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Bombo East I Forest Reserve

A biodiversity survey

**Frontier Tanzania
2002**

East Usambara Conservation Area Management Programme

Technical Paper 57

Bombo East I Forest Reserve

A biodiversity survey

Staddon, S., Fanning, E., & Howell, K. M. (eds.)

**Ministry of Natural Resources and Tourism,
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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; and rehabilitating the Amani Botanical Garden. 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 Finnish Forest and Park Service. 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.

The University of Dar es Salaam (UDSM)

The University of Dar es Salaam was established in July 1970 as a centre for learning and research in the arts and the physical, natural, earth, marine, medical and human sciences. The University is surveying and mapping the flora and fauna of Tanzania and is conducting research into the maintenance and improvement of the environment and the sustainable exploitation of Tanzania's natural resources.

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Frontier Tanzania Forest Research Programme (FT FRP)

The Society for Environmental Exploration and the University of Dar es Salaam have been conducting collaborative research into environmental issues since July 1989 under the title of Frontier Tanzania, of which one component is the Frontier Tanzania Forest Research Programme (FT FRP). Since July 1994, the FT FRP has been working in the forests of the East Usambara mountains in collaboration with the East Usambara Conservation Area Management Programme (EUCAMP). This survey of selected forests collects baseline biodiversity data and assists the EUCAMP in the management of the East Usambara forests.

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EXECUTIVE SUMMARY

Bombo East I Forest Reserve, located in the north of the East Usambara Mountain range of north-eastern Tanzania, covers an area of nearly 4.5 km² (448 ha), situated in Korogwe and Muheza District, Tanga Region. Altitude ranges from 220 m to 620 m above sea level (asl). The Forest Reserve contains lowland forest and open wooded grassland. Bombo East I Forest Reserve was gazetted as a Forest Reserve in 1993. A small part in the south-east was de-gazetted in 2000. Bombo East I is surrounded by Makorokoro, Mnazi Moja and Bombo Maji Moto villages.

As part of the East Usambara Conservation Area Management Programme, (EUCAMP), (formerly the East Usambara Catchment Forest Project), Frontier-Tanzania conducted biological surveys of Bombo East I and Bombo East II Forest Reserves between January and March 2002 for a total of 10 research weeks. The systematic vegetation survey covered all parts of the reserve with a sampling intensity of 0.5% and the zoological survey was focused on 3 trapping sites. This report provides an inventory of the trees, shrubs, herbs, mammals, reptiles, amphibians and butterflies recorded during the survey, and observations listed for birds. 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	59* 7** 34***	3.4%	10	1	5	1*
Mammals	35	17%	15	1	1	2
Birds	123	6%	95	1	2	1
Reptiles	16	6%	11	1	3	1
Amphibians	3	0%	1	0	0	0
Butterflies	106	12%	28	0	7	3
Total	383	n/a	160	4	18	8

* Species recorded in vegetation plots ** Species recorded in the regeneration plots only,

*** Species recorded opportunistically

Relative to other reserves surveyed by Frontier-Tanzania, Bombo East I Forest Reserve has a low floral diversity and average faunal diversity. The high number of non-forest dependent species can be explained by the very open nature of the predominant habitat within the FR.

In terms of flora, Bombo East I FR comprises open woodland and lowland forest. A large proportion of species recorded within Bombo East I FR were categorised as non-forest dwelling (Table 1). Only one plant species was identified as endemic to the Usambaras, this was *Cassia abbreviata*.

Despite its small size, Bombo East I Forest Reserve supports a high diversity of mammal and butterfly species. The reserve is home to 1 endangered and 2 vulnerable species according to IUCN categories. A new record for the East Usambaras was found, *Tatera cf. robusta* (Tatera Gerbil).

The greatest threat to Bombo East I Forest Reserve is fire disturbance that has threatened the forest annually and extensively in recent years. Pole cutting and animal hunting continue illegally on a small scale within the Forest Reserve. Local concern for the future of the forest reserve is apparent amongst elders in village communities.

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 1.

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 north-eastern 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 much of this is restricted to the Amani area and systematic surveys elsewhere are few. In order to get more comprehensive information on the forests, biodiversity surveys were initiated and contracted in July 1995. Frontier Tanzania, a joint venture between the University of Dar es Salaam and the Society conduct the surveys 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, as well as training forestry staff in the use of biological inventory techniques. They will also help setting priorities in the conservation of this valuable area.

The programme involves locally employed field assistants, permanent EUCAMP, Frontier-Tanzania, University of Dar es Salaam, and Tanzania Forestry Research Institute staff, 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, a work which also contributed the maps to these reports. 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 continue to amaze coming generations and that the light in the tunnel will become the bright future.

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1.0 INTRODUCTION

1.1 The East Usambara Mountains and forest diversity

The East Usambara Mountains are situated in north-eastern 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. Recently, work in the area has also included an attempt to understand the drainage and catchment value of the mountain's forests (Bruen, 1989; Litterick, 1989).

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). Many 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 (ha)	% of area
Lowland forest	29,497.4	62.9
Submontane forest	12,916.6	30.6
Forest plantation	2,723.6	6.5
TOTAL	45,137.6	

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 Zanj 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 Kwamgumi and Segoma Forest Reserves (Broadley, 1995) and a recently described amphibian species; *Stephopaedes usambara* (Poynton and Clarke, 1999) has been recorded by the surveys in Mtai and Kwamgumi 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 swynnertonii*; 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 Bombo East I Forest Reserve (Bombo East I 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 taken 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).

For forest dependence Mlingwa *et al.* (2000) was used:

- **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 is 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 Bombo East I Forest Reserve was conducted between 9th January and 20th March 2002 for a total of 10 research weeks. Frontier-Tanzania staff, EUCAMP Forest Officers, and locally employed field assistants from Tanga, Maramba, Kwemkole, Kwangumi, Bombo Maji Moto and Makorokoro 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% or 0.5% 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: Bombo East I Forest Reserve (Kisambaa - *Kilimandege*)
Muheza and Korogwe District, Tanga Region, Tanzania.

Area: 448 ha

Status: Forest Reserve

Maps: Ordnance Survey topographic maps 1: 50 000 Series Y742 (DOS 422)
Sheet 110/3 'Hemagoma' of 1988
Forest and Bee Keeping Division maps: Jb 2160

3.1.2 Location

Lat/Long: S 04°48'47.5" – S 4°50'46.5", E 38°43'39.7" – E 38°42'10.0"

UTM/UPS: 94 68028 - 94 64372 S 04 69805 - 04 67042 E

Elevation: 220 m – 620 m above sea level

Bombo East I Forest Reserve (Bombo East I FR) is situated in the East Usambara Mountains within the Kilanga Ngua forest station of EUCAMP. Administratively the forest falls under Korogwe and Muheza districts in Tanga region. The FR is approximately 30 km north-west of Maramba. Bombo East I FR is near the villages of Makorokoro, Nnazi Moja and Bombo Maji Moto.

3.1.3 Topography

Bombo East I is a lowland forest reserve rising to an altitude of 620 m. The reserve straddles a ridge to the east of the river Bombo which runs northwards from Nilo Forest Reserve and the villages of Kwemkole and Kilanga Ngua (Figure 1). The ridge on which the reserve is found is orientated from the north-east to the south-west. This ridge is a continuation of the horseshoe of hills to the south-west where Nilo FR is located.

The western border roughly follows the river Bombo. The eastern border is the lowest point of the reserve descending to 220 m. Farms are found right up to the border surrounding the reserve.

3.1.4 Land use

Bombo East I FR is one of the smallest FRs in the East Usambara Mountains. The latest survey of the area was carried out by Hyytiäinen (1995), and updated by Johansson and Sandy (1996). The entire habitat within Bombo East I FR was identified as 'poorly stocked lowland forest' (Table 3). The FR is mainly comprised of woodland made up of mixed deciduous trees such as *Lochocarpus bussei*, *Acacia spp.*, *Stereospermum kunthianum* and *Brachlaena huillensis*. The reserve serves as a water source for the Bombo river which is badly disturbed by the cultivation of rice in or adjacent to the river.

The FR is surrounded by villages and farms, but these are separated by dry woodland, bushes and roads running between the villages of Bombo Maji Moto, Mashewa and Bombo Mtoni.

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

Bombo East I Forest Reserve	Area (hectares)	% of area
Poorly Stocked Lowland Forest	448	100
Total	448	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.

Bombo East I FR, or *Kilimandege* as it is locally known, was gazetted as a forest reserve in 1993. As small part in the south-east of the reserve was de-gazetted again in 2000 to give surrounding villages more farmland.

Regular and extensive fires in recent years have occurred within the FR and have significantly reduced the quality and expanse of closed forest habitat. The most recent fire occurred in December 2001 and destroyed mostly the north and east of the reserve. According to local knowledge, fire and logging are thought to be the most serious danger to the reserve.

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

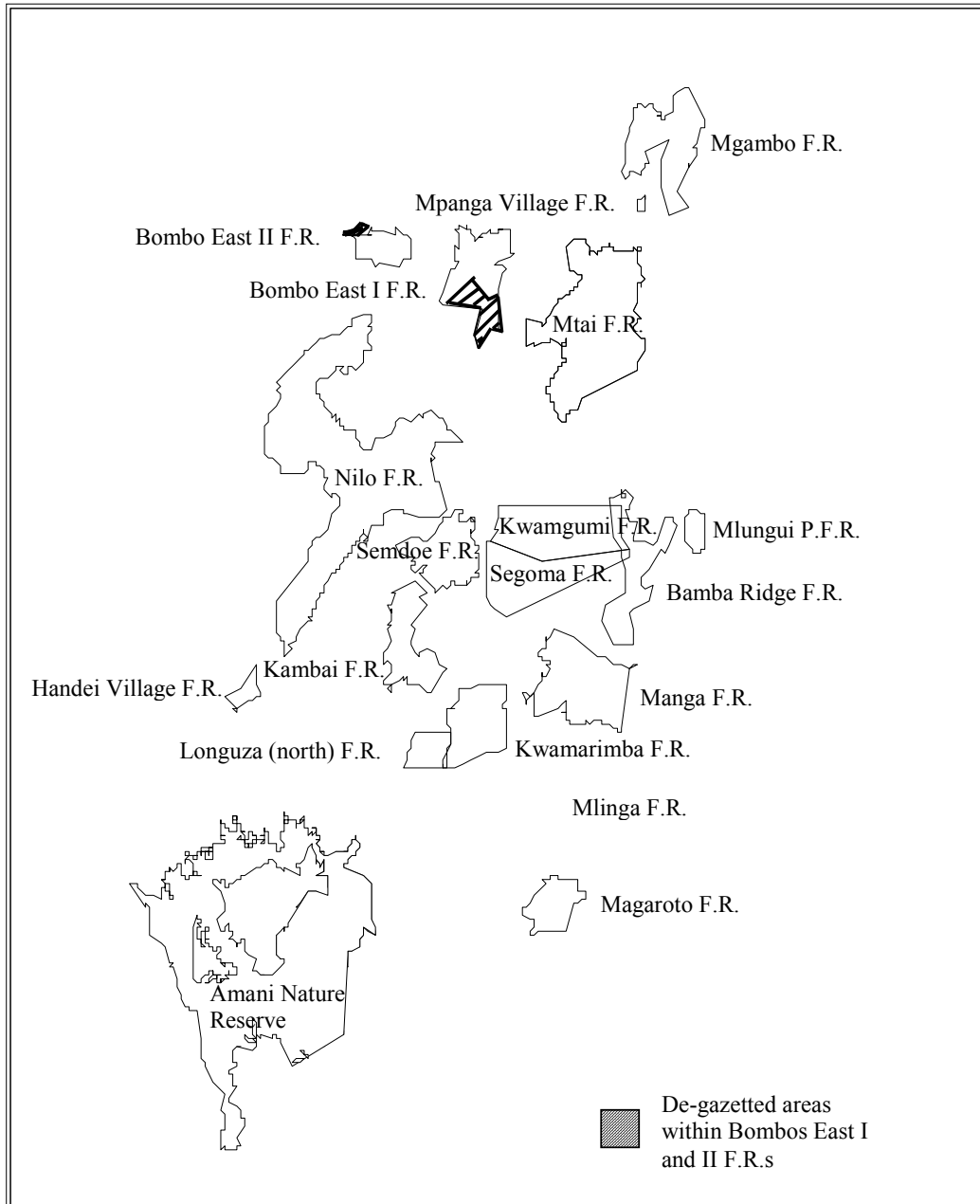


Figure 1 The location of Bombo I FR in relation to other East Usambara forests

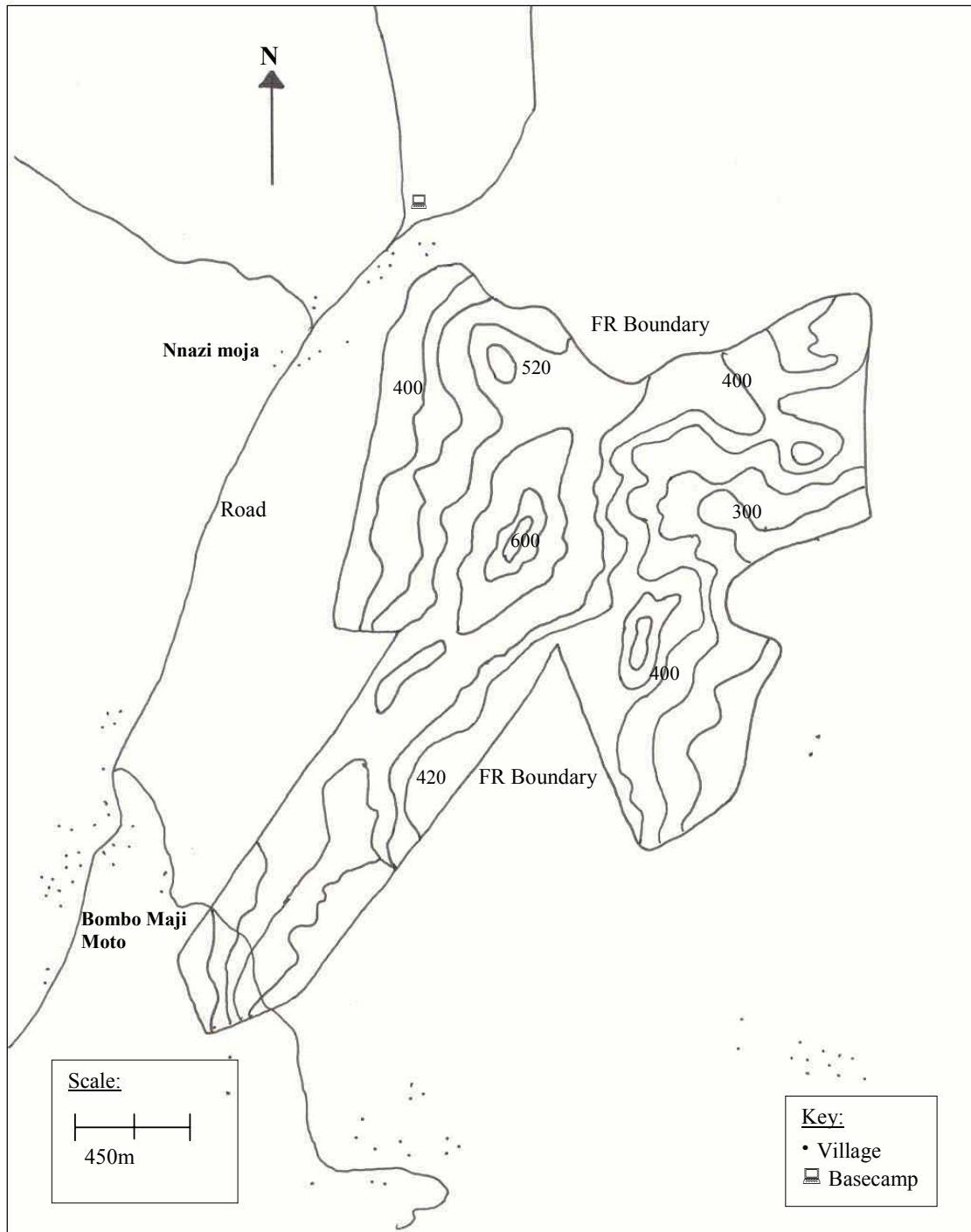


Figure 2 Topographical sketch map of Bombo East I FR.

4.0 VEGETATION

Authors: Salter, R.F., Ntemi, A.S., Svoboda, N.S., Staddon, S. & Bracebridge, C. pp.11-43

4.1 Introduction

A species inventory was compiled of the trees and shrubs found within Bombo East I 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.

4.2 Methods

The FR 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) and are illustrated in Figure 3.

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 450 m x 450 m grid marked in the field using tagged transect lines. The small size of the FR meant that intensification of the 450 m x 900 m grid system used, most recently, to sample Amani Nature Reserve and Nilo FR was necessary to document all habitats adequately. One plot 20 m x 50 m was sampled in each grid square, giving an approximate sampling intensity of 0.5%. The 20 m x 50 m vegetation plots were located in the southeast corner of each of the 450m x 450m grid rectangles. Within each sample (vegetation) plot, every tree with a diameter at breast height (dbh) of 10 cm and over was recorded, marked with red paint and identified. A botanist from EUCAMP 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 3 m x 3 m (and 6 m x 6 m) nested subplots at the centre of each vegetation plot. All trees and shrubs with a dbh below 10 cm 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 flora 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 FR. The disturbance transects were based on the 450 m x 450 m grid prepared for the vegetation plots (Figure 3). Each transect running east-west was sampled from border to border where accessible. Disturbance was recorded by 50 m section along each transect.

Every self-standing tree and sapling (not lianas or creepers) above 5 cm dbh was measured within 5 m 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 15 cm and a minimum of 2 m relatively straight trunk. Timber was classified as having a dbh greater than 15 cm with a minimum of 3 m 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, animal trapping, pitsawing) were documented every 50 m section and summarised in tables and in 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 1. All incidence records of 'other signs of disturbance' were summed and ranked, with the most disturbed plot ranked 1. The top four plots in each data set were combined to give the top eight disturbed plots.

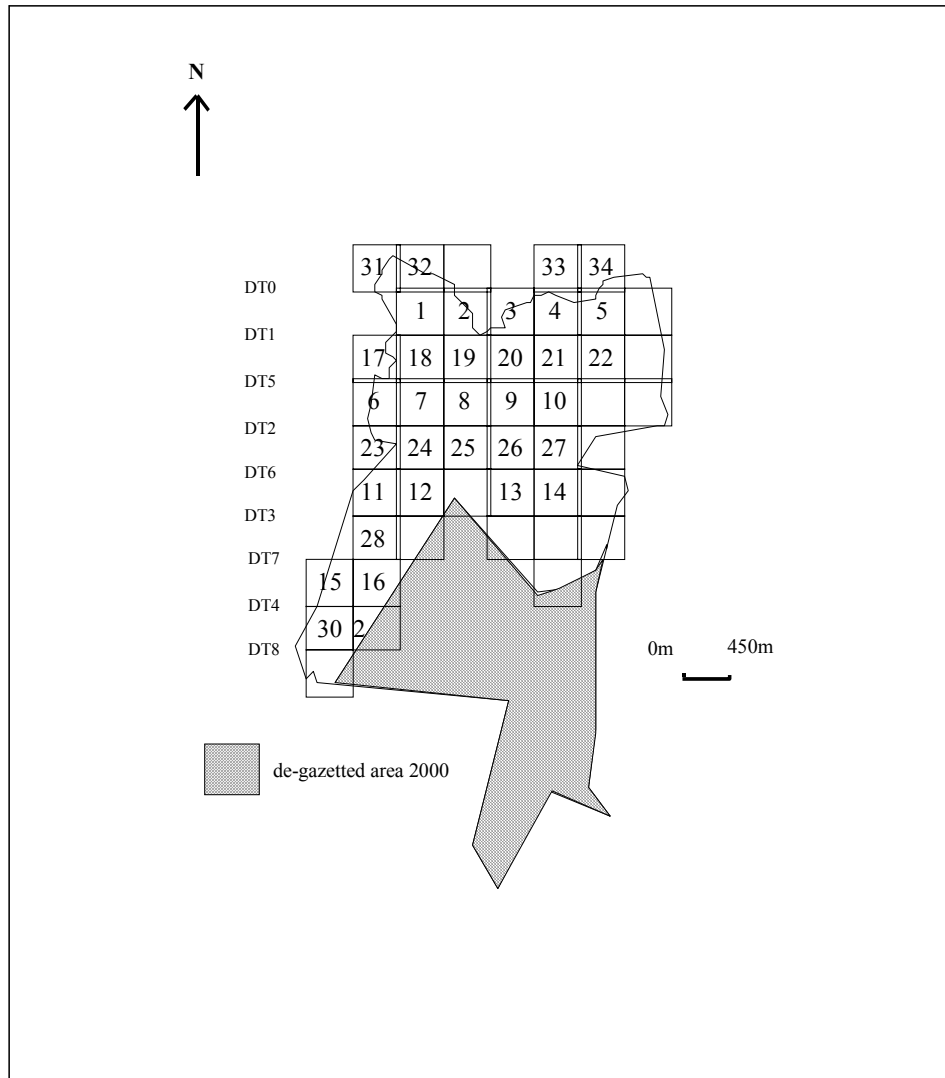


Figure 3 Location of vegetation plots and disturbance transects (DT) in Bombo East I FR. (GPS co-ordinates of vegetation plots are summarised in Appendix 2).

4.3 Results

4.3.1 Quantitative vegetation analysis

4.3.1.1 Vegetation Plots

A total of 31 20 m x 50 m vegetation plots were established. The dominant vegetation types within vegetation plots were open woodland (69% of plots) and lowland forest (28% of plots). 90% of all vegetation plots had an average canopy height of less than 10 m. Only two vegetation plots were recorded with canopy heights greater than 10 m. 87% of vegetation plots had been affected by fire. The average slope for all vegetation plots was moderately steep at 16 degrees. Vegetation plot descriptions are summarised in Appendix 3 and a vegetation map shown in Figure 4.

