (20)	3 (20)	4 (20)			
NYMPHALIDAE continued.							
<i>Euphaedra neophron littoralis</i>	8	-	4	1	1	14	2
<i>Euptera kinugnana</i>	3	-	-	-	-	3	1
<i>Eurytela dryope angulata</i>	-	2	-	-	1	3	1
<i>Euxanthe tiberius</i>	1	-	-	-	-	1	1
<i>Hamanumida daedalus</i>	-	1	-	-	1	2	1
<i>Henotesia perspicua</i>	-	1	-	-	-	1	1
<i>Hypolimnas misippus</i>	-	-	-	-	1	1	1
<i>Hypolimnas cf. deceptor</i>	-	-	-	-	1	1	1
<i>Junonia oenone oenone</i>	-	-	-	-	1	1	0
<i>Junonia natalica natalica</i>	-	1	-	-	1	2	1
<i>Libythea labdaca laius</i>	-	-	1	1	-	2	1
<i>Melanitis leda</i>	-	1	4	-	-	5	0
<i>Neptis carcassoni</i>	-	-	-	1	-	1	1
<i>Neptis goochi</i>	-	-	-	-	1	1	1
<i>Neptis saclava marpessa</i>	1	-	-	-	-	1	1
<i>Phalanta phalantha aethiopicus</i>	-	1	-	-	-	1	1
<i>Physcaeneura leda</i>	1	1	-	-	-	2	1
<i>Pseudacraea eurytus condrati</i>	1	-	-	-	-	1	1
<i>Pseudacraea lucretia expansa</i>	1	-	-	-	-	1	0
<i>Salamis cf. anacardii.</i>	-	-	-	-	1	1	1
<i>Salamis cacta</i>	-	-	-	-	1	1	1
PAPILIONIDAE							
<i>Graphium angolanus angolanus</i>	-	-	-	-	2	2	1
<i>Graphium antheus</i>	1	1	-	1	-	3	2
<i>Graphium colonna</i>	-	-	-	-	1	1	0
<i>Graphium polices</i>	1	-	-	-	-	1	0
<i>Graphium porthaon mackie</i>	-	-	-	1	-	1	1
<i>Papilio bromius</i>	4	-	-	-	-	4	1
<i>Papilio constantinus</i>	-	2	-	-	1	3	1
<i>Papilio dardanus polytrophus</i>	1	-	1	14	-	16	1
<i>Papilio demodocus demodocus</i>	-	8	-	-	1	9	1
<i>Papilio hornimani</i>	-	-	-	1	-	1	1
<i>Papilio nireus lyaeus</i>	-	-	-	1	-	1	1
<i>Papilio ophidicephalus ophidicephalus</i>	-	-	-	1	1	2	1
PIERIDAE							
Unknown sp	-	-	-	-	1	1	1
<i>Appias epaphia orbona</i>	-	-	-	2	1	3	2
<i>Appias lasti lasti</i>	1	-	-	-	-	1	1
<i>Appias sabina phoebe</i>	1	-	-	-	-	1	1
<i>Belenois creona severina</i>	-	22	-	27	1	50	4

11b continued.

Species	Number of individuals caught in systematic sweepnetting Trapsites 1-4 (sampling intensity in sweepnet hours)				Casual sweepnet captures	Total no. individuals captured	No. of specimens taken
	1 (20)	2 (20)	3 (20)	4 (20)			
PIERIDAE continued							
<i>Belenois thysa thysa</i>	2	3	-	1	1	7	1
<i>Belenois subeida</i>	-	1	-	-	-	1	1
<i>Colotis aurigineus</i>	-	1	-	-	-	1	1
<i>Colotis auxo incretus</i>	-	4	-	1	-	5	4
<i>Colotis danae</i>	-	-	-	-	1	1	1
<i>Colotis cf. diara jacksoni</i>	-	1	-	-	-	1	1
<i>Colotis euipe omphale</i>	1	4	-	-	1	6	1
<i>Colotis evagore antigone</i>	-	1	-	-	-	1	1
<i>Colotis ione</i>	-	-	-	-	2	2	1
<i>Colotis regina</i>	-	7	-	1	-	8	1
<i>Colotis sp.¹</i>	-	1	-	-	-	1	1
<i>Colotis sp.²</i>	-	-	-	1	-	1	1
<i>Colotis vesta</i>	-	1	-	-	1	2	1
<i>Dixeia doxo</i>	-	1	-	-	-	1	1
<i>Eronia leda</i>	-	-	-	-	1	1	0
<i>Eurema brigatta brigatta</i>	-	1	-	-	-	1	1
<i>Eurema floricola</i>	6	1	-	-	1	8	2
<i>Eurema regularis</i>	-	5	-	-	1	6	3
<i>Mylothris agathina</i>	-	-	-	1	-	1	1
<i>Mylothris similis</i>	-	1	-	-	-	1	1
<i>Nepheronia argia argia</i>	2	-	-	-	2	4	1
TOTAL	47	125	24	62	45	303	101

11c. Summary of butterflies caught casually within Mgambo Forest reserve (excluding the zoological trapsites).

Species	Number. of individuals caught in casual sweepnet captures	Total no. of individuals captured	No. of specimens taken
LYCAENIDAE			
<i>Leptotes adamsoni</i>	1	1	1
NYMPHALIDAE			
<i>Acraea eponina eponina</i>	1	1	0
<i>Amauris niavius niavius</i>	1	1	1
<i>Bicyclus safitza safitza</i>	2	2	0
<i>Charaxes cithaeron</i>	1	1	1
<i>Junonia cf. hierta</i>	1	1	1
<i>Junonia oenone oenone</i>	1	1	1
<i>Neptidopsis fulgurata platyptera</i>	1	1	1
<i>Physcaeneura leda</i>	1	1	1
<i>Sallya</i> sp..	1	1	1
<i>Tirumala petiverana</i>	1	1	1
PAPILIONIDAE			
<i>Graphium leonidas leonidas</i>	1	1	1
<i>Graphium</i> sp.	1	1	0
<i>Papilio dardanus polytrophus</i>	1	1	1
<i>Papilio cf. hornimani</i>	2	2	0
PIERIDAE			
<i>Eurema floricola</i>	1	1	1
TOTAL	18	18	12

Appendix 12: East Usambara Conservation Area Management Programme Technical Paper Series

(ISSN 1236-620X)

The East Usambara Conservation Area Management Programme Technical Papers Series consists of reports on forestry issues in the East Usambara Mountains. This series started in 1991. These reports aim to make information more widely available to staff members of the East Usambara Conservation Area Management Programme, to the Forestry and Beekeeping Division, and to other institutions and individuals concerned and interested in the conservation of the East Usambara forests.

The reports are prepared by staff members of the East Usambara Conservation Area Management Programme or by other researchers, consultants and interested individuals. The views expressed in the reports are those of the author(s).

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