A total of 476 individuals, representing 26 families and 59 species were recorded in 31 20 m x 50 m vegetation plots. Data is presented for both 0.25% and 0.5% sampling intensities. 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) with up to date synonyms provided by www.ini.org. 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
Angiospermae – Dicotyledonae					
ANACARDIACEAE					
<i>Lannea schweinfurthii</i> var. <i>stuhlmannii</i> (Engl.) J. D. Kokwaro 1980*	f	L&S&M ¹	W	21	12
<i>Rhus natalensis</i> Bernh. ex Krauss 1844	f	L&S&M ²	W	3	2
<i>Sclerocarya caffra</i> (Sond) 1850	O ¹	L&S&M ¹	W ¹	3	3
ANNONACEAE					
Unknown	?	?	?	33	1
<i>Uvaria acuminata</i> Oliver	f	L&S	W	1	1
ARALIACEAE					
<i>Cussonia arborea</i> Hochst. ex. A. Rich*	f	L&S&M	W	4	3
BALANITACEAE					
<i>Balanites aegyptica</i>* Wall	?	S&M²	W²	2	1
BIGNONIACEAE					
<i>Markhamia lutea</i> K. Schum 1895*	f	L&S	W	5	5
<i>Stereospermum kunthianum</i> Cham. 1832	f	L&S	W	24	10
BORAGINACEAE					
<i>Cordia ovalis</i> R.Br. ex. DC. 1845	f ¹	L&S&M ¹	W ¹	6	3
<i>Ehretia amoena</i> Klotzsch	O	L¹	W	1	1
BURSERACEAE					
<i>Commiphora africana</i> Sensu auct*	O	L&S	W	5	4
CAPPARIDACEAE					
<i>Boscia salicifolia</i> Oliver*	f	L&S	W	7	7
<i>Maerua cylindricarpa</i> Gilg & Benedict 1915	O¹	S&M¹	W¹	1	1
<i>Maerua kirkii</i> (Oliv.) F.White 1958	f	L&S¹	W¹	1	1

Table 4 continued

	Ecol. Type	Habitat	End. Status	Total no. of individuals	Present in n plots
CELASTRACEAE					
<i>Maytenus putterlickioides</i> (Loes.) Exell & Mendonça 1953	O ¹	L&S&M ¹	W ¹	2	1
<i>Maytenus undata</i> (Thunb.) Blakelock 1956*	f	L&S&M ²	W	3	1
COMBRETACEAE					
<i>Combretum molle</i> R. Br. ex. G. Don 1827	O	L	W	11	7
<i>Combretum schumannii</i> Engl. 1894	f	L&S ²	W	1	1
<i>Pteleopsis myrtifolia</i> Engl. & Diels	f	L	W	1	1
<i>Terminalia sambesiaca</i> Engl. & Diels	f	L	W	1	1
COMPOSITAE					
<i>Brachylaena huillensis</i> O. Hoffm 1902*	f	L&S&M ¹	W	1	1
<i>Brachylaena hutchinsii</i> Hutch.	f ¹	L&S&M ¹	W ¹	19	5
EUPHORBIACEAE					
<i>Croton pseudopulchellus</i> Pax*	f	L&S ¹	W	2	1
<i>Phyllanthus reticulatus</i> Poir	f	L&S&M ¹	W	1	1
<i>Spirostachys africana</i> Sond 1850	f	L&S ¹	W	1	1
<i>Suregada zanzibariensis</i> (Baill.) Mill. 1861	f	L	W	1	1
LEGUMINOSAE subfamily: CAESALPINOIDEAE					
<i>Cassia abbreviata</i> Oliver*	O ¹	L ¹	E ¹	1	1
<i>Scorodophloeus fischeri</i> (Taub.) J. Leonard (basionym. <i>Theodora fischeri</i> Taub 1895)	f	L&S&M ²	N	26	3
LEGUMINOSAE subfamily: MIMOSOIDEAE					
<i>Acacia clavigera</i> E.Mey	f ¹	L&S&M ¹	W ¹	2	2
<i>Acacia mellifera</i> Benth ¹ 1842*	O	S	W	9	4
<i>Acacia nilotica</i> Delile *	f	S ¹	W	17	5
<i>Acacia polyacantha</i> Willd.	f	L&S	W	11	4
<i>Acacia sieberiana</i> DC.	f	S ¹	W	8	1
<i>Albizia anthelmintica</i> Brongn 1860	O	S&L	W	9	8
LEGUMINOSAE subfamily: PAPILIONOIDEAE					
<i>Dalbergia melanoxylon</i> Guill & Perr*	f ¹	L&S&M ¹	W ¹	30	12
<i>Dichrostachys cinerea</i> (L.) Wight & Arn*	f	L&S	W	3	2
<i>Erythrina abyssinica</i> Lam	f	L&S&M ¹	W	2	1
<i>Lonchocarpus bussei</i> Harms (basionym <i>Philenoptera bussei</i> (Harms) B.D. Schrine)*	O	L&S&M ¹	W	37	14
<i>Milletia dura</i> Dunn 1911*	f	S&M	W	17	2
<i>Milletia oblata</i> Dunn 1911*	F	S&M	N	17	5
<i>Ormocarpum kirkii</i> S. Moore 1877	O	L&S	W	4	2
<i>Xeroderris stuhlmannii</i> (Taubert) Mendonça & E.P Sousa 1968	f	L&S&M ¹	W	1	1
LOGANIACEAE					
<i>Strychnos innocua</i> Delile*	O ¹	M ²	W ²	8	5

Table 4 continued.

	Ecol. Type	Habitat	End. Status	Total no. of individuals	Present in n plots
LOGANIACEAE continued					
<i>Strychnos spinosa</i> Lam (syn. <i>Strychnos madagascariensis</i> Poir) *	f	L ¹	W	8	3
MELIACEAE					
<i>Turraea robusta</i> Guerke 1894	f	S&M ¹	W	1	1
OLACACEAE					
<i>Ximenia americana</i> Linn.	O	L&S	W	1	1
RUBIACEAE					
<i>Catunaregan nilotica</i> (Stapf) Tirvengadam	O ¹	L&S ¹	W ¹	3	2
RUTACEAE					
<i>Vepris trichocarpa</i> (Engl.) Mziray 1992	?	?	?	1	1
SAPINDACEAE					
<i>Haplocoelum inopleum</i> Radlk. 1878	f ¹	L ¹	N ¹	5	3
<i>Lecaniodiscus fraxinifolius</i> Baker*	f	L&S&M	W	8	5
SAPOTACEAE					
<i>Afrosersalisia cerasifera</i> (Welw.)Aubrev.ex. Heine 1963	F	L&S&M	W	1	1
<i>Manilkara sulcata</i> Dubard 1915	f	L ²	W	14	5
SIMAROUBACEAE					
<i>Harrisonia abyssinica</i> Oliver	f	?	W	2	1
STERCULIACEAE					
		L ²			
<i>Dombeya shupangae</i> K.Schum 1900*	f	L ²	N	18	8
<i>Sterculia africana</i> (Lour.) Fiori 1911	O	S	W	2	2
TILIACEAE					
<i>Grewia bicolor</i> Juss. 1804	O	S	W	25	9
<i>Grewia holstii</i> Burret 1910*	f	L&S ¹	N	6	3
UMBELLIFERAE					
<i>Steganotaenia araliacea</i> Hochst 1844*	f	L&S&M	W	1	1

¹ Information is based on FTEA

² Information is based on LEAP (Knox, 2000)

Bold type – Additional species found as a consequence of intensifying vegetation plot sampling from 450 m x 900 m to 450 m x 450 m.

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: (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.

Regeneration Layer

Grewia holstii Burret*: species recorded in the regeneration sample plots 3 m x 3 m are marked *

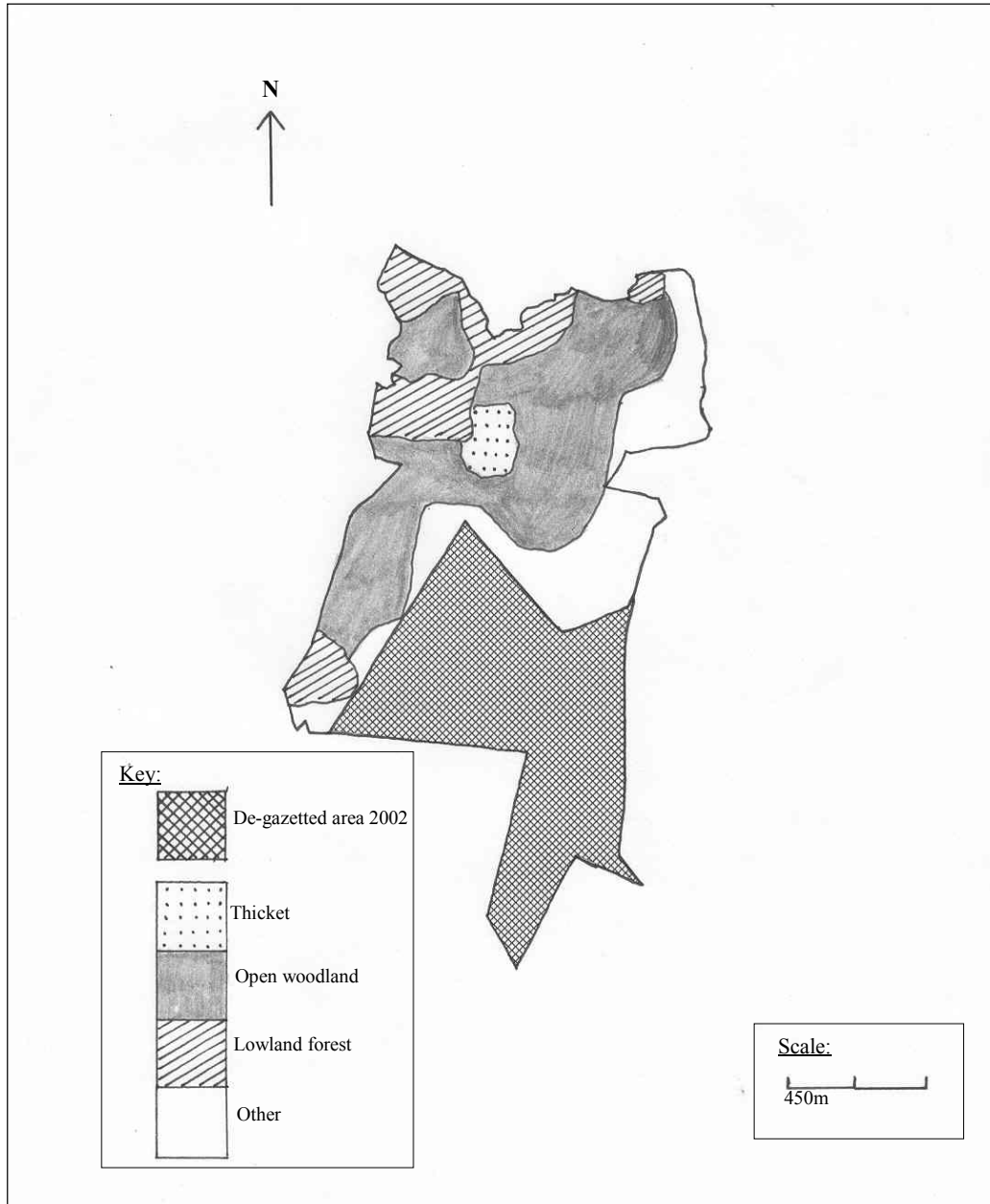


Figure 4 Sketch map of vegetation types in Bombo East I

4.3.1.2 Species Abundance

The most abundant species within vegetation plots was *Lonchocarpus bussei* representing 8.1% of all individuals sampled. This species was present within 45.2% of vegetation plots (Table 5). An unknown species of the Annonaceae family was ranked as the second most abundant species within vegetation plots representing 7.2% of all individuals sampled. This species was found in just one vegetation plot, classified as lowland forest, dominating all other species. *Dalbergia melanoxylon* was ranked as the third most abundant species representing 6.5% of all individuals sampled. The species was widespread covering 38.7% of vegetation plots. The most abundant species found in the reserve are generally widespread in their distribution, but certain species are very localised e.g., *Scorodophloeus fischeri* (Table 5).

Lonchocarpus bussei was present in the greatest number of plots (Table 6), common to plots classified as both lowland forest and disturbed open woodland. *Dalbergia melanoxylon* and *Lannea schweinfurthii* were commonly found in vegetation plots throughout the reserve ranked as second and third respectively in Table 6. These species were common in open woodland areas and often associated with fire damage.

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

		Rank	Total no. of individuals (n=459)	% of total individuals	In x plots (n=31)	% of total no. plots
LEGUMINOSAE	<i>Lonchocarpus bussei</i>	1	37	8.1	14	45.2
subfamily:						
PAPILIONOIDEAE						
ANNONACEAE	Unknown	2	33	7.2	1	3.2
LEGUMINOSAE	<i>Dalbergia melanoxylon</i>	3	30	6.5	12	38.7
subfamily:						
PAPILIONOIDEAE						
LEGUMINOSAE	<i>Scorodophloeus fischeri</i> *	4	26	5.7	3	9.7
subfamily:						
CAESALPINOIDEAE						
TILIACEAE	<i>Grewia bicolor</i>	5	25	5.4	9	29.0
BIGNONIACEAE	<i>Stereospermum kunthianum</i> *	6	24	5.2	10	32.3
ANACARDIACEAE	<i>Lannea schweinfurthii</i> var. <i>stuhlmannii</i>	7	21	4.6	12	38.7
COMPOSITAE	<i>Brachylaena hutchinsii</i>	8	19	4.1	5	16.1
STERCULIACEAE	<i>Dombeya shupangae</i>	9	18	3.9	8	25.8
LEGUMINOSAE	<i>Acacia nilotica</i>	10	17	3.7	5	16.1
subfamily:						
MIMOSOIDEAE						
LEGUMINOSAE	<i>Millettia dura</i>	10	17	3.7	2	6.5
subfamily:						
PAPILIONOIDEAE						
	<i>Millettia oblata</i>	10	17	3.7	5	16.1
SAPINDACEAE	<i>Manilkara sulcata</i> *	13	14	3.1	5	16.1
COMBRETACEAE	<i>Combretum molle</i>	14	11	2.4	7	22.6
LEGUMINOSAE	<i>Acacia polyacantha</i>	14	11	2.4	4	12.9
subfamily:						
MIMOSOIDEAE						
	<i>Acacia mellifera</i>	16	9	2.0	4	12.9
	<i>Albizia anthelmintica</i>	16	9	2.0	8	25.8

Table 6 Ranked abundance of tree and shrub species occurrence within vegetation plots.

		Rank	In x plots (n=31)	% of total no. plots	Total no. of individuals	% of total individuals
LEGUMINOSAE	<i>Lonchocarpus bussei</i>	1	14	45.2	37	8.1
subfamily:						
PAPILIONOIDEAE						
LEGUMINOSAE	<i>Dalbergia melanoxydon</i>	2	12	38.7	30	6.5
subfamily:						
PAPILIONOIDEAE						
ANACARDIACEAE	<i>Lannea schweinfurthii</i> var. <i>stuhlmannii</i>	2	12	38.7	21	4.6
BIGONIACEAE	<i>Stereospermum kunthianum</i> *	4	10	32.3	24	5.2
TILIACEAE	<i>Grewia bicolor</i>	5	9	29.0	25	5.4
STERCULIACEAE	<i>Dombeya shupangae</i>	6	8	25.8	18	3.9
LEGUMINOSAE	<i>Albizia anthelmintica</i>	6	8	25.8	9	2.0
subfamily:						
MIMOSOIDEAE						
COMBRETACEAE	<i>Combretum molle</i>	8	7	22.6	11	2.4
CAPPARIDACEAE	<i>Boscia salicifolia</i>	8	7	22.6	7	1.5
COMPOSITAE	<i>Brachylaena hutchinsii</i>	10	5	16.1	19	4.1
LEGUMINOSAE	<i>Acacia nilotica</i>	10	5	16.1	17	3.7
subfamily:						
MIMOSOIDEAE						
LEGUMINOSAE	<i>Milletia oblata</i>	10	5	16.1	17	3.7
subfamily:						
PAPILIONOIDEAE						
SAPOTACEAE	<i>Manilkara sulcata</i> *	10	5	16.1	14	3.1
LOGANIACEAE	<i>Strychnos innocua</i>	10	5	16.1	8	1.7
SAPINDACEAE	<i>Lecaniodiscus fraxinifolius</i> *	10	5	16.1	8	1.7
BIGNONIACEAE	<i>Markhamia lutea</i> *	10	5	16.1	5	1.1
LEGUMINOSAE	<i>Acacia polyacantha</i>	17	4	12.9	11	2.4
subfamily:						
MIMOSOIDEAE						
	<i>Acacia mellifera</i>	17	4	12.9	9	2.0
BURSERACEAE	<i>Commiphora africana</i>	17	4	12.9	5	1.1

4.3.1.3 Species Accumulation

The accumulation of species records throughout the systematic vegetation survey showed that a significant number of additional species were recorded as a consequence of increasing the sampling intensity from 450 m x 900 m (0.25%) to 450 m x 450 m (0.5%) (Figure 5).

Although the curve seems to be reaching a plateau, there is not enough evidence to suggest that the accumulation of species would not increase with even greater sampling intensity.

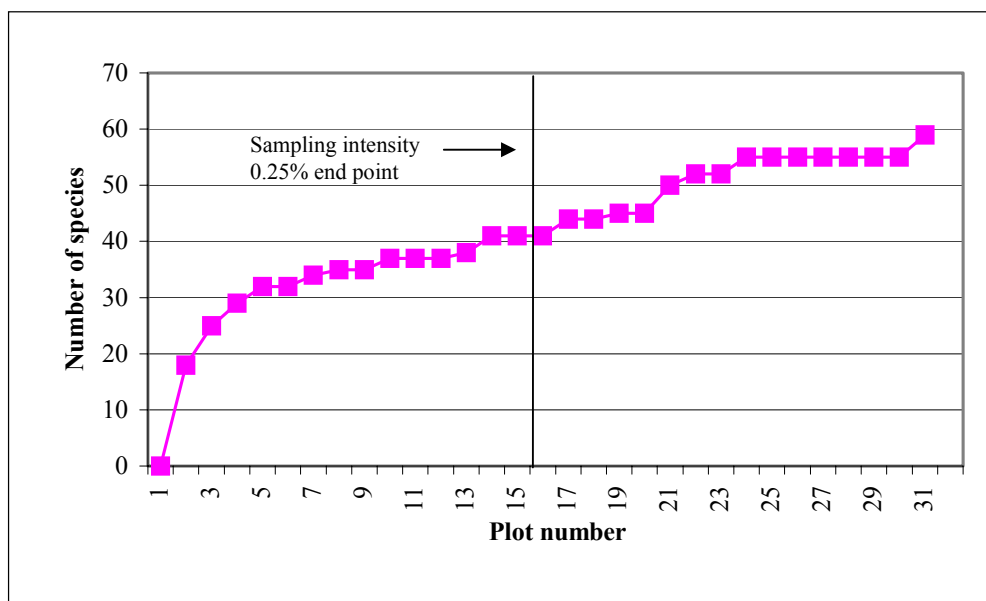


Figure 5 Species accumulation rates of trees and shrubs (10 cm dbh and larger) by vegetation plot for 0.5% sampling intensity.
(Species accumulation rates for 0.25% sampling intensity finish at vegetation plot 16).

4.3.1.4 Endemic Status

One species (1.7%) and one individual recorded in vegetation plots were endemic to the East Usambara Mountains, with 5 (8.5%) species and 72 individuals recorded as near endemic. The majority of species recorded (86.4%) were therefore widespread in their distribution (Table 4). Endemic and near endemic species were relatively widely dispersed throughout the FR (Figure 6 and 7). At both 0.5% and 0.25% sampling intensities, percentages of the total number of species and individuals were similar (Table 7).

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

Figures from 0.25% sampling intensity are shown in brackets.

	Number of species	% of species	Number of individuals	% of individuals
Endemic to the East Usambara Mountains (E(EU))	1 (0)	1.7 (0)	1 (0)	0.2 (0)
Near endemic (N)	5 (5)	8.5 (14.3)	72 (72)	15.1 (19)
Widespread (W)	51 (30)	86.4 (85.7)	369 (306)	77.5 (81)
Unknown (?)	2 (0)	3.4 (0)	34 (0)	7.1 (0)
Total	59 (35)	100 (100)	476 (378)	100 (100)

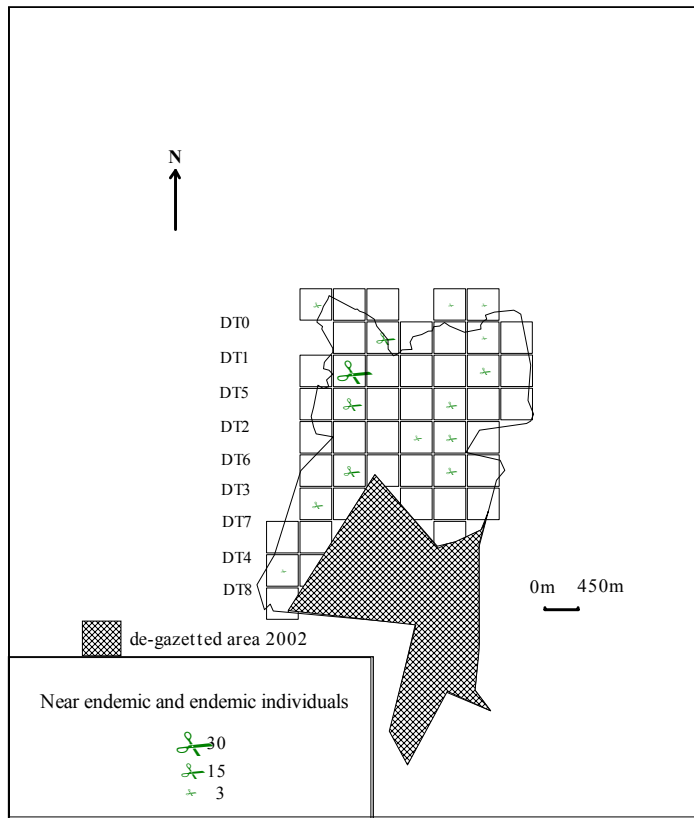


Figure 6 Distribution of endemic and near endemic tree and shrub individuals in Bombo East I FR.

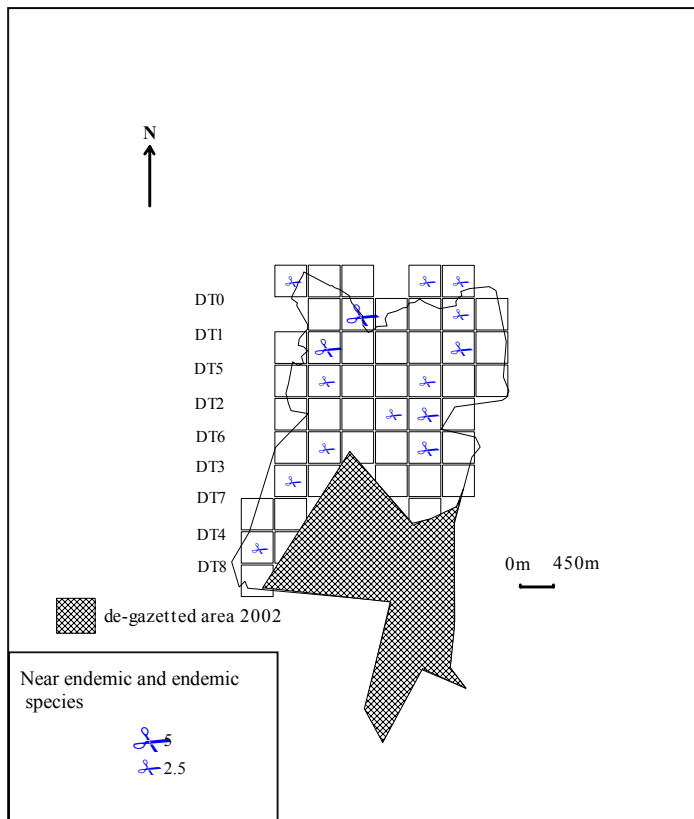


Figure 7 Distribution of endemic and near endemic tree and shrub species in Bombo East I FR.

4.3.1.5 Ecological type

A total of 2 (3.4%) species and 18 (3.8%) individuals recorded within vegetation plots were forest dependent (Table 8). The majority of species and individuals were forest dwelling (Table 8). Figures 8 and 9 show the distribution of forest dependent individuals and species, and give an indication of the distribution of some of the tall closed canopy forest found to the west of Bombo East I FR (refer to Figure 4).

Non-forest individuals and species are widespread (Figures 10 and 11), and give an indication of the distribution of non-forest habitats (refer to Figure 4).

For both 0.5% and 0.25% sampling intensities, percentages of the total number of tree and shrub species recorded in each ecological type were similar, although the number of individuals recorded for the 0.25% sampling intensity was significantly higher (Table 8).

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

Figures from 0.25% sampling intensity are shown in brackets.

Ecological Type	Number of species	% of total species	Number of individuals	% of total individuals
Forest dependent (F)	2 (2)	3.4 (5.8)	18 (18)	3.8 (4.8)
Forest dwelling (f)	38 (23)	64.4 (65.7)	300 (248)	63 (65.6)
Other (O)	16 (10)	27.1 (28.5)	122 (112)	25.6 (29.6)
Unknown (?)	3 (0)	5.1 (0)	36 (0)	7.6 (0)
Total	59 (35)	100 (100)	476 (378)	100 (100)

4.3.1.6 Habitat

A total of 19 species (32.2%) and 188 individuals (39.5%) present within vegetation plots had previously been recorded in other areas at altitudes of between 0 m and greater than 1250 m above sea level and therefore were categorised as species of lowland, submontane and montane forest (L&S&M) habitats (Table 8). Plant records from Bombo East I FR were most commonly categorised within this habitat type (*ie* all three forests types). Three (5.1%) species and 36 (7.6%) individuals were categorised as unknown. Only 5 (8.5%) species and 61 (12.8%) individuals were solely categorised as submontane forest species (S) and 1 species and 8 individuals as montane forest species (M). Figures 12 and 13 present the distribution of submontane and montane forest species throughout the FR. Submontane and montane individuals and species are present throughout Bombo East I FR (Figures 12 and 13), but particularly in areas of more closed canopy lowland forest (refer to Figure 4).

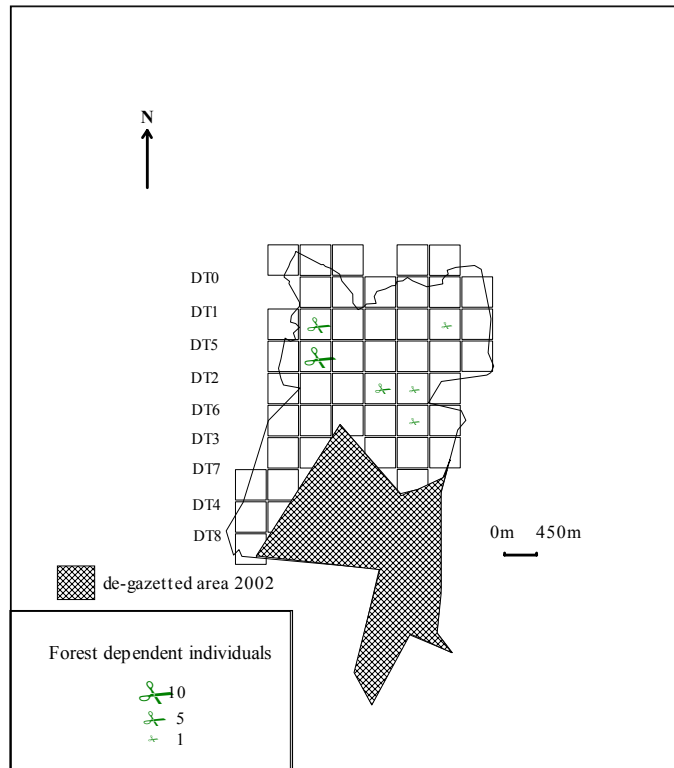


Figure 8 Distribution of forest dependent tree and shrub individuals in Bombo East I FR.

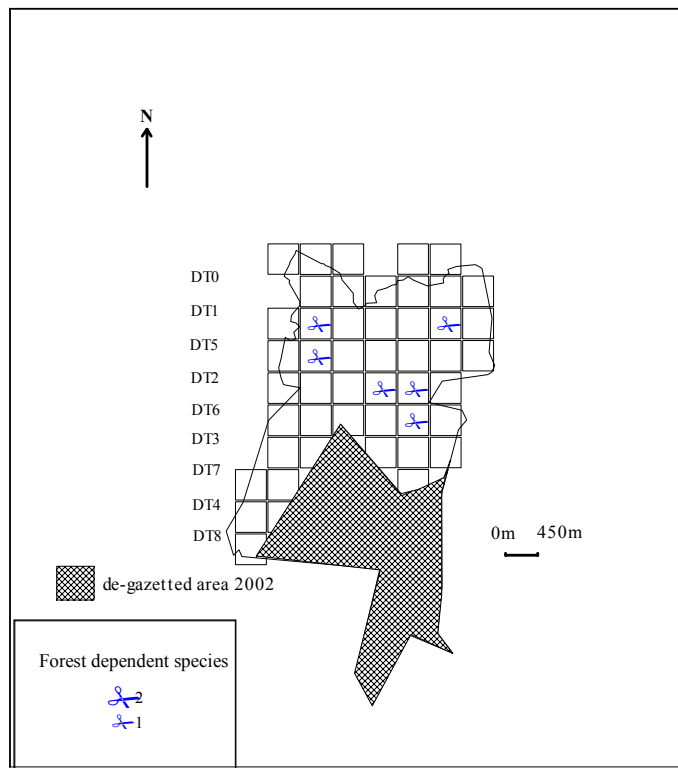


Figure 9 Distribution of forest dependent tree and shrub species in Bombo East I FR.

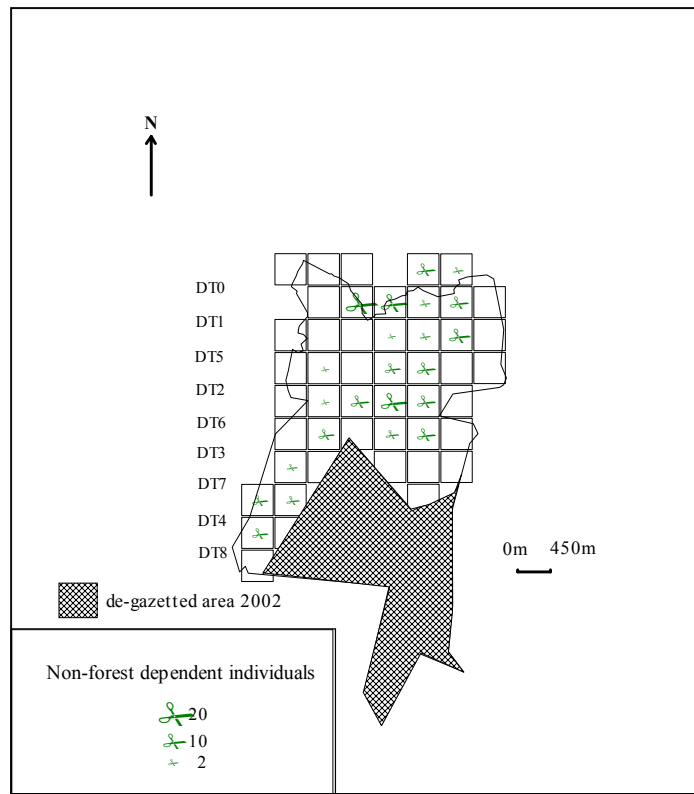


Figure 10 Distribution of non-forest dependent tree and shrub individuals in Bombo East I FR.

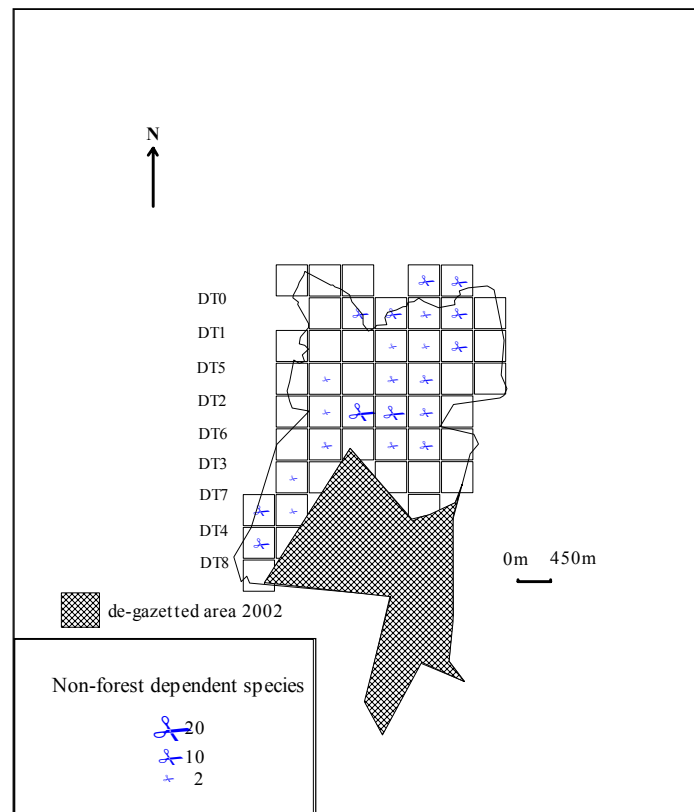


Figure 11 Distribution of non-forest tree and shrub species in Bombo East I FR.

Table 9 Summary of habitat type for tree and shrub species recorded in the 20 m x 50 m vegetation plots.

Habitat	No. of species	% of total species	No. of individuals	% of total individuals
Montane (M)	1 (1)	1.7 (2.9)	8 (8)	1.7 (2.1)
Submontane & montane (S&M)	5 (2)	8.5 (5.7)	38 (34)	8 (9)
Submontane (S)	5 (3)	8.5 (8.6)	61 (51)	12.8 (13.5)
Lowland, submontane & montane (L&S&M)	19 (14)	32.2 (40)	188 (168)	39.5 (44.4)
Lowland & submontane (L&S)	16 (9)	27.1 (25.7)	84 (67)	17.6 (17.8)
Lowland (L)	10 (6)	16.9 (17.1)	61 (50)	12.8 (13.2)
Unknown (?)	3 (0)	5.1 (0)	36 (0)	7.6 (0)
Total	59 (35)	100 (100)	476 (378)	100 (100)

(based on Table 4). Figures from 0.25% sampling intensity are shown in brackets.

A total of eight submontane forest species were found within lowland forest habitats in Bombo East I FR. One species, *Strychnos innocua* was categorised as a montane forest species (M) by the literature, but was recorded in open woodland between 300 and 495 masl within Bombo East I FR.

Table 10 Submontane and montane species sampled in lowland areas, and the altitudes at which they were recorded in Bombo East I FR.

Family	Species	Altitude (masl)
Balanitaceae	<i>Balanites aegyptica</i>	340
Cappardidaceae	<i>Maerua cylindricarpa</i>	500
Leguminosae subfamily: Papilionideae	<i>Milletia dura</i>	300, 340
Leguminosae subfamily: Papilionideae	<i>Milletia oblata</i>	390, 500, 340, 460
Leguminosae subfamily: Mimosoideae	<i>Acacia mellifera</i>	420, 410, 500, 300
Leguminosae subfamily: Mimosoideae	<i>Acacia nilotica</i>	300, 440, 530, 495, 420
Leguminosae subfamily: Mimosoideae	<i>Acacia sieberiana</i>	530
Loganiaceae	<i>Strychnos innocua</i>	440, 495, 390, 460, 300
Meliaceae	<i>Turraea robusta</i>	340

Altitude (masl): metres above sea level

Bold Type: Montane Forest species

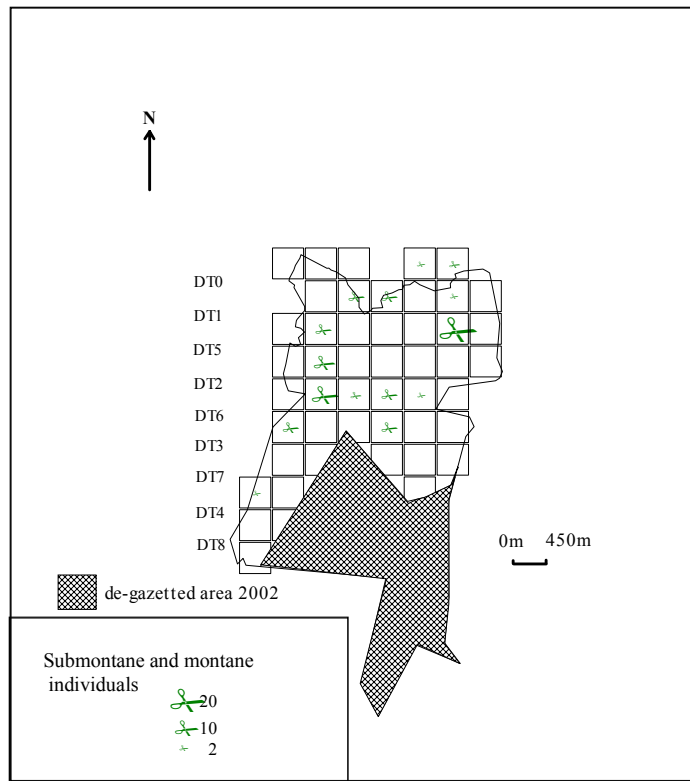


Figure 12 Distribution of submontane and montane tree and shrub individuals in Bombo East I FR.

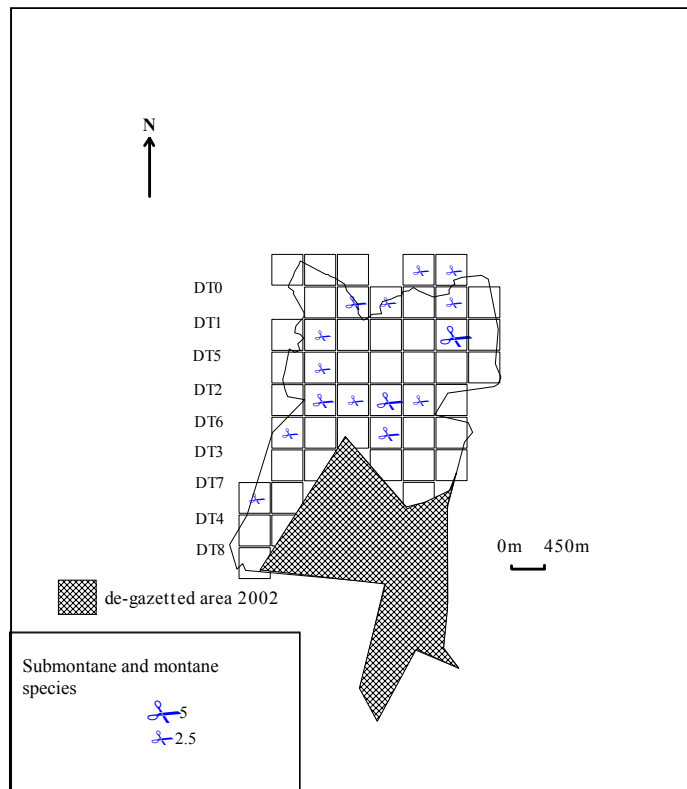


Figure 13 Distribution of submontane and montane tree and shrub species in Bombo East I FR

4.3.1.7 Range extensions

In 1986 and 1987 a botanical survey was conducted in the East Usambara Mountains (Ruffo *et al.* 1989). A total of 59 species were recorded in Bombo East I FR during the present survey, eight of these were recorded by Ruffo *et al.* (1989) at other locations in the East Usambaras, whilst 51 species were not recorded at all by Ruffo *et al.* (1989). Table 11 lists these new records for Bombo East I FR.

Despite more than seven years systematic and opportunistic vegetation survey work by the EUBS team throughout the majority of the East Usambara FRs 17 new species were found in the vegetation plots in Bombo East I FR that were new to the East Usambara Biodiversity Database. These species are listed in Appendix 4.

Table 11 Tree and shrub species found outside their previously recorded range in the East Usambara Mountains, and those species not listed by the 1986/7 survey (Ruffo *et al.*, 1989).

Species	Range
Angiospermae – Dicotyledonae	
ANACARDIACEAE	
<i>Lannea schweinfurthii</i> var. <i>stuhlmannii</i> (Engl.) J.D. Kokwaro 1980	Not listed
<i>Rhus natalensis</i> Bernh. ex. Krauss 1844*	Not listed
<i>Sclerocarya caffra</i> (Sond.) 1850	Not listed
ANNONACEAE	
Unknown	
<i>Uvaria acuminata</i> Oliver	Not listed
ARALIACEAE	
<i>Cussonia arborea</i> Hochst. ex. A. Rich	Not listed
BALANITACEAE	
<i>Balanites aegyptica</i> Wall	Not listed
BIGNONIACEAE	
<i>Markhamia lutea</i> K. Schum 1895*	Kilanga/Lutindi, Longuza/Marimba, Mlinga, Kwangumi/Segoma, Mtai
<i>Stereospermum kunthianum</i> Cham. 1832*	Not listed
BORAGINACEAE	
<i>Cordia ovalis</i> R.Br. ex. DC. 1845	Not listed
<i>Enretia amoena</i> Klotzsch	Not listed
BURSERACEAE	
<i>Commiphora africana</i> (A.Rich) Engl.	Not listed
CAPPARIDACEAE	
<i>Boscia salicifolia</i> Oliver	Not listed
<i>Maerua cylindricarpa</i> Gilg & Benedict 1915	Not listed
<i>Maerua kirkii</i> (Oliv.) F.White 1958	Not listed
CELASTRACEAE	
<i>Maytenus putterlickioides</i> (Loes.) Exell & Mendonça 1953	Not listed
<i>Maytenus undata</i> (Thunb.) Blakelock 1956	Lutindi, Kilanga, Kizara/Kizerui
COMBRETACEAE	
<i>Combretum molle</i> R.Br. ex G. Don 1827	Not listed

Table 11 continued

Species	Range
COMBRETACEAE continued	
<i>Combretum schumannii</i> Engl. 1894	Kwamsambia/Kihuhwi, Kilanga, Lutindi, Longuza, Marimba, Kwangumi/Segoma
<i>Pteleopsis myrtifolia</i> Engl. & Diels	Not listed
<i>Terminalia sambesiaca</i> Engl. & Diels	Not listed
COMPOSITAE	
<i>Brachylaena huillensis</i> D. Hoffm 1902	Not listed
<i>Brachylaena hutchinsii</i> Hutch.	Not listed
EUPHORBIACEAE	
<i>Croton pseudopulchellus</i> Pax	Not listed
<i>Phyllanthus reticulatus</i> Poir	Not listed
<i>Spirostachys africana</i> Sond 1850	Not listed
<i>Suregada zanzibariense</i> (Baill.) Mill 1861.	Not listed
LEGUMINOSAE subfamily: CAESALPINOIDEAE	
<i>Cassia abbreviata</i> Oliver	Not listed
<i>Scorodophloeus fischeri</i> (Taub.) J.Leonard. (basionym. <i>Theodora fischeri</i> Taub. 1895)*	Longuza
LEGUMINOSAE subfamily: MIMOSOIDEAE	
<i>Acacia clavigera</i> E.Mey	Not listed
<i>Acacia mellifera</i> Benth. 1842	Not listed
<i>Acacia nilotica</i> Delile.	Not listed
<i>Acacia polyacantha</i> Willd	Not listed
<i>Acacia sieberiana</i> DC.	Not listed
<i>Albizia anthelmintica</i> Brongn 1860	Not listed
LEGUMINOSAE subfamily: PAPILIONOIDEAE	
<i>Dalbergia melanoxylon</i> Guill & Perr	Not listed
<i>Dichrostachys cinerea</i> (L.) Wight & Arn	Not listed
<i>Erythrina abyssinica</i> Lam	Not listed
<i>Lonchocarpus bussei</i> Harms. (basionym.	Not listed
<i>Philenoptera bussei</i> (Harms) B.D. Schrine)	
<i>Milletia dura</i> Dunn 1911	Not listed
<i>Milletia oblata</i> Dunn 1911	Sangarawe, Monga (FTEA)
<i>Ormocarpum kirkii</i> S. Moore 1877	Not listed
<i>Xeroderris stuhlmannii</i> (Taub.) Mendonça & E.P Sousa 1968	Not listed
LOGANIACEAE	
<i>Strychnos innocua</i> Delile	Not listed
<i>Strychnos spinosa</i> Lam (syn. <i>Strychnos madagascariensis</i> Poir)	Not listed
MELIACEAE	
<i>Turraea robusta</i> Guerke 1894	Not listed

Table 11 continued

Species	Range
OLACACEAE	
<i>Ximenia americana</i> Linn.	Not listed
RUBIACEAE	
<i>Catunaregan nilotica</i> (Stapf) Tirvengadum	Not listed
RUTACEAE	
<i>Vepris trichocarpa</i> Engl. Mziray 1992	Not listed
SAPINDACEAE	
<i>Haplocoelum inopleum</i> Radlk.	Not listed
<i>Lecaniodiscus fraxinifolius</i> Baker*	Kwamsambia/Kihuhwi, Lutindi
SAPOTACEAE	
<i>Afrosersalisia cerasifera</i> (Welw.) Aubrev. ex.Heine 1963	Bulwa/Kamkoro
<i>Manilkara sulcata</i> Dubard 1915*	Lutindi/Longuza
SIMAROUBACEAE	
<i>Harrisonia abyssinica</i> Oliver	Not listed
STERCULIACEAE	
<i>Dombeya shupangae</i> K.Schum 1900	Not listed
<i>Sterculia africana</i> (Lour.) Fiori 1911	Not listed
TILIACEAE	
<i>Grewia bicolor</i> Juss. 1804	Not listed
<i>Grewia holstii</i> Burret 1910	Not listed
UMBELLIFERAE	
<i>Steganotaenia araliacea</i> Hochst. 1844	Not listed

4.3.1.8 Timber species

Bombo East I FR has not been subject to such extensive commercial logging as other more accessible and resource rich areas such as Amani NR and Nilo FRs. However, small-scale extraction of timber for local and commercial use over the years is suspected to have been significant. The most commonly extracted trees within Tanzania (Ruffo *et al.*, 1989) are listed in Table 12 to present an indication of the remaining populations of these species within Bombo East I FR.

Two tree species recorded within the vegetation plots were listed by Ruffo *et al.* (1989) as useful for timber use. These species 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).

Table 12 The abundance of selected timber and plywood species.

Family	Species	Ruffo <i>et al.</i> , 1989 category	No. Indivs (n=459)	No. plots (n=31)
Timber only				
Combretaceae	<i>Combretum schumannii</i>	Timber only	3	3
Combretaceae	<i>Terminalia sambesiaca</i>	Timber only	1	1

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

Brachylaena huillensis is highly threatened in the East Usambara forests. It is a multi-purpose tree but has valuable hard wood properties. In Kwamgumi FR it is affected by cutting for building material. The main threats to this tree in Bombo East I are charcoal burning, fire, cutting for building poles, carving and firewood.

Dalbergia melanoxylon is one of the leading valuable commercial woods in the world. This tree was common within the reserve. It is commonly used as a carving wood, for ethnoveterinary and human medicines. Surprisingly this species is still abundant in Bombo East I FR.

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

4.3.1.9 Sampling Intensity

Already it has been shown from the species accumulation curve (Figure 5) and the vegetation plot species list (Table 4) that a significant number of species and individuals were collected as a consequence of intensifying survey work from 0.25% to 0.5%. Table 13 summarises the most important differences between the two sampling intensities.

Table 13 Comparison of results obtained from vegetation sampling as a consequence of intensification of fieldwork.

	0.5% sampling intensity (450m x 450m grid system)	0.25% sampling intensity (450m x 900m grid system)
Number of vegetation plots sampled	31	16
Total number of individuals sampled	476	395
Total number of species sampled	59	41
Mean no. of trees per plot (St. Dev.)	14.87 (15.38)	12.88 (13.49)
Mean no. of species per plot (St. Dev.)	6 (4.52)	5.56 (4.84)
No. of endemic species (E(EU))	1	0
No. of near endemic species (N)	5	5
No. of forest dependent species (F)	2	2

St. Dev: Standard deviation – measure of variability about the mean (the higher the number the more variability there around the main value).

4.3.1.10 Regeneration

An additional seven species were recorded solely in the regeneration layer two within the 3 m x 3 m sample plots and seven in the 6 m x 6 m sample plots (Table 14). Identification of two of these species to species level was not possible (Table 14). Out of the 31 plots established 11 plots had no trees or shrubs regenerating.

None of the species present in the regeneration layer were recorded during the survey performed by Ruffo *et al.* (1989). *Euclea crispa* (Ebenaceae) is endemic to the East Usambara Mountains and is a new record for the East Usambara Plant Biodiversity Database.

Potentially four of the regenerating species are useful to humans, *Ochna thomasiana* for ornamental use and *Acacia* sp., *Zanthoxylum* sp., *Grewia* sp., for various uses including honey

production, charcoal, medicinal uses and food depending on the species (Ruffo, 1989 & Luoga et al, 2000).

Herbaceous vegetation dominated the ground layer in regeneration plots, with grasses predominant. Grasses of *Imperatum*, *Olyra*, *Digitaria*, *Panicum* spp. and herbs of *Justicia*, and *Ipomoea* spp. dominated in these plots. Soils were a mixture of loamy clay, sandy clay, sandy loam and rock. Regeneration in general was poor with an average of 1.29 and 2.32 species regenerating per plot within 6 m x 6 m and 3 m x 3 m plots respectively. A more detailed summary of regeneration plot information is shown in Appendix 7.

Table 14 Species recorded exclusively in the regeneration layer.

	Ecol. Type	Habitat	Endemic Status
EBENACEAE			
<i>Euclea crispa</i>	?	?	E
LEGUMINOSAE subfamily MIMOSOIDEAE			
<i>Acacia sp.</i>	?	?	?
OCHNACEAE			
<i>Ochna thomasi</i> Engl. & Gilg ex Gilg	?	L ²	N ²
RUTACEAE			
<i>Zanthoxylum sp.</i>	?	?	?
STERCULIACEAE			
<i>Dombeya kirkii</i> Mast	O	M	W
<i>Cola scheffleri</i> K.Schum & Engl.	F	L&S	E(EU)
TILIACEAE			
<i>Grewia sp.</i>	?	?	?

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.

4.3.1.11 Regeneration sampling intensity

In Bombo East I FR, the increase in the size of sample plot during regeneration sampling from 3 m x 3 m to 6 m x 6 m produced an additional 10 species (Table 15). An additional 125 individuals were recorded, 39 stems of dbh 1 to 9.5 cm and 87 stems of dbh greater than 1 cm (Table 15).

Table 15 Comparison of results obtained from regeneration sampling as a consequence of increasing the size of nested plots from 3 m x 3 m to 6 m x 6 m.

	Regeneration plot 6x6m	Regeneration plot 3x3m
Total number of species	29	19
Total number of individuals	231	106
Total number of stems (1-9.5cm)	65	24
Total number of stems (<1cm)	166	82
Mean number of individuals per plot	3.42	7.45
Standard Deviation (s) (degree of variance)	5.77	11.06
Mean no. sp. per plot	2.32	1.29
Standard Deviation (s) (degree of variance)	1.27	1.94

4.3.1.12 Opportunistic plant collection and observation

A total of 34 species were opportunistically recorded within Bombo East I FR which were not otherwise found in vegetation or regeneration plots. These represented 24 families. No endemic, near endemic or forest dependent species were recorded during opportunistic collection.

Eight species from the opportunistic checklist (Table 16) are new species records for the East Usambara Biodiversity Database. These species are summarised in Appendix 4.

Table 16 Checklist of opportunistic plant observation within Bombo East I FR

Species	Ecol. Type	Habitat	Endemic Status
Angiospermae – Dicotyledonae			
ACANTHACEAE			
<i>Dyschoriste hildebrandtii</i> Lindau. ex. O.B.Clark	?	L&S&M ²	W ²
ANNONACEAE			
<i>Asteranthe asterias</i> Eng & Diels	f	L	N
APOCYNACEAE			
<i>Carissa tetramera</i> (Sacl) Stapf	?	?	?
<i>Saba comorensis</i> (Bojer) Pichon 1953	f	L&S	W
BIGNONIACEAE			
<i>Kigelia africana</i> Benth.	f	S	W
CAPPARACEAE			
<i>Capparis tomentosa</i> Lam	f	L&S	W
<i>Capparis sepiaria</i> var <i>stuhmannii</i> (Gilg) De Wolf	f ¹	L ¹	W ¹
CAPPARACEAE			
<i>Maerua triphylla</i> A.Rich	f	L&S	W

Table 16 continued

Species	Ecol. Type	Habitat	Endemic Status
COMBRETACEAE			
<i>Combretum apiculatum</i> Sond. 1850	O	L&S	W

<i>Combretum exalatum</i> Engl.1895	O	L&S ¹	N
<i>Terminalia prunioides</i> M. Laws	O	L&S&M ¹	W
COMMELINACEAE			
<i>Commelina Schliebenii</i> Mildbr 1932	?	?	?
CYCADACEAE			
<i>Encephalartos hildebrandtii</i> A. Br & Bouché 1874	?	L ²	W ²
CYPERACEAE			
<i>Cyperus niveus</i> Retz. 1791	?	?	?
EBENACEAE			
<i>Euclea natalensis</i> A. DC.	f	L&S	W
EUPHORBIACEAE			
<i>Acalypha</i> sp	?	?	?
<i>Croton polytrichus</i> Pax 1893	f	L&S ¹	W
<i>Excoecaria madagascariensis</i> Muell Arg	f ^d	L&S&M ¹	W ¹
<i>Phyllanthus guineensis</i> Pax	f	L&S&M ¹	W ¹
<i>Ricinus communis</i> L.	f	L&S	W
ICACINACEAE			
<i>Pyrenacantha kaurabassana</i> Baill. 1872	f	L&S	W
LEGUMINOSAE subfamily: PAPILIONOIDEAE			
<i>Mundulea sericea</i> (Wild) A.Cheval 1925	f ^d	L&S ¹	W ¹
MENISPERMACEAE			
<i>Stephania abyssinica</i> Walp	O ¹	?	W ¹
OLACACEAE			
<i>Ximenia caffra</i> Sond. 1850	O ¹	L&S&M ¹	W ¹
PASSIFLORACEAE			
<i>Adenia rumicifolia</i> Engl. & Harms 1921 (basionym. <i>Adenia lobata</i> subsp. <i>rumicifolia</i> (Engl.) K.A. Lye)	f	L&S	W
POACEAE			
<i>Digitaria abyssinica</i> (Hochst) Stapf 1907	?	L&S&M ²	W ²
RUBIACEAE			
<i>Coffea zanguebariae</i> Lour	O ¹	L ¹	W ¹
SALVADORACEAE			
<i>Azima tetraacantha</i> Lam.	O ¹	L&S ¹	W ¹
SAPINDACEAE			
<i>Deinbollia borbonica</i> Scheff 1869	O	L&S	W
TILIACEAE			
<i>Grewia forbesii</i> Harv. ex. Mast	f	L&S ¹	W ¹
<i>Grewia microcarpa</i> K.Schum	f	L&S	W
Table 16 continued			
Species	Ecol. Type	Habitat	Endemic Status
VERBENACEAE			
<i>Clerodendrum</i> sp	?	?	?
<i>Lantana camara</i> L. 1753	f	L&S	W

Lantana trifolia L.f^dL&S&M¹W¹**KEY TO ABBREVIATIONS FOR TABLE 16**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.

Regeneration Layer

Grewia holstii Burret*: species recorded in the regeneration sample plots 3 m x 3 m are marked *

4.3.2 Disturbance transects

4.3.2.1 Pole and Timber extraction

Pole and timber extraction was recorded along all nine transects. The results are summarised in Table 17 for poles and Table 18 for timber. The term pole refers to all stems 5 – 15 cm dbh, the term timber refers to stems > 15cm dbh.

Table 17 Disturbance transect results for pole counts in Bombo East I FR.

Transect number	Length of transect (m)	Total poles sampled	Standing poles	<i>Standing poles Per ha</i>	Naturally dead poles	<i>Naturally dead poles per ha</i>	Cut poles	<i>Cut poles per ha</i>
0	1600	628	396 (63%)	247.50	210 (33%)	131.25	22 (4%)	13.75
1	2450	2021	1327 (66%)	541.63	631 (31%)	257.55	63 (3%)	25.71
2	2100	1121	655 (58%)	311.90	359 (32%)	170.95	107 (10%)	50.95
3	1850	846	603 (71%)	325.95	232 (27%)	125.41	11 (1%)	5.95
4	650	139	98 (71%)	150.77	41 (30%)	63.08	0 (0%)	0.00
5	2600	1710	1164 (68%)	447.69	487 (28%)	187.31	59 (4%)	22.69
6	2200	750	542 (72%)	246.36	187 (25%)	85.00	21 (3%)	9.55
7	750	259	179 (69%)	238.67	74 (29%)	98.67	6 (2%)	8.00
8	750	422	249 (59%)	332.00	95 (23%)	126.67	78 (18%)	104.00
Total	14950	7896	5213 (66%)		2316 (29%)		367 (5%)	
Average				315.83		138.43		26.73
(Standard deviation)				(± 118.03)		(± 59.28)		(± 32.66)

Note: A pole is defined as 5-15cm dbh with 2m straight trunk.

Generally, pole extraction is not very prominent in Bombo East I FR, most poles are still standing (between 58 and 72%). The most poles were recorded on disturbance transects 1 and 5, also the two longest transects sampled. Naturally dead poles account for about one-third of all recorded poles on all transects. Most affected by pole extraction was disturbance transect 8 with 18% of all recorded poles cut. Least affected was disturbance transect 4 with no cut poles recorded.

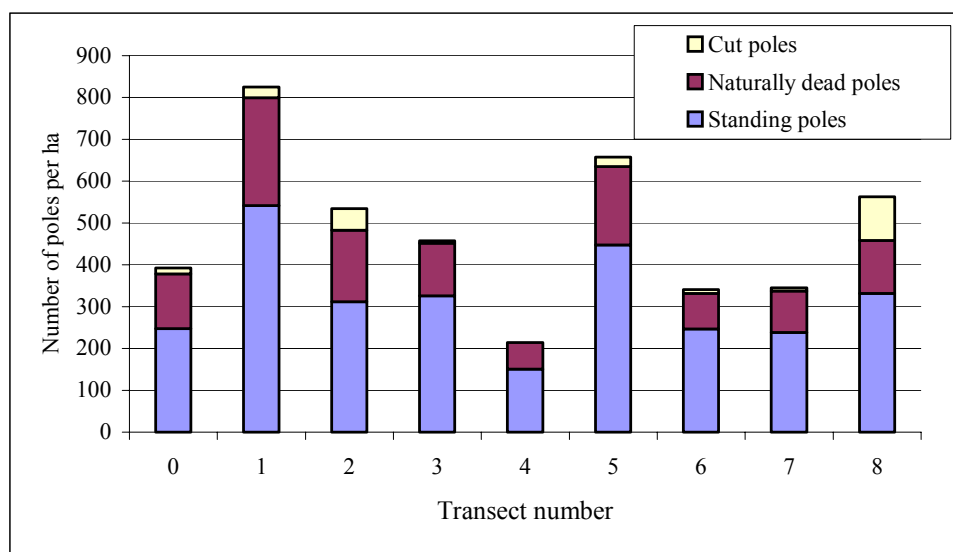


Figure 14 Relative abundance of live, naturally dead and cut poles in Bombo East I FR.

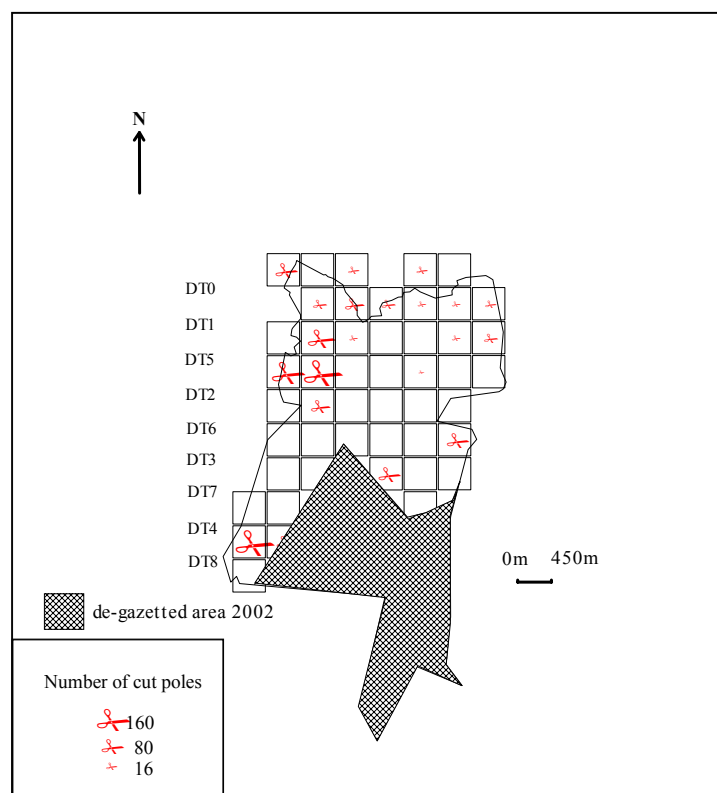


Figure 15 Pole extraction in Bombo East I FR (including those old and newly cut).

Figure 15 illustrates old and recent pole extraction per hectare in Bombo East I FR in relation to position within the FR. The sections of vegetation plots 6, 7, and 30 are most affected by pole extraction, accounting for most of the cut poles of disturbance transects 2 and 8

The occurrence of timber extraction is approximately equal to pole extraction (5% average). Most cut timbers were recorded along disturbance transect 0 and 2 with 16 and 8% of all timbers cut respectively. Of all disturbance transects sampled, transect 8 and 4 experience the least timber extraction, with 100 and 88% of all recorded timbers standing and alive respectively.

Table 18 Disturbance transect results for timber counts in Bombo East I FR.

Transect number	Length of transect (m)	Total timbers sampled	Standing timbers	<i>Standing timbers per ha</i>	Naturally dead timbers	<i>Naturally dead timbers per ha</i>	Cut timbers	<i>Cut timbers per ha</i>
0	1600	307	173 (56%)	108.13	85 (28%)	53.13	49 (16%)	30.63
1	2450	647	379 (59%)	154.69	228 (35%)	93.06	40 (6%)	16.33
2	2100	327	208 (64%)	99.05	93 (28%)	44.29	26 (8%)	12.38
3	1850	227	181 (80%)	97.84	46 (20%)	24.86	0 (0%)	0.00
4	650	43	38 (88%)	58.46	5 (12%)	7.69	0 (0%)	0.00
5	2600	515	406 (79%)	156.15	101 (20%)	38.85	8 (1%)	3.08
6	2200	305	243 (80%)	110.45	61 (20%)	27.73	1 (<1%)	0.45
7	750	110	88 (80%)	117.33	22 (20%)	29.33	0 (0%)	0.00
8	750	18	18 (100%)	24.00	0 (0%)	0.00	0 (0%)	0.00
Total	14950	2499	1734 (69%)		641 (26%)		124 (5%)	
Average (Standard deviation)				102.90 (+ 41.91)		35.44 (+ 27.29)		6.98 (+ 10.77)

Note: Timber is defined as >15cm dbh and 3m straight trunk.

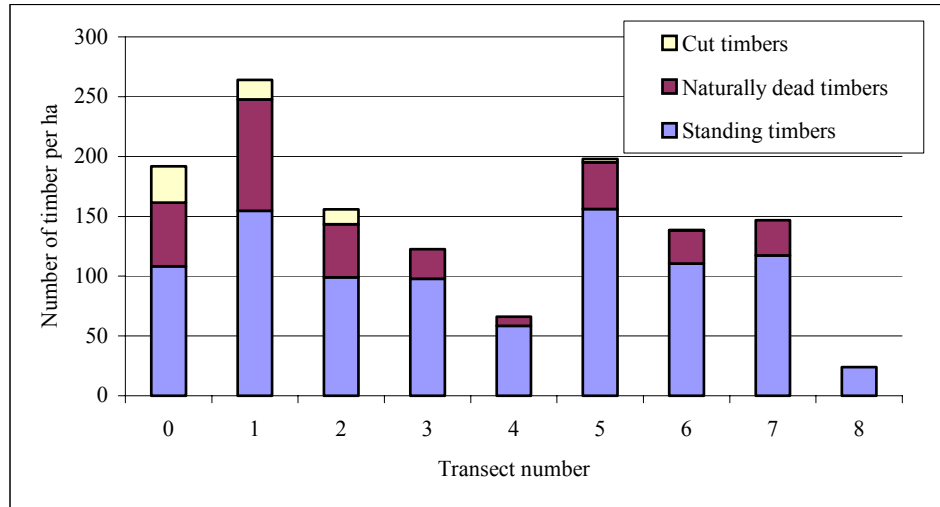


Figure 16 Relative abundance of live, naturally dead and cut timbers in Bombo East I FR.

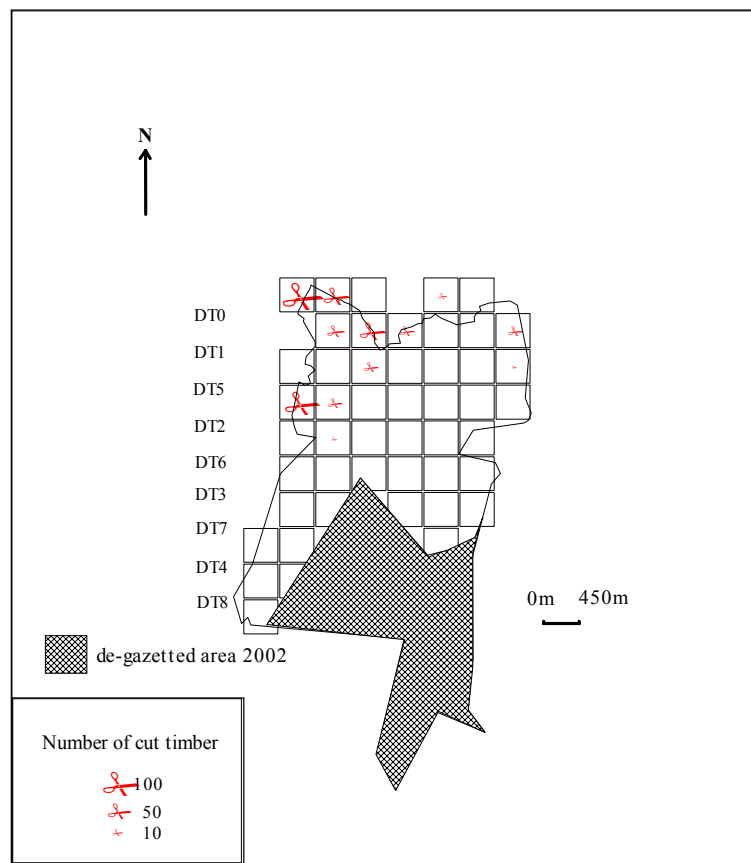


Figure 17 Timber extraction in Bombo East I FR.

Figure 17 illustrates timber extraction in Bombo East I FR in relation to its position within the FR. It is evident that the section of vegetation plot 31 on disturbance transect 0 and vegetation plot 6 on disturbance transect 2 have the largest amount of timber extracted per hectare. Vegetation plot 6 was also a hotspot for pole extraction.

4.3.2.2 Fires

Fires represent a significant threat to sites within Bombo East I FR. In December 2001, just a few months prior to the survey, fire spread throughout much of the FR. Figure 5 clearly shows the main areas affected by fire. Nearly all fire records are concentrated in the eastern side of the FR, however, most of the FR experienced fire, the only area of the FR without any records of fire is the south-east.

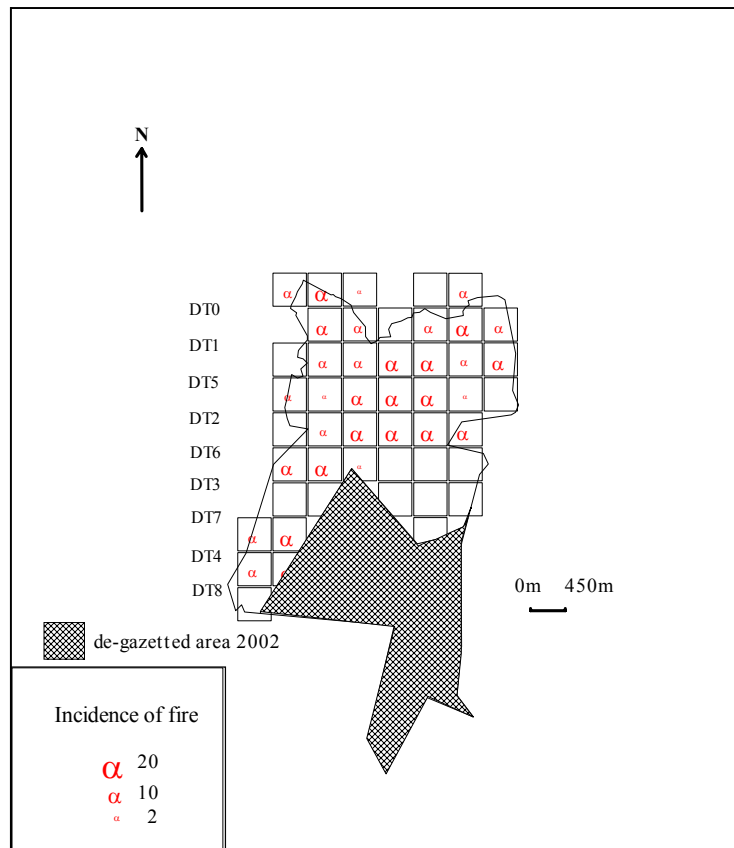


Figure 18 Records of fire in Bombo East I FR.

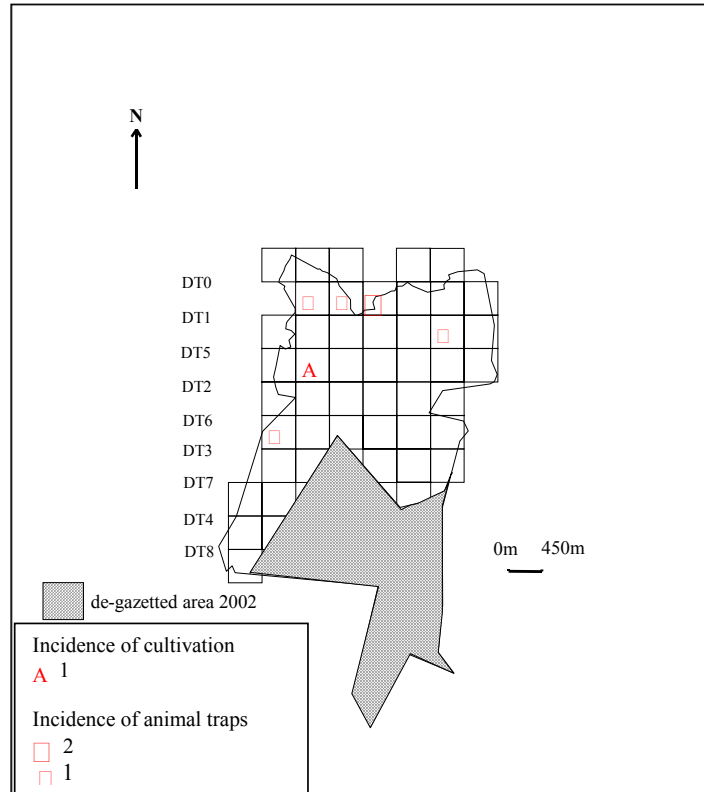


Figure 19 Records of various disturbance types in Bombo East I FR.

4.3.2.3 Animal Trapping and other Disturbances

Animal traps were observed in 6 out of a total 299 transect sections (2%). Both active and tripped snare traps designed to capture small antelope were recorded. Pitfall traps designed to catch bushpig were observed on many occasions whilst walking in the north of the reserve, near to borders. Figure 19 shows the location of animal traps observed in Bombo East I FR. One record each of charcoal burning and cultivation within the FR are illustrated in Figure 19, too.

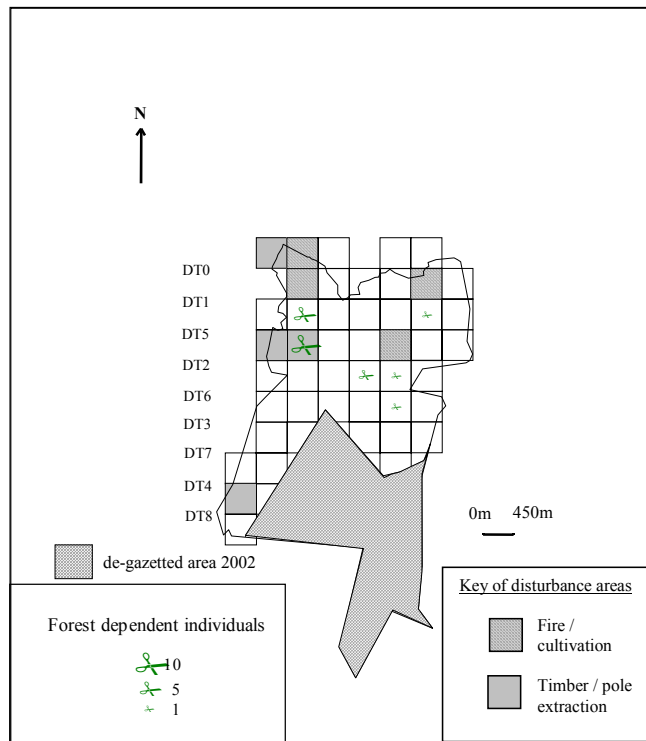


Figure 20 Areas of highest disturbance in relation to the distribution of tree and shrub individuals that are forest dependent in Bombo East I FR.

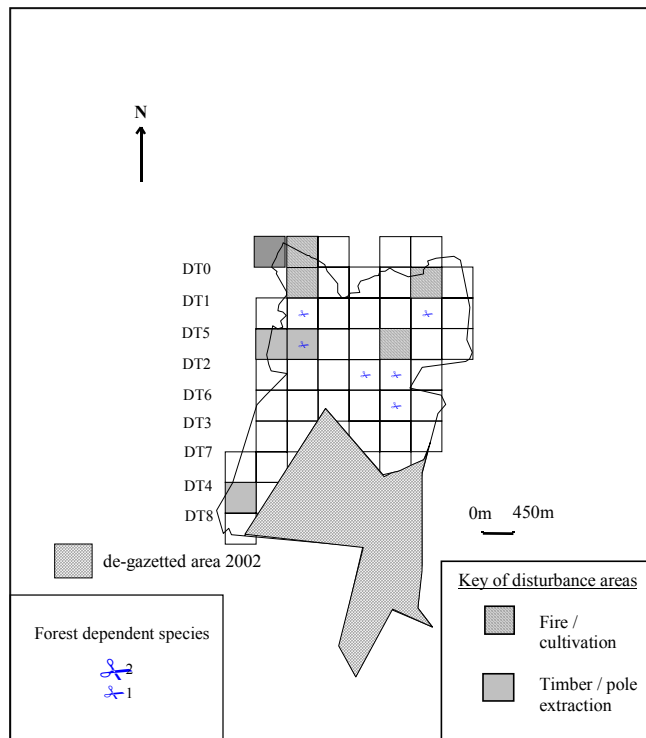


Figure 21 Areas of highest disturbance in relation to the distribution of tree and shrub species that are forest dependent in Bombo East I FR.

Of the eight most disturbed plots by fire and pole and timber extraction (Figure 20 and 21) only one, plot 7, has a high number of forest dependent individuals and species.

4.4 Discussion

Bombo East I FR covers an area of 448 hectares with an altitude range of 220 m to 620 m above sea level. The reserve has been heavily affected by fire disturbance and is predominately species poor open woodland.

Habitat

Of the 31 vegetation plots surveyed systematically the dominant vegetation types within vegetation plots were open woodland (69% of plots) and lowland forest (28% of plots). 90% of all vegetation plots had an average canopy height of less than 10 m. Only two vegetation plots were recorded with canopy heights greater than 10m. 87% of vegetation plots had been affected by fire.

Species richness

In the systematic vegetation plots 476 trees and shrubs were surveyed, representing 59 species from 26 families. An additional seven species were recorded solely in the regeneration layer opportunistic observations and collections recorded an additional 34 plant species from 24 families. In total 100 plant species from 37 families were recorded.

Relative to other FRs surveyed in the East Usambara Mountains the botanical diversity of Bombo East I FR was very low, partly due to the small size and extensive nature of recent fire disturbance.

The most abundant species in vegetation plots, representing 7.8% of individuals was the woodland species *Lonchocarpus bussei* (Leguminosae: subfamily Papilionoideae), which dominated within 14 plots. Other commonly encountered species throughout vegetation plots were *Lannea schweinfurthii* (Anacardiaceae), *Sterospermum kunthianum* (Bignoniaceae) and *Dalbergia melanoxylon* (Leguminosae: subfamily Papilionoideae). These species were common in open woodland areas and often associated with fire damage.

Species Accumulation Rates

The accumulation of species records throughout the systematic vegetation survey showed a general increase with sampling intensity and, although the curve seemed to level off (Figure 5), not enough evidence was available to suggest that the accumulation of species would not increase with greater sampling intensity. Opportunistic collection of flora supplemented the botanical checklist significantly.

Endemic Status

One species (*Cassia abbreviata* - Leguminosaceae: subfamily Caesalpinoideae) and one (1.7%) individual recorded in vegetation plots were endemic to the East Usambara Mountains, with 5 (8.5%) species and 72 individuals recorded as near endemic. The majority of species recorded (86.4 %) were therefore widespread in their distribution (Table 4). The majority of species recorded in vegetation plots (86.4%) had widespread distributions. One species was recorded as endemic to the East Usambara Mountains and 5 species near endemic. The most commonly recorded near-endemic tree and shrub species in the reserve were: *Scorodophloeus fischeri* (Leguminosaceae: subfamily Caesalpinoideae) (27 individuals) *Milletia dura* (Leguminosaceae: subfamily Papilionoideae) (17 individuals) and *Dombeya shupangae* (Sterculiaceae) (18 individuals). Near endemic species were relatively widespread within the reserve.

The sole endemic species recorded in vegetation plots was non-forest dependent and of the five near-endemic species, one species (*Milletia oblata* - Leguminosaceae: subfamily Papilionoideae) was considered to be forest dependent. The rest were forest dwelling but non-forest dependent. The only endemic species was found in one of the few areas of forest surveyed with no fire disturbance. Near endemic species were located throughout the FR, even in open woodland and

disturbed habitats. No endemic, near endemic or forest dependent species were recorded during opportunistic collection.

Ecological Type

A total of two (3.4%) species and 18 (3.8%) individuals recorded within vegetation plots were forest dependent (Table 8). The majority of species and individuals were forest dwelling but a high percentage were non-forest dependent. The most commonly recorded forest dependent tree species was *Millettia oblata* (Leguminosae: subfamily Papilionoideae) represented by 17 individuals in five vegetation plots, some of which were affected by fire but were generally less disturbed than the majority of plots.

Thirty-eight species (64.4%) were recorded in vegetation plots as forest dwelling and ten species (27.1%) non-forest dwelling. *Dalbergia melanoxylon* (Leguminosae: subfamily Papilionoideae) was the most abundant forest dwelling species represented by 30 individuals in 12 disturbed open woodland plots. *Lonchocarpus bussei* (Leguminosae: subfamily Papilionoideae), represented by 37 individuals in 14 plots was the most abundant non-forest species present in open woodland and disturbed lowland forest habitats.

Habitat

Of the tree species surveyed with known altitudinal preferences, 17 % were considered to be solely typical of lowland forest, 8.5% of submontane forest and 1.7% of montane forest. The remainder were considered to be typical of a combination of habitats, the majority (32.2% of species) present with lowland, submontane and montane habitats.

The sole montane species occurred in five lowland plots surveyed. The most commonly recorded lowland species was *Lonchocarpus bussei* (Leguminosae: subfamily Papilionoideae) represented by 37 individuals in 14 vegetation plots.

Range Extensions

A total of 59 species were recorded in Bombo East I FR during the present survey, eight of these were recorded by Ruffo *et al.* (1989) at other locations in the East Usambaras, whilst 51 species were not recorded at all by Ruffo *et al.* (1989).

A total of 25 species are new records for the East Usambara Biodiversity Database. Eight of these species were from the opportunistic checklist.

Regeneration

Thirty nine percent of the species found in the vegetation plots were also recorded within the regeneration subplots. These are indicated in Table 4 with an asterisk. An additional seven species were recorded in the regeneration layer alone.

Of those species found solely in the regeneration layer *Euclea crispa* (Ebenaceae) is a new record for the East Usambara Plant Biodiversity Database. All species were new to Ruffo *et al.* (1989).

Potentially four of the regenerating species are useful to humans, *Ochna thomasiana* for ornamental use and *Acacia sp.*, *Zanthoxylum sp.*, *Grewia sp.*, for various uses including honey production, charcoal, medicinal uses and food depending on the species (Ruffo, 1989 & Luoga *et al.*, 2000).

Sampling Intensity

An increase in sampling intensity from 0.25% to 0.5% increased the value of the vegetation survey significantly. An additional 15 vegetation plots were established, recording an additional 81 individuals representing 18 species. An additional one endemic species was recorded as a consequence of increasing sampling intensity. In small reserves it is therefore recommended that a sampling intensity of 0.5% be used.

An increase in the sampling intensity of regeneration plots from 3 m x 3 m to 6 m x 6 m significantly increased the number of individuals and species sampled in the regeneration layer.

Disturbance

Evidence of fire was observed in nearly all plots of Bombo East I FR. Most heavily affected were the plots in the north (e.g. 32 and 1) and centre of the FR (e.g. 8-10 and 25-27). Most of the affected plots were recorded to the east of the ridge in the north and to the west of it further south. This could indicate that the fires started and spread from the shambas in the north, and east of the FR. In the burnt areas little forest canopy was recorded and wooded grassland dominates. Also it is noticeable that there are fewer forest dependent species and individuals (see Figure 8 to 11) in the most severely fire-affected areas. It seems likely that fire is limiting the regeneration of forest species thereby limiting forest expansion within the FR.

Pole cutting and timber cutting show similar patterns of extraction, with particular plots (e.g. 2, 6, 7 and 31) having high rates. Generally there is much more pole than timber cutting, due to the higher density of poles in woodland areas of the FR (e.g. plots 29, 30 and the section to the eastern border from plot 14). Highest rates of extraction were recorded close to the FR borders, near human habitations near plots 6 and 7, 31 and 30.

Evidence of other disturbances was low, with only one record each of cultivation and charcoal burning in the north of the FR. No evidence of pitsawing or timber plank production was recorded. Animal traps, mostly for small antelope and bushpig were recorded near the northern border as well. Reasons for disturbances concentrating in the north could include the close vicinity to human settlements.

5.0 FAUNA

Authors: Svoboda, N. S. Staddon, S. Salter, R. & Bracebridge, C. pp. 44-68

5.1 Introduction

The fauna of Bombo East I Forest Reserve (Bombo East I 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 choice of taxonomic groups. The inventories were analysed to assess the relative biodiversity value of the reserve considering forest dependence, endemism and conservation concern.

5.2 Methods

Within Bombo East I FR, target taxa were surveyed using a combination of standardised, repeatable methods at ten-night 'zoological trappingsites'. Transect surveys of dung and other animal signs, and the opportunistic collection and observation of 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 Frontier Tanzania Forest Research Programme *Methodology Report* (SEE, 1998).

5.2.1 Bucket pitfall traps

Small mammals, amphibians and reptiles were sampled using bucket pitfall traps. Three 50 m linear transects were created at each zoological trappingsite. To form each trap line, eleven 20 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 5 m apart. A sheet of vertical plastic (approximately 0.5 m and no less than 0.2 m high) was set up along the bucket line crossing the centre of each bucket to form a 'drift fence'. A 10-15 cm 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 50 m apart, but was located in order to encompass a range of micro-habitats. Detailed habitat notes were taken for each trap 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, 22.9 cm x 7.6 cm x 8.9 cm) baited with roasted coconut and peanut butter. Traps were placed at least 2 m 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 (16.00 hr or later) for the duration of the trappingsite and checked early the following morning (09.00 hr or earlier). Traps were closed during each day of the trappingsite. Detailed habitat notes were taken for each trap.

In order to identify recaptured rodents, released individuals were given a distinct mark-code by trimming small patches of fur in a given pattern.

5.2.3 Bat mist-netting

Bats were sampled using varying combinations and configurations of mist-nets set on base camp and one of the three trappingsites. A combination of up to three mist-nets of varying sizes (3 m x 3.5 m, 6 m x 3.5 m, 9 m x 3.5 m) were utilised at any one time. Nets were placed across predicted 'flight corridors' such as rivers and paths. Nets were opened at dusk (approximately 18.30 hr) and checked every 15 minutes for the duration of the netting session.

5.2.4 Butterfly sweep-netting

Low-flying butterflies were sampled using hand-held sweep-nets. Two man-hours were spent netting along each of 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 the remaining two lines. Traps were baited with fermented banana in the mornings (usually around 09.00 hr) and then 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 1 m x 1 m 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 5 cm within each quadrat. All molluscs encountered were collected and preserved.

5.2.7 Millipede plots

Millipedes were sampled in three 3 m x 3 m quadrats per trapsite; again, 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 5 cm 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 recorded along transect lines through the Forest Reserve (Figure 3). These transects were also used to investigate human disturbances (see Chapter 4). A 2 m strip either side of each transect line was searched for animal dung, tracks and paths, as well as other signs such as burrows, diggings, feathers etc. All animal signs were recorded and geographical and habitat details were taken on each stretch of transect. 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

Taxa were also collected and observed on a casual basis throughout the survey period. Observations and vocalisations of larger mammals were expected to be particularly useful in revealing the presence of species not encountered in the standard trapsite techniques and dung and sign surveys.

5.2.10 Identification

In order to verify the identification of species recorded, a number of measures were taken. Wherever possible, two specimen (one male, one female) of each species recorded were taken and preserved whilst in the field. These were subsequently sent to a variety of experts for taxonomic verification (Appendix 1). Specimen were also taken of any animal that could not be confidently identified in the field or cross-referenced to a specimen already taken. However, all molluscs and millipedes were taken as specimen, as these taxon are very difficult to identified.

For each taxon, 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) to verify identification.

5.3 Trapping sites and sampling intensity

Zoological trappingsites were established at three different locations in Bombo East I FR. Trappingsites were strategically positioned to incorporate a range of habitats reflective of the reserve. The location of trappingsites within Bombo East I FR are shown in Figure 22.

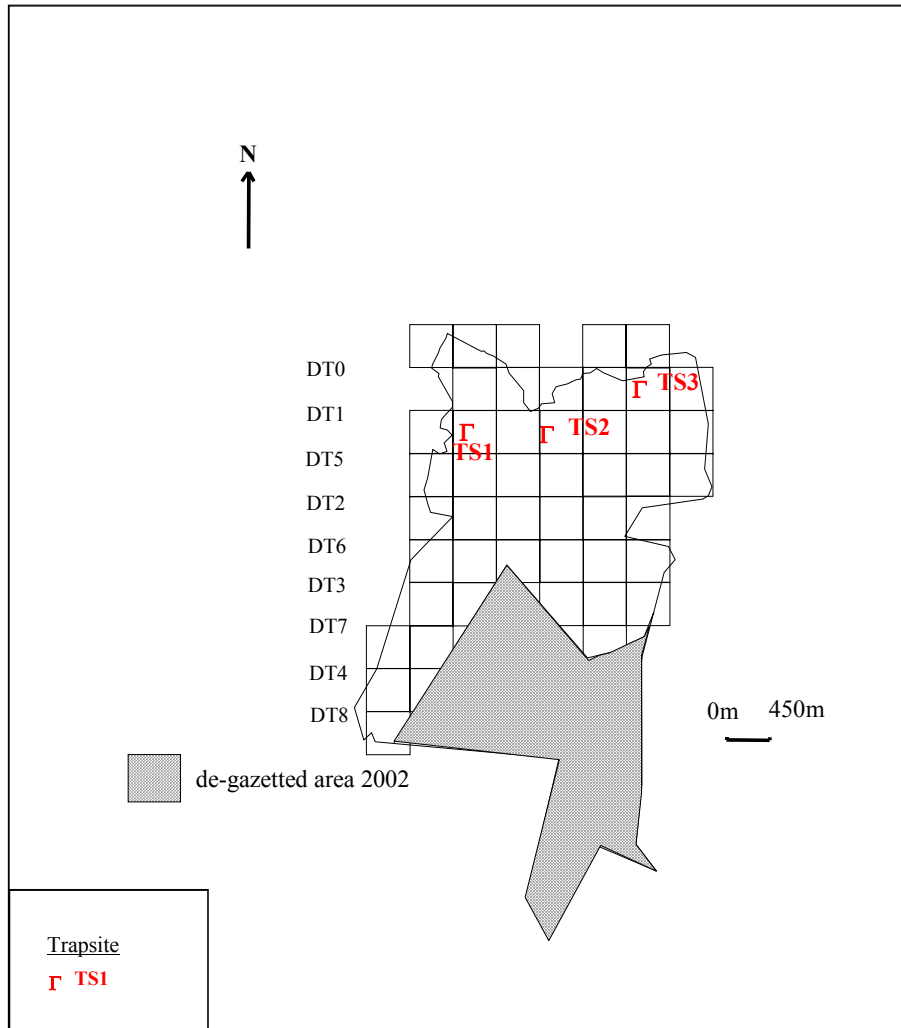


Figure 22 Location of trappingsites in Bombo East I FR.

Table 19 provides brief descriptions of the trapping sites. Table 20 summarises the sampling intensity for each site and each trapping method. Table 21 briefly describes bat mist-netting sites.

Table 19 Descriptions and locations of zoological trapsites in Bombo East I FR.

Trapsite Number	Duration (nights)	Vegetation type	Altitude (masl)	Topography	Co-ordinates
1	10	Lowland Forest and Burnt Woodland	400	Gentle Middle Slope and Gully	S 04° 49' 11.6" E 038° 42' 28.2"
2	10	Lowland Forest and Burnt Woodland	500	Gentle Middle and Upper Slope and Hill Top	S 04° 49' 06.8" E 038° 42' 55.0"
3	10	Lowland Forest and Burnt Woodland	450	Gentle Middle and Upper Slope and Hill Top	S 04° 048' 47.2" E 038° 43' 32.3"

Table 20 Zoological sampling intensities in Bombo East I 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	18.01.02-27.01.02	997	330	50	20	3	3
2	30.01.02-08.02.02	994	330	50	20	3	3
3	11.02.02-20.02.02	999	330	50	20	3	3
TOTAL		2990	990	150	60	9	9

Table 21 Bat mist-netting sites and sampling intensities in Bombo East I FR and at base camp.

Net site number	Site location	Site description	Co-ordinates	Altitude (m)	Sampling intensity (square metres of net x no. of hours)
1	Base camp	Along path in scrub and cultivation. Gentle lower slope.	S 04° 48' 34.8" E 038° 42' 10.6"	360	135
2	Trapsite 3	In dry gully, along the border of the FR and on forest edge. Gentle upper slope	S 04° 48' 47.2" E 038° 43' 32.3"	450	415.5
TOTAL					550.5

5.4 Results

5.4.1 Mammals

5.4.1.1 Small mammals (not including bats)

A total of 36 small mammals were captured during 2990 Sherman trapping nights in Bombo East I FR. Of these, 16 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 4 families. A summary of trapping data is given in Appendix 8 and a list of species captured and their ecological, endemic and threat status is presented in Table 22.

Ecological type, endemic status and threat status for Tables 22, 23, 24 and 25 were compiled using the National Biodiversity Database (UDSM, 1997), IUCN (Hilton-Taylor, 2000), Kingdon (1974 and 1997) and CITES listings (2001). These cannot be given for captures identified to genus only. Nomenclature follows Kingdon (1997). Final taxonomic verification of species identification have not yet been received for rodents, shrews and bats.

Table 22 Summary of small mammals captured in Bombo East I Forest Reserve.

Species	Ecol. type	End. status	Threat status			Total nos. captured
			IUCN 2000	UDSM 1997	CITES 2001	
CRICETOMYINAE						
<i>Beamys hindei</i> (Lesser Pouched Rat)	F	N	VU	DD		2
GERBILLINAE						
<i>Tatera cf. robusta</i> (Tatera Gerbil)	O	W				3
MURIDAE						
<i>Acomys spinosissimus</i> (Spiny Mouse)	f	W				16
<i>Grammomys cf. dolichurus</i> (Narrow-footed Woodland Mouse)	O	W				9
<i>Mus cf. minutoides</i> (Common Mouse)	O	W				1
<i>Rattus rattus</i> (Common Rat)	O	W				1
SCIURIDAE						
<i>Paraxerus palliatus palliatus</i> (Red-bellied Coast Squirrel)	f	W	VU			1
<i>Paraxerus ochraceus</i> (Ochre Bush Squirrel)	f	W				1
SORICIDAE						
<i>Crocidura cf. hildegardae</i> (White-toothed Shrew)	f	W				2
TOTAL						36

KEY TO ABBREVIATIONS FOR TABLES 22 and 23

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)

An interesting find within the reserve, albeit a tentative identification until positively verified, was that of *Tatera cf. robusta* (Tatera Gerbil), which has not been recorded within the East Usambaras prior to this time. It is common in all of sub-saharan Africa, except within rainforest areas. Bombo is mainly an dry open habitat, thus perhaps it's presence here reflects that.

By far the most commonly recorded species was *Acomys spinosissimus* (Spiny Mouse), constituting 44% of all small mammal captures.

One species captured is forest dependent, *Beamys hindei* (Lesser Pouched Rat) (Hamilton-Tayler, 2000) (Table 22) and is classed as vulnerable by IUCN. Four species are forest dwelling (*Crociodura cf. hildegardae* - White-toothed Shrew, *Acomys spinosissimus* - Spiny Mouse, *Paraxerus ochraceus* - Ochre Bush Squirrel and *Paraxerus palliatus palliatus* - Red-bellied Coast Squirrel). *Paraxerus palliatus palliatus* is also categorised as vulnerable by IUCN (Hilton-Taylor, 2000).

On base camp one additional species was recorded, *Hylomyscus cf. denniae* (African Wood Mouse). This was captured in a Sherman trap to opportunistically capture small mammals at base camp. It is a forest dwelling species and therefore of interest.

5.4.1.2 Dung survey

Dung from 13 mammal species were recorded (Table 23). Many records were difficult to identify to species, but were included here to give an overall impression of the fauna of the FR. Dung was identified with the help of local field assistants (Wasambaa), a reference dung collection and Walker (1996). To gain some estimate of abundance, the number of 50m transect sections along which dung was recorded were calculated and given as 'number occurrences' in Table 24. Maximal number of occurrence per 50 m transect section is one.

Table 23 Summary of dung survey in Bombo East I FR.

Species	Common Name	Ecol. type	End. status	Threat Status		No. of Occurrences	Altitudinal Ranges (m)
				IUCN 2000	CITES 2001		
ANTILOPINAE							
<i>Cephalophus monticola</i>	Blue Duiker	F	W			1	360
<i>Cephalophus</i> sp.	Duiker	-	-			19	360 – 560
<i>Madoqua</i> sp.	Dikdik	-	-			12	170 – 540
BOVIDAE							
<i>Bovid bovid</i>	Domestic Cattle	O	W			3	390 – 560
CANIDAE							
<i>Canis canis</i>	Domestic Dog	O	W			1	420
CERCOPITHECIDAE							
<i>Papio cynocephalus</i>	Yellow Baboon	f	W		II	5	310 – 580
MACROSCELIDEA							
Unknown sp.	Elephant Shrew	O	W			4	400 – 560
SUIDAE							
<i>Potamochoerus larvatus</i>	Bush Pig	O	W			4	305 – 560
THRYONOMYIDAE							
<i>Thryonomys</i> sp.	Cane-Rat	O	W			17	370 – 580
	Bush Pig	O	W			4	305 – 560
VIVERRIDAE							
<i>Genetta</i> sp.	Genet	f	W			1	560
<i>Civettictis civetta</i>	African Civet	f	W			2	380 – 540

For key to abbreviations, see Table 22.

Duiker and cane-rat dung was most frequently recorded (28 % and 26 % of all dung recordings respectively). Nearly all occurrences of cane-rat dung were on burnt ground. Most duiker dung was found in lowland forest towards the edges of the FR. An interesting record was that of domestic cattle and dog. Both were recorded on the edge of the FR.

5.4.1.3 Mammal observations

A total of 17 species from 11 families were observed both directly and indirectly within the FR. This includes species detected from the presence of tracks, paths, diggings, etc, but not those detected through the dung survey. All mammal observations are summarised in Table 24. Because most observations were made by indirect means identification to species level was not always possible. However, all signs are included here to give an impression of the FR species assemblage and large mammal diversity, not sampled in trapsites.

Table 24 Summary of mammal observations in Bombo East I FR.

Species	Ecol. type	End. status	Threat status		Evidence
			IUCN 2000	CITES 2001	
ANTILOPINAE					
<i>Cephalophus monticola</i> (Blue Duiker)	F	W		II	sp;
<i>Cephalophus</i> sp. (Duiker)	-	-			pa; sp
BOVIDAE					
<i>Bovid bovid</i> (Domestic Cattle)	O	W			pa; sp
CERCOPITHECIDAE					
<i>Papio cynocephalus</i> (Yellow Baboon)	f	W		II	voc; obs; fed; pa
<i>Cercopithecus (a.) pygerythrus</i> (Vervet Monkey)	O	W		II	voc
<i>Cercopithecus (n.) mitis</i> (Gentle Monkey)	f	W		II	voc
COLOBIDAE					
<i>Colobus angolensis palliatus</i> (Angola Pied Colobus)	F	W	DD	II	voc; obs, hair
GALAGONIDAE					
<i>Otolemur garnettii</i> (Small-eared Greater Galago)	f	W		II	voc; obs
<i>Galagoides zanzibaricus</i> (Zanzibar Galago)	F	W	LR/NT	II	voc; obs
HERPESTIDAE					
Unknown sp. (Mongoose)	-	-			bur
HYRACOIDAE					
<i>Dendrohyrax validus</i> (Eastern Tree Hyrax)	F	NE	EN/VU		voc
THRYONOMYIDAE					
<i>Thryonomys</i> sp. (Cane-Rat)	O	W			bur; tr;
SUIDAE					
<i>Potamochoerus larvatus</i> (Bush Pig)	O	W			dig; fed; pa, sp
VIVERRIDAE					
<i>Genetta</i> sp. (Genet)	f	W			sk
<i>Civettictis civetta</i> (African Civet)	f	W		III	sp; hair,
<i>Madoqua</i> sp. (Dikdik)	-	-			pa; sp

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

CITES listings:

- I – Appendix One listed species

VU – Vulnerable		II – Appendix Two listed species
LR/NT – Lower Risk/Near Threatened		III – Appendix Three listed species
DD – Data Deficient		
Evidence:		
voc - vocalisations heard	tr - trap	fed - remains of feedings
obs - observed	dig - diggings	hair - fur/hair found
bur - burrow		sk - skull found
		bns - bones found
		sp - spoor
		pa - path

Of particular interest were the aural accounts of three cryptic nocturnal mammals, *Dendrohyrax validus* (Eastern Tree Hyrax) and two species of nocturnal primates, *Galagoides zanzibaricus* (Zanzibar Galago) and *Otolemur garnettii* (Small-eared Greater Galago) at trapsite 3. *Dendrohyrax validus* was categorised by IUCN as a forest dependent, endangered species (Hilton-Taylor, 2000). Tree Hyrax and Galago taxonomy is currently undergoing changes on the basis of call differences between populations and thus sound recordings were made for further analysis. *Galagoides zanzibaricus* (Zanzibar Galago), a near endemic, lower risk/near threatened species (Hilton-Taylor, 2000), was observed and heard on trapsite 3. Little is known about this Dwarf Galago and sound recordings of its main vocalisations will help to gain a clearer understanding of its ecology and behaviour. Additionally, an infant *G. zanzibaricus* was found abandoned on the forest floor, nurtured for three days and, after its natural death, taken as a specimen. Sound recordings of the infant’s distress and contact call were made. All recordings await further analysis. Another nocturnal primate, *Otolemur garnettii* was heard and observed at trapsite 3 and also around base camp, living in cultivated land. Based on contact calls every dusk and dawn, the group at base camp was estimated to include 10-15 individuals.

A group of forest dependent *Colobus angolensis palliatus* were observed in lowland forest along disturbance transect 2 near vegetation plot 6. Three wooden arrows were stuck in the tree in which they were sighted, suggesting that this species has been hunted in Bombo East I FR. The record of a Colobus skin within the FR, near trapsite 1 added to this speculation.

5.4.1.4 Bats

A total of 15 individuals were caught during 550.5 net-metre-hours of trapping at trapsite 3 in Bombo East I FR and at basecamp. These individuals represented 8 species from 4 families. Eleven individuals were retained for taxonomic purposes. A summary of trapping data is shown in Appendix 8 and a species list presented in Table 25. Identifications remain tentative while awaiting taxonomic verification from Frankfurt Zoological Museum (refer to Appendix 1).

Ecological type, endemic status and threat status for Tables 25 were compiled using the National Biodiversity Database (UDSM, 1997), IUCN (Hilton-Taylor, 2000), Kingdon (1989 and 1997) and CITES listings (2001). Nomenclature follows Kingdon (1997).

Table 25 Summary of bat records in Bombo East I FR

Species	Common name	Ecol. type	End. status	Threat Status			Total nos. captured
				IUCN 2000	UDSM 1997	CITES 2001	
NYCTERIDAE							
<i>Nycteris theibaica</i>	Slit-faced Bat	O	W				1
PTEROPODIDAE							
cf. <i>Stenonycteris lanosus</i>	Mountain Fruit Bat	F	W				1
<i>Lissonycteris angolensis</i>	Angola Fruit Bat	f	W				3
RHINOLOPHIDAE							
<i>Rhinolophus clivosus</i>	Horseshoe Bat	O	W				3
Table 25 continued							
<i>Rhinolophus</i> cf. <i>hildebrandtii</i>	Horseshoe Bat	O	W				3

<i>Rhinolophus landeri</i>	Horseshoe Bat	f	W	1
VESPERTILIONIDAE				
<i>Myotis bocagei</i>	Hairy Bat	O	W	1
<i>Nycticeius (Scotoecus)</i>	Twilight or	O	W	2
<i>hirundo hindei</i>	Evening Bat			
TOTAL				15

KEY TO ABBREVIATIONS FOR TABLE 25Ecological (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
 III – Appendix Three listed species

A potentially interesting capture was cf. *Stenonycteris lanosus* (Mountain Fruit bat), a forest dependent species. Formal taxonomic identification is needed to verify this find. Two species captured, *Rhinolophus landeri* (Horseshoe Bat) and *Lissonycteris angolensis* (Angola Fruit bat) were forest dwelling species, with the remaining bat species non-forest dependent for their survival.

5.4.2 Birds

A total of 123 species from 41 families were recorded, mostly by Mr. Billy Munisi, a guide in the Amani Nature Reserve. No systematic survey of bird fauna was however undertaken and the findings therefore do not represent a complete inventory, but an impression of bird activity in Bombo East I FR (Table 26). All identifications are certain.

Where possible Mlingwa *et al.* (2000) and Stuart (1989) were used to determine ecological type and Stattersfield *et al.* (1998) used to define endemic status. Where no information was available in these sources, ecological type, endemic status and threat status were compiled using IUCN (Hilton-Taylor, 2001), CITES (2001) and Zimmerman *et al.* (1996). Nomenclature follows Zimmerman *et al.* (1996).

Table 26 Summary of birds observed opportunistically in Bombo East I FR.

Species	Common name	Ecol. type	End. status	Threat Status	
				IUCN 2000	CITES 2001
ACCIPITRIDAE					
<i>Aquila wahlbergi</i>	Wahlberg's Eagle	f	W		II
<i>Buteo a. augur</i>	Augur Buzzard	f	W		II
<i>Circaetus cinereus</i>	Brown Snake Eagle	f	W		II
<i>Circus pygargus</i>	Montague's Harrier	f	W		II
<i>Elanus c. caerules</i>	Black-shouldered Kite	f	W		II
<i>Gypohierax angolensis</i>	Palm-nut Vulture	f	W		II
<i>Hieraetus pennatus</i>	Booted Eagle	f	W		II

Table 26 continued

Species	Common name	Ecol. type	End. status	Threat Status	
				IUCN 2000	CITES 2001
<i>Kaupifalco m. monogrammicus</i>	Lizard Buzzard	f	W		II
<i>Lophaetus occipitalis</i>	Long-crested Eagle	f	W		II
<i>Polemaetus bellicosus</i>	Martial Eagle	f	W		II
<i>Polyboroides t. typus</i>	African Harrier Hawk	f	W		II
<i>Terathopius ecaudatus</i>	Bateleur	f	W		II
ALCEDINIDAE					
<i>Halcyon albiventris orientalis</i>	Brown-hooded Kingfisher	f	W		
<i>Halcyon c. helicuti</i>	Striped Kingfisher	f	W		
<i>Halcyon l. leucocephala</i>	Grey-headed Kingfisher	f	W		
APODIDAE					
<i>Cypsiurus parvus laemostigma</i>	African Palm Swift	f	W		
<i>Telacanthura ussheri stictilaema</i>	Mottled Spine Tail	F1	W		
ARDEIDAE					
<i>Bubulcus i. ibis</i>	Cattle Egret	f	W		III
BUCEROTIDAE					
<i>Bycanistes bucinator</i>	Trumpeter Hornbill	F2	W		
<i>Tokus alboterminatus</i>	Crowned Hornbill	f1	W		
CAPITONIDAE					
<i>Pogoniulus pusillus affinis</i>	Red-fronted Tinkerbird	f	W		
<i>Lybius melanopterus</i>	Brown-breasted Barbet	f	W		
<i>Trachyphonus darnaudii</i>	D'Arnaud's Barbet	f	W		
<i>Stactolaema leucotis klimensis</i>	White-eared Barbet	F1	W		
CICONIIDAE					
<i>Ciconia epis copusruicroscelis</i>	Woolly Necked Stork	f	W		
COLIIDAE					
<i>Colinus striatus kikuyuensis</i>	Speckled Mousebird	f	W		
COLUMBIDAE					
<i>Streptopelia capicola somalica</i>	Ring-necked Dove	f	W		
<i>Streptopelia semitorquata</i>	Red-eyed Dove	f	W		III
<i>Streptopelia s. senegalensis</i>	Laughing Dove	f	W		III
<i>Treron calva</i>	African Green Pigeon	F	W		III
<i>Turtur chalcospilos</i>	Emerald-spotted Wood Dove	f	W		
<i>Turtur tympanistria</i>	Tambourine Dove	F1	W		III
CORACIIDAE					
<i>Coracias g. garrulus</i>	Eurasian Roller	f	W		
<i>Eurystomus glaucurus sahelicus</i>	Broad Billed Roller	f	W		
CUCULIDAE					
<i>Ceuthmochares aereus</i>	Yellowbill	F2	W		
<i>Chysococcyx caprius</i>	Diederik Cuckoo	f	W		
<i>Chysococcyx c. cuprens</i>	African Emerald Cuckoo	f	W		
<i>Chysococcyx klaas</i>	Klaas' Cuckoo	f1	W		
<i>Oxylophus jacobinus</i>	Black-and-White/Jacobin Cuckoo	f	W		
DICRURIDAE					
<i>Dicrurus a. adsimilis</i>	Common Drongo	f	W		
<i>Dicrurus ludwigii sharpei</i>	Square-tailed Drongo	F3	W		

Table 26 continued

Species	Common name	Ecol. type	End. status	Threat Status	
				IUCN 2000	CITES 2001
EMBERIZIDAE					
<i>Emberiza cabanisi</i>	Cabanis' Bunting	F	E		
ESTRILDIDAE					
<i>Amadina fasciata alexanderi</i>	Cut-throat Finch	f	W		III
<i>Estrilda astrild</i>	Common Waxbill	f	W		III
<i>Hypargos niveoguttatus macrospilotus</i>	Peter's Twinspot	F1	W		
ESTRILDIDAE continued					
<i>Lonchura bicolor</i>	Black and White Mannikin	f	W		III
<i>Lonchura bicolor nigriceps</i>	Rufous-backed Mannikin	f	W		III
<i>Lonchura cucullata scutata</i>	Bronze Mannikin	f	W		III
<i>Lonchura fringilloides</i>	Magpie-Mannikin	f	W		III
<i>Lagonosticta senegala ruberrima</i>	Red-billed Firefinch	f	W		III
<i>Uraeginthus b. bengalus</i>	Red-cheeked Cordon-Bleu	f	W		III
<i>Vidua funerea nigerrima</i>	Variable Indigobird	f	W		
<i>Vidua macroura</i>	Pin-tailed Whydah	f	W		III
EURYLAIMIDAE					
<i>Smithornis capensis meinertzhageni</i>	African Broadbill	FF3	W		
FALCONIDAE					
<i>Falco peregrinus minor</i>	Peregrin Falcon	f	W		I
FRINGILLIDAE					
<i>Serinus mozambicus</i>	Yellow-fronted Canary	f	W		III
HIRUNDINIDAE					
<i>Hirundo abyssinica unitatis</i>	Lesser Striped Swallow	f	W		
INDICATORIDAE					
<i>Indicator indicator</i>	Greater/Black-throated Honeyguide	f	W		
<i>Indicator meliphiles</i>	Pallid Honeyguide	f1	W		
LANIIDAE					
<i>Lanius callurio</i>	Red-backed Shrike	f	W		
MALACONOTIDAE					
<i>Dryoscopus cubla</i>	Black-backed Puffback	F1	W		
<i>Laniarius aethiopicus</i>	Tropical Boubou	f	W		
<i>Malaconotus blanchoti approximans</i>	Grey-headed Bush Shrike	f	W		
<i>Tchagra australis emini</i>	Brown-crowned Tchagra	f	W		
<i>Tchagra s. senegala</i>	Black-crowned Tchagra	f	W		
MEROPIDAE					
<i>Merops nubicus</i>	Carmin Bee-Eater	f	W		
<i>Merops s. superciliosus</i>	Madagascar Bee-Eater	f	W		
MONARCHIDAE					
<i>Erythrocerus holochlorus</i>	Little Yellow Flycatcher	FF3	N		
<i>Terpsiphone viridis</i>	African Paradise Flycatcher	f1	W		
<i>Trochocercus cyanomelas bivittatus</i>	Blue Mantled Crested Flycatcher	f	W		
MOTACILLIDAE					
<i>Motacilla aquimp vidua</i>	African Pied Wagtail	f	W		
MUSCICAPIDAE					
<i>Muscicapa striata neumanni</i>	Spotted Flycatcher	f	W		

Table 26 continued

Species	Common name	Ecol. type	End. status	Threat Status	
				IUCN 2000	CITES 2001
MUSOPHAGIDAE					
<i>Tauraco fischeri</i>	Fischer's Turaco	F2	N*	LR/NT	II
NECTARINIIDAE					
<i>Anthreptes collaris</i>	Collared Sunbird	F1	W		
<i>Anthreptes reichenowi yohanae</i>	Plain-backed Sunbird	FF3	W	LR/NT	
NECTARINIIDAE continued					
<i>Nectarinia amethystina kalckreuthi</i>	Amethyst Sunbird	f	W		
<i>Nectarinia hunteri</i>	Hunter Sunbird	f	W		
<i>Nectarinia veroxii fischeri</i>	Mouse-coloured Sunbird	f	W		
NUMIDIDAE					
<i>Guttera pucherani</i>	Crested Guineafowl	F	W		
ORIOOLIDAE					
<i>Oriolus larvatus rolleti</i>	Black-headed Oriole	f	W		
<i>Oriolus o. oriolus</i>	Eurasian Golden Oriole	f	W		
PHASIANIDAE					
<i>Coturnix coturnix erlangeri</i>	Common Quail	f	W		
<i>Francolinus sephaena</i>	Crested Francolin	f	W		
PHOENICULIDAE					
<i>Phoeniculus purpurens</i>	Green Wood Hoopoe	F1	W		
<i>Rhinopomastus cyanomelas schalowi</i>	Common Scimitarbill	f	W		
PICIDAE					
<i>Campethera c. cailiautii</i>	Green-backed/Little Spotted Woodpecker	f1	W		
<i>Dendropicus fuscescens</i>	Cardinal Woodpecker	f	W		
PLATYSTEIRIDAE					
<i>Batis minor</i>	Black-headed Batis	FF3	W		
PLOCEIDAE					
<i>Anaplectes rubriceps</i>	Red-headed Weaver	f	W		III
<i>Euplectes albonotatus eques</i>	White-winged Widowbird	f	W		
<i>Euplectes ardens</i>	Red-collared Widowbird	f	W		III
<i>Euplectes f. franciscanus</i>	Northern Red Bishop	f	W		
<i>Euplectes hordeaceus</i>	Black-winged Red Bishop	f	W		III
<i>Euplectes nigroventris</i>	Zanzibar Red Bishop	f	W		
<i>Ploceus cucullatus</i>	Black-headed Weaver	f	W		III
<i>Ploceus ocularis suahelicus</i>	Spectacled Weaver	f	W		
<i>Ploceus r. rubignosus</i>	Chestnut Weaver	f	W		
<i>Ploceus subaureus aureoflavus</i>	African Golden Weaver	f	W		
PRIONOPIDAE					
<i>Prionops retzii garculina</i>	Retz's Helmet-shrike	f1	W		
<i>Prionops scopifrons kirki</i>	Chestnut-fronted Helmet-shrike	F2	W		
PYCNONOTIDAE					
<i>Andropadus importunus</i>	Zanzibar Sombre Greenbul	f	W		
<i>Chlorocichla flaviventris centralis</i>	Yellow-bellied Greenbul	F1	W		
<i>Nicator gularis</i>	Eastern Nicator	F	W		
<i>Phyllastrephus debilis</i>	Tiny Greenbul	FF3	W		

Table 26 continued

Species	Common name	Ecol. type	End. status	Threat Status	
				IUCN 2000	CITES 2001
PYCNONOTIDAE continued					
<i>Phyllastrephus fischeri</i>	Fischer's Greenbul	FF3	W		
<i>Phyllastrephus strepitans</i>	Northern Brownbul	f	W		
SCOPIIDAE					
<i>Scopus u. umbretta</i>	Hamerkop	f	W		
STURNIDAE					
<i>Cinnyricinclus leucogaster verreauxi</i>	Violet-backed Starling	f	W		
STURNIDAE continued					
<i>Lamprotornis c. chloropterus</i>	Lesser blue-eared Starling	f	W		
<i>Lamprotornis corruscus mandanus</i>	Black-bellied Starling	F2	W		
SYLVIIDAE					
<i>Apalis flavida</i>	Yellow-breasted Apalis	f	W		
<i>Apalis melanocephala</i>	Black-headed Apalis	FF2	W		
<i>Camaroptera brachyura</i>	Grey-backed Camaroptera	f2	W		
<i>Cisticola chiniana heterophrys</i>	Rattling Cisticola		W		
<i>Hippolais pallida elaeica</i>	Olivaceous Warbler	f	W		
<i>Sylvietta brachyura leucopsis</i>	Northern Crombec	f	W		
TROGONIDAE					
<i>Apaloderma n. narina</i>	Narina's Trogon	F3	W		
TURDIDAE					
<i>Cercotrichas g. guttata</i>	Spotted Morning Thrush	f	W		
<i>Cercotrichas leucophrys</i>	White-browed Scrub Robin	F	W		
<i>Cercotrichas q. quadrivirgata</i>	Eastern Bearded Scrub Robin	f1	W		
<i>Cossypha h. henglini</i>	White-browed Robin Chat	f	W		
<i>Cossypha natalensis</i>	Red-capped Robin Chat	F1	W		

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

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

KEY TO ABBREVIATIONS FOR TABLE 26 AND 27

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
 III – Appendix Three listed species

A total of 77 % of bird species (95 species) recorded in Bombo East I FR were non-forest species (Mlingwa *et al.*, 2000), with 17% (21 species) forest generalists and 6% (7 species) forest specialists. Forest specialists are summarised in Table 27.

Table 27 Summary of forest dependent birds with corresponding threat status categories.

Species name	Common name	Ecol. type	End. status	Threat Status	
				IUCN 2000	CITES 2001
<i>Anthreptes reichenowi yokanae</i>	Plain-backed Sunbird	FF3		LR/NT	
<i>Apalis melanocephala</i>	Black-headed Apalis	FF2			
<i>Batis minor</i>	Black-headed Batis	FF3	W		
<i>Erythrocerus holochlorus</i>	Little Yellow Flycatcher	FF	N		
<i>Phyllastrephus debilis</i>	Tiny Greenbul	FF3			
<i>Phyllastrephus fischeri</i>	Fischer's Greenbul	FF3			
<i>Smithornis capensis meinertzhageni</i>	African Broadbill	FF3			

Three bird species observed in Bombo East I FR were of restricted range and are summarised in Table 28.

Table 28 Restricted ranges of endemic and near endemic birds (Statterfield *et al.* (1998), Zimmerman *et al.* (1996))

Species name	Common name	Range
<i>Emberiza cabanisi</i>	Cabanis' Bunting	East and West Usambara Mountains, also found south of area.
<i>Erythrocerus holochlorus</i>	Little Yellow Flycatcher	Coastal lowland north to Boni Forest and East Usambara Mountains.
<i>Tauraco fischeri</i>	Fischer's Turaco	East and West Usambara Mountains and East African Coastal forests

5.4.3 Reptiles

A total of 23 reptile individuals representing 16 species and 5 families were captured in Bombo East I FR. Reptiles were captured over 990 pitfall-trap nights and opportunistic collection within the FR. The species are summarised in Table 29. Sixteen individuals were taken as specimens for taxonomic purposes. Appendix 9 summarises reptile trapping data, including whether collected through systematic or opportunistic methods. 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). Identifications remain tentative while awaiting taxonomic verification from Natural History Museum of Zimbabwe (refer to Appendix 1).

Table 29 Summary of reptile pitfall and opportunistic captures at zoological trapsites in Bombo East I FR.

Family	Common Name	Ecol. type	End. status	Threat Status			No. of individuals captured
				IUCN 2000	UDSM 1997	CITES 2001	
COLUBRIDAE							
<i>Aparallactus capensis</i>	Cape Centipede Eater	O	W				1
<i>Aparallactus werneri</i>	Usambara Centipede Eater	f	N				1
<i>Lamprophis capensis</i>	Brown House Snake	O	W				1
<i>Lycophidion capense loveridgei</i>	Loveridge's Cape Wolf Snake	O	W				1
<i>Thelotornis "usambaricus" sp. nov.</i>	Vine Snake	F	E				1
GEKKONIDAE							
<i>Hemidactylus mabouia</i>	Tropical House Gecko	f	W				2
<i>Hemidactylus squamulatus</i>	Boulenger's Gecko	O	W				2
Table 29 continued							
GEKKONIDAE continued							
<i>Lygodactylus luteopicturatus</i>	Yellow-headed Dwarf Gecko	O	N				1
<i>Lygodactylus picturatus</i>	White-headed Dwarf Gecko	O	N				1
GERROSAURIDAE							
<i>Gerrosaurus major</i>	Great-plated Lizard	O	W				2
LACERTIDAE							
<i>Helibolus speki spekii</i>	Speke's Sand Lizard	O	W				2
<i>Nocrus boulengeri</i>	Boulenger's Scrub Lizard	O	W				1
SCINCIDAE							
<i>Mabuya macuilabris</i>	Speckle-lipped Skink	f	W				1
<i>Mabuya planifrons</i>	Tree Skink	O	W				1
<i>Mabuya striata</i>	Striped Skink	f	W				2
<i>Mabuya varia</i>	Variable Skink	O	W				3
TOTAL							24

KEY TO ABBREVIATIONS FOR TABLE 29

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

CITES listings:

- I – Appendix One listed species

VU – Vulnerable	II – Appendix Two listed species
LR/NT – Lower Risk/Near Threatened	III – Appendix Three listed species
DD – Data Deficient	

Four species captured were categorised as forest dwelling; *Hemidactylus mabouia* (Tropical House Gecko), *Mabuya striata* (Striped Skink), *Aparallactus capensis* (Cape Centipede Eater) and *Aparallactus wernerii* (Usambara Centipede Eater), three as near endemic (*Lygodactylus luteopicturatus* – Yellow-headed Dwarf Gecko, *Lygodactylus picturatus* – White-headed Dwarf Gecko and *Aparallactus wernerii* – Usambara Centipede Eater) (UDSM, 1997). *Aparallactus wernerii* (Usambara Centipede Eater) is a forest dwelling species, as well as being endemic to the coastal and hill forests of Eastern Tanzania (Spawls *et al*, 2002). An interesting capture is *Thelotornis usambaricus* sp. nov. (Vine Snake), a forest dependent species and an endemic to the East Usambaras. It is currently being described as a new species and all *Thelotornis* material from the East Usambaras will constitute the type material for *T. "usambaricus"* sp. nov. (Broadley, pers. comm.).

Additional observations were made outside, but near Bombo East I FR and at base camp representing 5 families and 8 species; *Hemidactylus mabouia* (Tropical House Gecko), *Lygodactylus luteopicturatus* (Yellow-headed Dwarf Gecko), *Chamaeleo dilepis* (Flap-necked Chameleon), *Telescopius semiannulatus* (Tiger Snake), *Psammophis mossambicus* (Olive Sand Snake / Hissing Sand Snake) *Rhinotyphlops mucruso* (Zambezi Blind Snake) *Thelotornis usambaricus* sp. nov. (Twig / Vine Snake) and *Bitis a. arietans* (Puff Adder). Of these, five individuals were kept for taxonomic purposes. Unsurprisingly, all reptiles captured at base camp are non-forest dependent and widespread species.

5.4.4 Amphibians

A total of 4 amphibians were captured during 990 pitfall trapping nights. These individuals represent 3 species and 3 families. All 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). These cannot be given for captures identified to genus only. Identifications remain tentative while awaiting taxonomic verification from the British Natural History Museum (refer to Appendix 1).

Table 30 Summary of pitfall and opportunistic amphibian captures in Bombo East I 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				2
BUFONIDAE							
<i>Bufo gutturalis</i>	Square-marked Toad	O	W				1
HYPEROLIIDAE							
<i>Hyperolius viridiflavus</i>	Reed and Lily Frog	f	W				1
TOTAL							4

KEY TO ABBREVIATIONS FOR TABLE 30

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
 III – Appendix Three listed species

Two of the three species captured is forest dwelling, *Arthroleptis stenodactylus* (Squeaker Frog) and *Hyperolius viridiflavus* (Reed and Lily Frog).

An additional 5 individuals were captured at base camp, representing three families and four species; *Bufo gutturalis* (Guttural Toad), *Hyperolius tuberilinguis* (Reed Frog), *Afrixalus sp.* (Leaf-folding Frog) and *Chiromantis xerampelina* (Foamnest Frog). None of these depend or dwell in forests. Three individuals were retained for taxonomic verification. Not surprisingly, all amphibians captured at base camp were non-forest dependent and widespread species.

5.4.5 Invertebrates

5.4.5.1 Butterflies

A total of 106 species of butterflies were captured in Bombo East I FR, using sweep-nets and canopy traps. These species represent 4 families. One-hundred-and-eighty-two specimens were retained for taxonomic purposes. Official taxonomic identifications have yet to be obtained, thus identification remain tentative. Ecological type and endemic status were compiled using Larsen (1996), and Kielland (1990). Those cannot be given for individuals identified to genus only. The butterfly species list for Bombo East I FR is presented in Table 31. Capture data is summarised in Appendix 11. Final taxonomic verification of species identification have not yet been received for the butterfly specimens.

Table 31 Summary of butterflies captured in Bombo East I FR.

Species	Ecol. type	End. status
LYCAENIDAE		
Unknown sp.	-	-
<i>Anthene cf. lasti</i>	F	W
<i>Anthene otacilia kikuyi</i>	O	W
<i>Anthene</i> sp.	-	-
<i>Axiocerses harpax ugandana</i>	O	W
<i>Euthrysops nandensis nandensis</i>	O	NE
<i>Lepidochysops</i> sp.	-	-
<i>Leptotes</i> sp.	-	-
<i>Ornipholidotos peucetia</i>	f	W
<i>Pentila</i> sp.	-	-
<i>Pentila tropicalis/pauli</i>	O	W
<i>Pentila tropicalis mombasa</i>	F	W
<i>Teriomina subpunctata</i>	F	W
NYMPHALIDAE		
<i>Acraea</i> sp.	-	-
<i>Acraea anemosa</i>	f	W
<i>Acraea caecilia</i>	O	W
<i>Acraea encedon encedon</i>	O	W
<i>Acraea esebria esebria</i>	f	W
<i>Acraea insignis insignis</i>	f	W
<i>Acraea natalica natalica</i>	O	W
<i>Acraea pardopsis punctatissima</i>	O	W
<i>Acraea cf. zetes zetes</i>	O	W
<i>Bicyclus safitza safitza</i>	O	W
<i>Byblia</i> sp.	-	-
<i>Byblia anvatara acheloia</i>	f	W
<i>Byblia ilithyia</i>	O	W
<i>Charaxes</i> sp. 1 (black and white)	-	-
<i>Charaxes</i> sp. 2 (specimen 119)	-	-
<i>Charaxes</i> sp. 3	-	-
<i>Charaxes achaemenes</i>	f	W

Table 31 continued

Species	Ecol. type	End. status
NYMPHALIDAE continued		
<i>Charaxes berkeley</i>	F	W
<i>Charaxes bohemani</i>	O	W
<i>Charaxes brutus angustus</i>	f	W
<i>Charaxes candiope candiope</i>	f	W
<i>Charaxes castor</i>	f	W
<i>Charaxes cf. chepalungu</i>	F	W
<i>Charaxes cf. cithaeron</i>	f	W
<i>Charaxes cithaeron nairobicus</i>	F	W
<i>Charaxes contrarius contrarius</i>	f	NE
<i>Charaxes etesipe gordonii</i>	F	W
<i>Charaxes etheocles envansi</i>	f	W
<i>Charaxes jahlusa kenyensis</i>	f	W
<i>Charaxes cf. usambarae maridadi</i>	F	NE
<i>Charaxes varanes</i>	f	W
<i>Charaxes varanes vologese</i>	f	W
<i>Charaxes viola picta</i>	O	W
<i>Charaxes xiphares walwandi</i>	f	W
<i>Charaxes cf. zoolina zoolina</i>	O	W
<i>Euphaedra neophron littoralis</i>	F	NE
<i>Eurytela dryope angulata</i>	f	W
<i>Hamanumida daedalus</i>	f	W
<i>Henotesia persicus</i>	O	W
<i>Hypolimnias cf. hisippus</i>	O	W
<i>Junonia oenone oenone</i>	O	W
<i>Junonia hierta cebrene</i>	f	W
<i>Junonia natalica natalica</i>	f	W
<i>Melantis leda</i>	f	W
<i>Neptis rogersi</i>	F	W
<i>Neptis cf. serena serena</i>	f	W
<i>Neptis saclava marpessa</i>	f	W
<i>Pseudacraea sp.</i>	-	-
<i>Pseudacraea lucretia protracta</i>	f	W
<i>Pseudacraea lucretia expansa</i>	F	W
<i>cf. Salamis cacta cacta</i>	f	NE
<i>Sallya garega garega</i>	f	W
<i>Sallya moranti moranti</i>	f	W
PAPILIONIDAE		
<i>Catopsilia florella</i>	O	W
<i>Graphium sp.</i>	-	-
<i>Graphium antheus</i>	f	W
<i>Graphium philonoe philonoe</i>	f	W
<i>Papilio constaninus constaninus</i>	f	W
<i>Papilio dardanus polytrophus</i>	f	W
<i>Papilio demodocus demodocus</i>	f	W
<i>Papilio hornimani</i>	F	NE
<i>Papilio ophidicephalus ophidicephalus</i>	f	W
PIERIDAE		
Unknown sp.	-	-
<i>Belenois sp. 1</i>	-	-
<i>Belenois sp. 2</i>	-	-
<i>Belenois aurota aurota</i>	f	W
<i>Belenois creona severina</i>	f	W

Table 31 continued.

Species	Ecol. type	End. status
PIERIDAE continued		
<i>Belenois gidica</i>	O	W
<i>Belenois thysa thysa</i>	f	W
<i>Colotis</i> sp.	-	-
<i>Colotis anatus anatus</i>	O	W
<i>Colotis antivippe zera</i>	f	W
<i>Colotis aurigneus</i>	f	W
<i>Colotis</i> cf. <i>aurigneus/uesta manningtoni</i>	O	W
<i>Colotis auxoincretus</i>	O	W
<i>Colotis danae eupompe</i>	f	W
<i>Colotis</i> cf. <i>dariae jackisoni</i>	O	NE
<i>Colotis</i> cf. <i>evagore antigone</i>	f	W
<i>Colotis</i> cf. <i>eucharis evarne</i>	O	W
<i>Colotis euippe omphale</i>	f	W
<i>Colotis ione</i>	f	W
<i>Colotis pallene</i>	O	W
<i>Dixeia</i> sp.	-	-
<i>Dixeia charina</i>	O	W
<i>Dixeia</i> cf. <i>orbona violua</i>	f	W
<i>Eurema</i> sp. 1	-	-
<i>Eurema</i> sp. 2	-	-
<i>Eurema brigitta brigitta</i>	O	W
<i>Eurema</i> cf. <i>deyardinsi oberthri</i>	f	W
<i>Eurema hecabe solifera</i>	f	W
<i>Eurema</i> cf. <i>regularis</i>	f	W
<i>Eurema senegalensis</i>	F	W
<i>Pinacopteryx eriphia melanarge</i>	O	W

KEY TO ABBREVIATIONS FOR TABLE 31Ecological (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.

Seventy-six percent of all butterfly species captured in Bombo East I FR were widespread in distribution with only 6% species of near endemic status. Eighteen percent are of unknown distribution. Twelve percent of butterfly species were forest dependent, 44% forest dwelling and 26% non-forest species. Eighteen percent are of unknown ecological type.

5.4.5.2 Molluscs

A total of 201 molluscs were collected in zoological trappings 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 87 millipedes were collected in zoological trappings 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

As most endemic and forest dependent species were found within zoological trappings, their distribution cannot be extrapolated for the whole of the FR. However, fire was the most significant form of disturbance in Bombo East I FR (refer to Disturbance discussion) and it is likely that fire poses the greatest threat to endemic and forest dependent fauna within the reserve.

5.5 Discussion

5.5.1 Introduction

Bombo East I FR encompasses 448 ha, thus a small FR. The biodiversity survey nevertheless yielded some interesting results. Species composition within most taxa suggested an open and dry habitat, with few forest dependent and dwelling species recorded. Bombo East I FR had very different habitat types than many of the other FRs within the East Usambaras, consisting of open woodland and lowland forest. Recent fire within the FR has effected most of the eastern side of the FR where thicket rather than forest now dominates.

Table 32 Summary of faunal families and species (identifications remain tentative) and inclusive of casual observations, dung surveys etc.

Taxon	Number of families	Number of species
Mammals (not including bats)	17	27
Bats	4	8
Birds	41	123
Reptiles	5	16
Amphibians	3	3
Butterflies	4	106
TOTAL	74	283

5.5.2 Species Abundance and Importance

To provide an estimate of species abundance, the frequency of species-capture was investigated. Any three records of an animal assumed it to be locally abundant. This makes the assumption that the frequency with which an animal is recorded reflects its general abundance, although it must be highlighted that abundance of highly cryptic species may not be reflected accurately.

5.5.2.1 Mammals

The most commonly captured mammal species were *Acomys spinosissimus* (Spiny Mouse, 16 individuals captured) and *Grammomys* cf. *dolichurus* (Narrow-footed Woodland Mouse 9 individuals captured). Both species were caught most frequently at trapsites 1 and 3. In general, trapsite 2 did not yield many captures (only 4 mammals in total). Trapsite 2 was situated in denser lowland forest than trapsites 1 and 3, and was similar in microhabitat for each line with one line in burnt woodland, and the other two in lowland forest habitat.

Of the larger mammals, direct sightings of *Cercopithecus (n.) mitis* (Gentle/Blue Monkey) and *Colobus angolensis palliatus* (Angola Pied Colobus) in the forested areas, and *Papio cynocephalus* (Yellow Baboon) troops near the forest borders were most common. Species recorded indirectly through spoor and dung on many occasions throughout the FR were *Thryonomys gregorianus* (Cane Rat), *Madoqua* sp. (Dikdik) and *Cephalophus* sp. (Duiker sp.).

At trapsite 3, the only trapsite where nocturnal surveys were conducted, *Otolemur garnettii* (Small-eared Greater Galago), *Galagoides zanzibaricus* (Zanzibar Galago) and *Dendrocybus validus* (Eastern Tree Hyrax) were frequently heard and recorded on tape. All three species were recorded in lowland forest, near the top of a hill. As cryptic nocturnal species are most readily differentiated through their distinct contact and alarm calls, these sound recordings will help to verify their taxonomy.

The most commonly caught bat species were the two Horseshoe Bat species, *Rhinolophus clivosus* and *Rhinolophus* cf. *hildebrandtii*, both with three captured individuals at the edge of lowland forest at trapsite 3.

5.5.2.2 Birds

Birds encountered more than 3 times during the bird survey were assumed to be abundant and included *Phoeniculus purpurens* (Green Wood Hoopoe), *Turtu chalcospilos* (Emerald-spotted Wood Dove), *Prionops scopifrons kirki* (Chestnut-fronted Helmetshrike) and *Bycanistes bucinator* (Trumpeter Hornbill). Bird surveys took place along the edge of the FR and along random transect lines within the FR.

5.5.2.3 Reptiles

No reptiles were captured in abundance, however, at trappingsites 1 and 3 relatively more reptiles were captured (9 and 7 individuals respectively, compared with 5 at trappingsite 2). Trappingsite 2 was situated within the FR, but had lower canopy cover than the other two trappingsites and was generally a lesser quality habitat.

Four species, *Lygodactylus picturatus* (White-headed Dwarf Gecko), *Mabuya planifrons* (Tree Skink), *Heliobolos spekii* (Speke's Sand Lizard) and *Nocrus boulengeri* (Boulenger's Scrub Lizard) were recorded in the East Usambaras for the first time. These records within Bombo East I FR represent range extensions for the four species.

5.5.2.4 Amphibians

An extremely low number of amphibians were captured within the FR. This almost certainly reflects the dry weather conditions experienced during the survey period (see Appendix 12: Weather Data). The very dry nature of the FR, which had no surface water, is also an influence on the abundance of amphibians. With two individual captured, *Arthroleptis stenodactylus* (Shovel-footed Squeaker) represents the most commonly caught species.

5.5.3 Endemics and near-endemics

Endemic or near endemic species were found at all three trappingsites in equal numbers (2 individuals at each trappingsite).

Nine species recorded during the survey were endemic or near endemic; *Beamys hindei* (Lesser pouched Rat), *Dendrohyrax validus* (Eastern Tree Hyrax), *Tauraco f. fischeri* (Fisher's Turaco), *Erythrocerus holochlorus* (Little Yellow Flycatcher), *Emberiza cabanisi* (Cabanis' Bunting), *Lygodactylus luteopicturatus* (Yellow-headed Dwarf Gecko), *Lygodactylus picturatus* (White-headed Dwarf Gecko), *Aparallactus werneri* (Usambara Centipede Eater), *Thelotornis 'usambarensis'* sp. nov. (Vine Snake). Only three were recorded frequently, though: *Beamys hindei* (Lesser pouched Rat, 2 individuals), *Dendrohyrax validus* (Eastern Tree Hyrax, only through vocalisations), and *Tauraco f. fischeri* (Fisher's Turaco).

The following species were also forest dependent species: *Beamys hindei* (Lesser pouched Rat), *Dendrohyrax validus* (Eastern Tree Hyrax), *Erythrocerus holochlorus* (Little Yellow Flycatcher) and *Thelotornis "usambaricus"* sp. nov. Vine Snake).

5.5.4 Forest dependent species

Only one mammal species captured at the trapsites in Bombo East I FR was forest dependent, *Beamys hindei* (Lesser pouched Rat). Despite the similarities of habitats between trapsites, it was only recorded at trapsite 3. The fruit bat, cf. *Stenonycteris lanosus*, captured from basecamp, was also a forest dependent species. Of the larger mammals, not targeted in trapsites, four were forest dependent and include *Colobus angolensis palliatus* (Angola Pied Colobus), *Galagoides zanzibaricus* (Zanzibar Galago), *Dendrohyrax validus* (Eastern Tree Hyrax) and *Cephalophus monticola* (Blue Duiker). All were sighted/heard three or more times during the survey. Seven bird species were classified as forest dependent; *Apalis melanocephala* (Black-headed Apalis), *Anthreptes reichenowi yokanae* (Plain-backed Sunbird), *Batis minor* (Black-headed Batis), *Smithornis capensis meinertzhageni* (African Broadbill), *Phyllastrephus debilis* (Tiny Greenbul), *Phyllastrephus fischeri* (Fischer's Greenbul) and *Erythrocerus holochlorus* (Little Yellow Flycatcher). One reptile species, *Thelotornis "usambaricus"* nov. sp. (Vine Snake) was forest dependent. No amphibian species was forest dependent.

Beamys hindei (Lesser pouched Rat), *Dendrohyrax validus* (Eastern Tree Hyrax), *Erythrocerus holochlorus* (Little Yellow Flycatcher), and *Thelotornis "usambaricus"* sp. nov. (Vine Snake) were also endemic or near endemic species.

5.5.5 High risk species

With the assumption that species observed rarely may have a low abundance, that forest dependent or dwelling species rely on the most threatened habitat, and that restricted range species are inherently higher risk, high risk species in Bombo East I FR can be determined. Due to the nature of the FR's habitat, both forest dependent and forest dwelling species were considered. Cryptic species, such as chameleons and nocturnal mammals have not been considered however, as difficulties in sampling will bias the results.

Vertebrate species that were recorded less than three times during the survey, and were both forest dependent or forest dwelling and endemic or near-endemic are as follows, *Beamys hindei* (Lesser Pouched Rat), *Paraxerus palliatus palliatus* (Red-bellied Coast Squirrel), *Lygodactylus luteopicturatus* (Yellow-headed Dwarf Gecko), *Lygodactylus picturatus* (White-headed Dwarf Gecko), *Aparallactus wernerii* (Usambara Centipede-eater), *Tauraco fischeri* (Fischer's Turaco), *Erythrocerus holochlorus* (Little Yellow Flycatcher), *Emberiza cabanisi* (Cabanis's Bunting).

5.5.6 Ecological Type

Fifty-three percent of the 283 fauna species captured or observed in Bombo East I FR were non-forest species. This included 15 mammal, 95 bird, 11 reptile, 1 amphibian and 28 butterfly species. This reflected the open nature of the dominating habitat, mainly woodland. Only 27 species recorded were forest dependent (9%), comprising 5 mammal, 7 bird, 1 reptile and 13 butterfly species. No amphibian species recorded were forest dependent. Table 33 summarises these results.

Table 33 Summary of ecological type of mammal, bird, reptile, amphibian and butterfly species recorded in Bombo East I FR

Ecological type	No. of species	% of total species recorded
Forest dependent	27	9
Forest dwelling but not forest dependent	84	30
Non-forest species	150	53
Unknown	22	8
TOTAL:	283	100

5.5.7 Endemic Status

The vast majority, 86 %, of all animal species captured in Bombo East I FR had a widespread distribution. This figure comprises 30 mammal, 120 bird, 12 reptile, 3 amphibian and 80 butterfly species. Five point five percent of all species recorded were endemic or near-endemic, including 2 mammal, 3 bird, 4 reptile and 7 butterfly species. No amphibian species recorded had a limited distribution. These results are presented in Table 34.

Table 34 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	3	1
Near-Endemic: ranges in restricted locations	13	5
Widespread	245	86
Unknown	22	8
Total:	283	100

5.5.8 Threat Status

Species recorded within Bombo East I FR and were listed in the IUCN regulations (Hilton-Taylor, 2000) include, *Beamys hindei* (Lesser pouched Rat) as vulnerable (VU), *Paraxerus palliatus palliatus* (Red-bellied Coast Squirrel) as vulnerable (VU), *Dendrohyrax validus* (Eastern Tree Hyrax) as endangered/vulnerable (EN/VU), *Colobus angolensis palliatus* (Angola Pied Colobus) as data deficient (DD) and *Galagoides zanzibaricus* (Zanzibar Galago) as lower risk/near threatened (LR/NT). One bird species was classified as lower risk/near threatened (LR/NT), *Anthreptes reichenowi yohanae* (Plain-backed Sunbird).

Species under CITES regulation included the primates: *Papio cynocephalus* (Yellow Baboon), *Colobus angolensis palliatus* (Angola Pied Colobus), *Cercopithecus (a.) pygerythrus* (Vervet Monkey), *Cercopithecus (n.) mitis* (Gentle Monkey), *Otolemur garnettii* (Small-eared Greater Galago), *Galagoides zanzibaricus* (Zanzibar Galago) and *Cephalophus monticola* (Blue Duiker), as well as 13 bird species, all listed under CITES Appendix II, and *Civettictis civetta* (African Civet) and 19 bird species, listed under CITES Appendix III (CITES, 2001). One bird species was listed under Appendix I (*Falco peregrinus minor*, Peregrin Falcon).

6.0 CONCLUSIONS

Authors: Salter, R.F. and Svoboda, N.S. pp. 69-70

This report presents data collected during the baseline biodiversity survey of Bombo East I 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.

Bombo East I Forest Reserve was gazetted in its present shape and size in 2000. The gazetted reserve covers an area of 448 ha, with an altitudinal range of 220 m to 620 m. The forest reserve has altered significantly as a consequence of intensive widespread fires and is presently made up of a mixture of lowland forest and open woodland.

6.1 Disturbance

Fire was considered to be the most significant threat to both flora and fauna in Bombo East I FR, and was recorded in two thirds of all vegetation plots sampled resulting in very open woodland habitats. A comparison of present figures with those of Johannson and Sandy (1996) suggest that fire has significantly reduced forest area in Bombo East I FR. Only two vegetation plots surveyed were recorded with canopy heights greater than 10 m. Open grass/bushland and woodland habitats dominate in burnt areas, with fire resistant tree species common. This increased the susceptibility of the reserve to future fire disturbance.

Other forms of disturbance included pole and timber extraction concentrated in the few remaining areas of lowland forest. Other incidences of disturbance like trapping, cultivation and charcoal burning were low in Bombo East I FR. Areas of particularly high levels of disturbance were mainly concentrated in north western and southern areas of the forest reserve.

6.2 Species Richness

Bombo East I FR was found to contain a minimum of 59 species of plant, 27 mammal, 8 bat, 123 bird, 16 reptile, 3 amphibian and 106 butterfly species (figures for molluscs and millipedes have yet to be determined). Relative to the other fifteen forest reserves surveyed during the East Usambara Biodiversity Sureveys, Bombo East I FR has a below average species richness of plants, and a lower than average species richness of mammals, reptiles and amphibians. Species richness is likely to be associated with forest reserve size and the degree of patchiness and/or isolation of forested areas. Bombo East I FR is both small in size and with a patchy distribution of forest habitats that are isolated as a consequence of fire disturbance. Genetic exchange between populations is thought to be limited.

6.3 Flora

One tree species that was endemic to the Usambara Mountains was recorded in the vegetation plots and 5 that were recorded have ranges restricted to the Eastern Arc and/or East African lowland forests. Two species were dependent on primary forest, none of which were endemic or near endemic to the Usambara Mountains. Ten non-forest tree and shrub species were recorded within the reserve boundaries.

6.4 Fauna

Sixteen animal species were listed as endemic or near endemic to the Usambara Mountains. Twenty-seven fauna species were forest dependent, many of which were butterflies.

One species recorded in Bombo East I FR has been categorised as endangered (either listed by IUCN, 2000 or UDSM, 1997); the Eastern Tree Hyrax.

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 fire is of serious concern throughout Bombo East I Forest Reserve and increased protection is required to prevent future disturbance destroying the patches of forest that remain. Further degradation of forest habitats in Bombo East I FR will lead to local population extinction, particularly of those species identified as being at high risk.

According to local communities, 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.

Bombo East I FR, as one of the smallest forest blocks in the East Usambara Mountains, has a particularly high risk of flora and faunal population extinction compared to larger forest reserves. Unfortunately since Independence, the value of the Bombo East I forest has not been so well understood by local communities, possibly as a result of population immigration from other regions of Tanzania. There is a need for older generations and forestry managers 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, but much work remains. Bombo East I 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.

7.0 REFERENCES

- Broadley, D.G. 1995. A new species of *Prosymna* Gray (Serpentes: COLUBRIDAE) from coastal forest in northeastern Tanzania. *Arnoldia Zimbabwe* 10 (4): 29 - 32.
- Bruen, M. 1989. Hydrological considerations of development in the East Usambara mountains. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. pp 117-139.
- CITES listings 2001. Copied from TRAFFIC office, Dar-es-Salaam, Tanzania, March 2001.
- Collar, N.J. & Stuart, S.N. 1987. *Priorities for conservation action*. ICBP Monograph No. 3. 1988. Cambridge.
- Griffiths, C.J. 1993. The geological evolution of East Africa. In J.C. Lovett, & S.K. Wasser (eds.). *Biogeography and ecology of the rain forests of eastern Africa*. Cambridge University Press, Cambridge. 9-22 pp.
- Hamilton, A.C. 1989. The place and the problem. A survey of forest types on the East Usambara Mountains using the variable-area tree plot method. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. pp 213-226.
- Hilton-Taylor, C. (compiler) 2000. *2000 IUCN Red List of Threatened Species*. IUCN, Gland, Switzerland and Cambridge, UK. xviii+61 pp.
- Howell, K.M. 1989. The East Usambara Fauna. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. pp 315-355.
- Howell, K.M. 1993. Herpetofauna of the eastern African forests. In J.C. Lovett, & S.K. Wasser (eds.). *Biogeography and ecology of the rain forests of eastern Africa*. Cambridge University Press, Cambridge. pp 173-201.
- Hyytiäinen, K. 1995. Land use classification and mapping for the East Usambara mountains. *East Usambara Conservation Area Management Programme*.
- ICBP. 1992. *Putting Biodiversity on the Map: Priority areas for conservation*. Cambridge, UK. International Council for Bird Preservation.
- IUCN 1996. *IUCN Red list of threatened animals*. IUCN, Gland, Switzerland.
- HILTON-TAYLOR 2000. *IUCN Red List of Threatened Species*. IUCN, Gland, Switzerland and Cambridge, UK. xviii+61 pp.
- Iversen, S.T. 1991a. *The Usambara mountains, NE Tanzania: History, Vegetation and conservation*. Uppsala University, Uppsala.
- Iversen, S.T. 1991b. *The Usambara mountains, NE Tanzania: Phytogeography of the vascular plant flora*. Uppsala University, Uppsala.
- Johansson S. & Sandy R. 1996. Updated Forest area information in the Usambara mountains. *Working Paper 19, East Usambara Conservation Area Management Programme*.
- Kielland, J. 1990. *Butterflies of Tanzania*. Hill House Publishers (Melbourne & London).
- Kikula, I.S. 1989. Spatial changes in forest cover on the East Usambara mountains. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. Pp 79 - 86.

- Kingdon, J. 1974. *East African Mammals. An atlas of evolution in Africa. Vol. 2B: Hares and rodents*. University Chicago Press, Chicago.
- Kingdon, J. 1989. *East African mammals. An atlas of evolution in Africa. Vol. 2A: Insectivores and bats*. University of Chicago Press, Chicago.
- Kingdon, J. 1997. *The Kingdon field guide to African Mammals*. Academic Press, London. 464 pages.
- Kingdon, J & Howell, K. M. 1993. Mammals in the forests of Eastern Africa. In J.C. Lovett, & S.K. Wasser (eds.). *Biogeography and ecology of the rain forests of eastern Africa*. Cambridge University Press, Cambridge. Pp 229-241.
- Knox, E.B. 2000. List of East African Plants (LEAP). *Database compiled largely from the Flora of Tropical East Africa (Rotterdam: Balkema) and Beentje (1994)*.
- Kokwaro, J.O. 1994 *Medicinal Plants of East Africa*. Kenya Literature Bureau, Nairobi.
- Larsen, T.B. 1996. *The Butterflies of Kenya and their Natural History*. Oxford Univeristy Press, Oxford.
- Litterick, M. 1989. Assessment of water quality of the Sigi river. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. Pp 141-155.
- Luoga, E. J., Witkowski, E. T. F. and Balkwill, K., 2000. *Differential utliization and ethnobotany of trees in Kitulanghalo Forest Reserve and surrounding communal lands, Eastern Tanzania*. Economic Botany 54 (3). Pp. 328-343.
- Lovett, J.C. 1989. The botanical importance of the East Usambara forests in relation to other forests in Tanzania. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. Pp 207-212.
- Mittermeier, R. A., Myers, N., Gil, P. R., and Mittermeier, C. G., 1999. *Hotspots: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions*. CEMEX and Conservation International. Washington DC, USA.
- Mlingwa, C.O.F., Waiyaki, E.M., Bennun, L.A. and Burgess, N.D. 2000. Birds. In: Burgess, N.D. and Clarke, G.P. *Coastal Forests of Eastern Africa* xiii +443pp. IUCN, Gland, Switzerland and Cambridge, UK.
- Passmore, N. I. And V. C. Carruthers. 1995. *South African frogs: a complete guide*. Southern book publishers.
- Pohjonen, V.M. 2001. *East Usambara Biodiversity Database*, EUCAMP, unpublished. 28/10/2001.
- Polhill, D. 1988. *Flora of Tropical East Africa. Index of collecting localities*. Royal Botanical Gardens, Kew.
- Poynton J.C. & Clarke, B.T. 1999. Two species of *Staphopaedes* (Anura: Bufonidae) from Tanzania, with review of the genus. *African Journal of Herpetology*. 48(1&2): 1-14.
- Poynton J.C. & Broadley, D.G. 1991. Amphibia zambesiaca 5. Zoogeography. *Ann. Natal Mus*. Vol 32:221-277.
- Rodgers, W.A. 1996. Biodiversity values of Tanzanian forests: A training and awareness manual for forest managers and conservationists. FAO, Dar es Salaam.
- Rodgers, W.A. & Homewood, K.M. 1982. The conservation of the East Usambara Mountains, Tanzania: a review of biological values and land use pressures. *Biol. J. Linn. Soc.* 24: 285-304.
- Ruffo, K. 1989. Some useful plants of the East Usambara Mountains. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. pp 185-194.

- Ruffo, K.; Mmari, C.; Kibuwa, S.P.; Lovett, J.; Iversen, S. & Hamilton, A.C. 1989. A preliminary list of the plant species recorded from the East Usambara forests. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. pp 157-179.
- Schmidt, P. 1989. Early exploitation and settlement in the Usambara mountains. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. pp 357-361.
- SEE, 1998. Methodology report (SEE, 1996. Frontier Tanzania Forest Research Programme: Methodology report 'Old and New'. L. Stubblefield & P. Cunneyworth eds. *Technical paper of the Society for Environmental Exploration*, London).
- Spawls, S., Howell, K., Drewes, R. and Ashe, J. 2002. *A Field Guide to the Reptiles of East Africa*. Academic Press, London, UK.
- Stattersfield, A.J., Crosby, M.J., Long, A.J. and Wege, D.C. 1998. *Endemic Bird Areas of the World. Priorities for Biodiversity Conservation* BirdLife Conservation Series No. 7, BirdLife International
- Stuart, S.N. 1989. The avifauna of the East Usambara mountains. Chapter 35 - Forest conservation in the East Usambara mountains Tanzania. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. pp 357-361.
- Tye, A. 1994. Magarotto rainforest conservation - Proposal for establishment of a new reserve. *EUCDP, IUCN, Amani, Tanzania (unpublished.)*.
- UDSM. 1997. *National Biodiversity Database 1997*. Unpublished. Department of Zoology and Marine Biology, University of Dar es Salaam, Dar es Salaam.
- Walker, C. 1996. *Signs of the Wild*. Struik. 215 pages.
- Zimmerman, D.A., Turner, D.A. & Pearson, D.J. 1996. *Birds of Kenya and Northern Tanzania*. Russel Friedman Books, South Africa.

8.0 APPENDICES

Appendix 1: Taxonomic Verification

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Appendix 2: GPS Co-ordinates of vegetation plots

Summary of GPS Co-ordinates of vegetation plots in Bombo I FR.

Vegetation Plot number	Longitude	Latitude	Grid Ref. 37M	Grid Ref. UTM
1	038° 42' 39.3''	04° 49' 02.9''	0467945	9467555
2	038° 42' 54.3''	04° 49' 02.1''	0468406	9467580
3	038° 43' 09.5''	04° 49' 03.0''	0468875	9467551
4	038° 43' 24.9''	04° 49' 02.3''	0469348	9467572
5	038° 43' 39.7''	04° 49' 02.2''	0469805	9467578
6	038° 42' 24.5''	04° 49' 32.2''	0467489	9466653
7	038° 42' 39.3''	04° 49' 32.2''	0467945	9466655
8	038° 42' 53.0''	04° 49' 32.3''	0468366	9466651
9	038° 43' 08.8''	04° 49' 31.8''	0468830	9466667
10	038° 43' 22.3''	04° 49' 31.6''	0469269	9466674
11	038° 42' 24.4''	04° 50' 02.2''	0467487	9465733
12	038° 42' 38.9''	04° 50' 01.2''	0467934	9465763
13	038° 43' 08.3''	04° 50' 02.2''	0468839	9465733
14	038° 43' 22.5''	04° 50' 01.3''	0469275	9465761
15	038° 42' 09.8''	04° 50' 31.5''	0467037	9464833
16	038° 42' 23.8''	04° 50' 30.7''	0467469	9464858
18	038° 42' 38.3''	04° 49' 16.5''	0467915	9467135
19	038° 42' 52.8''	04° 49' 16.4''	0468361	9467140
20	038° 43' 07.4''	04° 49' 15.7''	0468811	9467160
21	038° 43' 21.6''	04° 49' 15.7''	0469249	9467163
22	038° 43' 35.8''	04° 49' 14.8''	0469685	9467190
24	038° 42' 39.1''	04° 49' 47.1''	0467939	9466198
25	038° 42' 53.6''	04° 49' 47.8''	0468385	9466176
26	038° 43' 07.7''	04° 49' 48.4''	0468821	9466157
27	038° 43' 22.9''	04° 49' 47.5''	0469287	9466185
28	038° 42' 23.4''	04° 50' 19.7''	0467457	9465197
30	038° 42' 10.0''	04° 50' 46.5''	0467042	9464372
31	038° 42' 24.7''	04° 40' 48.0''	0467476	9468010
32	038° 42' 38.9''	04° 48' 48.1''	0467933	9468008
33	038° 43' 39.7''	04° 48' 47.5''	0469805	9468028
34	038° 43' 53.7''	04° 48' 48.5''	0469805	9468028

Appendix 3: General vegetation plot descriptions

Summary of vegetation plot descriptions in Bombo I FR.

Plot Number	Topography	Altitude (masl)	Slope (degrees)	Vegetation Condition	Canopy Height (m)	Disturbance Category	Features of Interest	No. species	No. Indivs	Dominant sp.
1	GUS	450	10	Open woodland	-	Fire	None	0	0	
2	GMS	30	10	Lowland forest	<10	Cutting & traps (old)	None	49	18	<i>Manilkara sulcata</i>
3	GMS	460	3	Lowland forest	<10	None	None	35	11	<i>Grewia bicolor</i>
4	GMS	410	6	Open woodland	<10	Fire / traps	Track	4	5	<i>Stereospermum kunthianum</i>
5	SLS	390	10	Open woodland	<10	Cutting	Track	8	10	<i>Combretum molle</i>
6	GLS	442	15	Lowland forest	-	Cutting / fire	None	0	0	
7	SMS	-	-	Lowland forest	<10	Cutting	None	6	22	<i>Milletia oblata</i>
8	SMS	-	-	Thicket	<10	Fire	None	1	1	<i>Dalbergia melanoxylon</i>
9	SLS	420	25	Open woodland	<10	Fire	None	5	9	<i>Lonchocarpus bussei</i>
10	GMS	360	20	Open woodland	<10	Fire	None	9	21	<i>Dalbergia melanoxylon</i>
11	SUS	580	18	Open woodland	<10	Fire	None	1	5	<i>Acacia nilotica</i>
12	SMS	460	25	Open woodland	10-20	Fire	None	4	15	<i>Dombeya shupangae</i>
13	SUS	420	28	Open woodland	<10	Fire	None	3	6	<i>Acacia nilotica</i>
14	GLS	260	8	Open woodland	20-30	Fire	None	10	16	<i>Ormocarpum kirkii</i> , <i>Lecaniodiscus fraxinifolius</i>
15	SUS	495	30	Open woodland	<10	Fire	None	7	8	<i>Stereospermum kunthianum</i>
16	SMS	390	30	Open woodland	<10	Fire	None	2	4	<i>Lonchocarpus bussei</i>
18	GMS	520	22	Lowland forest	<10	Cutting / fire	None	7	65	Unknown sp.
19	SMS	460	27	Open woodland	<10	Fire	None	2	4	<i>Stereospermum kunthianum</i>
20	SMS	460	26	Open woodland	<10	Fire	None	5	13	<i>Dalbergia melanoxylon</i>
21	SMS	305	20	Open woodland	<10	Fire	None	4	6	<i>Commiphora africana</i>

Appendix 3 continued.

Plot Number	Topography	Altitude (masl)	Slope (degrees)	Vegetation Condition	Canopy Height (m)	Disturbance Category	Features of Interest	No. species	No. Indivs	Dominant sp.
22	SMS	340	1	Lowland forest	<10	Fire	None	17	40	<i>Milletia dura</i>
24	GUS	530	30	Open woodland	<10	Open woodland	None	3	13	<i>Acacia sieberiana</i>
25	SUS	410	16	Open woodland	<10	Fire	Rock outcrops	5	10	<i>Lochocarpus bussei</i>
26	GUS	500	3	Open woodland	<10	Fire	None	15	37	<i>Dalbergia melanoxylon</i>
27	GLS	390	14	Open woodland	<10	Fire	None	8	13	<i>Lochocarpus bussei</i>
28	GMS	410	16	Open woodland	<10	Fire	None	6	12	<i>Acacia polyacantha</i> , <i>Dombeya shupangae</i>
30	GUS	520	12	Lowland forest	<10	Fire	None	6	7	<i>Lochocarpus bussei</i>
31	GUS	340	9	Lowland forest	<10	Fire	None	2	3	<i>Scorodophoeus fischeri</i>
32	GUS	380	9	Lowland forest	<10	Fire	None	0	0	
33	GMS	440	18	Open woodland	<10	Fire	Gully	9	17	<i>Stereospermum kunthianum</i>
34	GLS	300	2	Lowland forest	<10	Fire	None	9	15	<i>Stereospermum kunthianum</i> , <i>Acacia mellifera</i>

KEY TO ABBREVIATIONS FOR APPENDIX 3

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, Bombo I FR.

VEGETATION PLOT TREES AND SHRUBS

ANACARDIACEAE	<i>Sclerocarya caffra</i> (Sond.) 1850
BORAGINACEAE	<i>Ehretia amoena</i> Klotzsch
CAPPARIDACEAE	<i>Maerua cylindricarpa</i> Gilg & Benedict 1915 <i>Maerua kirkii</i> (Oliv.) F.White 1958
CELASTRACEAE	<i>Maytenus putterlickioides</i> (Loes.) Exell & Mendonça 1953
COMBRETACEAE	<i>Pteleopsis myrtifolia</i> Engl. & Diels
EUPHORBIACEAE	<i>Phyllanthus reticulatus</i> Poir <i>Spirostachys africana</i> Sond 1850 <i>Suregada zanzibariensis</i> (Baill.) Mill. 1861
LEGUMINOSAE subfamily:	<i>Cassia abbreviata</i> Oliver
CAESALPINOIDACEAE	
LEGUMINOSAE subfamily:	<i>Acacia clavigera</i> E.Mey
MIMOSOIDEAE	<i>Acacia sieberiana</i> DC.
LEGUMINOSAE subfamily:	<i>Erythrina abyssinica</i> Lam.
PAPILIONOIDEAE	<i>Xeroderris stuhlmannii</i> (Taub.) Mendonça & E.P Sousa 1968
RUBIACEAE	<i>Catunaregan nilotica</i> (Stapf) Tirvengadum
SAPOTACEAE	<i>Afrosersalisia cerasifera</i> (Welw.) Aubrev. ex. Heine 1963
UMBELLIFERAE	<i>Steganoaenia araliacea</i> Hochst.

OPPORTUNISTIC COLLECTION AND OBSERVATION

Angiospermae – Dichotyledonae

ACANTHACEAE	<i>Dyschoriste hildebrandtii</i> Lindau. ex. O.B.Clark
APOCYNACEAE	<i>Carissa tetramera</i> (Sacl) Stapf
CAPPARACEAE	<i>Capparis sepiaria</i> var <i>stuhlmannii</i> (Gilg) De Wolf
COMMELINACEAE	<i>Commelina Schliebenii</i> Mildbr 1932
EUPHORBIACEAE	<i>Phyllanthus guineensis</i> Pax.
OLACACEAE	<i>Ximenia caffra</i> Sond. 1850
POACEAE	<i>Digitaria abyssinica</i> (Hochst) Stapf 1907
SALVADORACEAE	<i>Azima tetracantha</i> Lam.

Appendix 5: Useful plants

A summary of useful plants sampled systematically in vegetation plots and opportunistically in Bombo I FR.

	Building Poles	Fuelwood	Tool handles	Pestles	Mortars	Ornamental	Dyes	Honey	Edible fruits	Other
BIGNONIACEAE										
<i>Kigelia africana</i> Benth.										*
BURSERACEAE										
<i>Commiphora africana</i> (A.Rich) Engl.										Live fence*
CAPPARIDACEAE										
<i>Maerua triphylla</i> A.Rich									*	
COMBRETACEAE										
<i>Combretum molle</i> R. Br. ex. G. Don 1827		*								Charcoal*
<i>Combretum schumannii</i> Engl. 1894	+	+		+				+		
<i>Pteleopsis myrtifolia</i> Engl. & Diels		*								Charcoal*
<i>Terminalia sambesiaca</i> Engl. & Diels				+				+		
LEGUMINOSAE subfamily:										
CAESALPINACEAE										
<i>Afzelia quanzensis</i> Welw.	*									
LEGUMINOSAE subfamily: PAPILIONOIDEAE										
<i>Dalbergia melanoxylon</i> Guill & Perr										Carving*
<i>Lonchocarpus bussei</i> Harms (basionym. <i>Philenoptera bussei</i> (Harms) B.D. Schrine)		*								Charcoal*
<i>Milletia oblata</i> Dunn 1911	+	+	+			+		+		
<i>Xeroderris stulmannii</i> (Taubert) Mendonça & E.P Sousa 1968							*			
OCHNACEAE										
<i>Ochna thomasiana</i> Engl. & Gilg. ex. Gilg ¹						+				

Appendix 5 continued

Species	Building Poles	Fuelwood	Tool handles	Pestles	Mortars	Ornamental	Dyes	Honey	Edible fruits	Other
RUTACEAE										
<i>Zanthoxylum</i> sp. ¹								+		
SAPINDACEAE										
<i>Lecaniodiscus fraxinifolius</i> Baker*		*								
<i>Deinbollia borbonica</i> Scheff 1869										Withies
TILIACEAE										
<i>Grewia bicolor</i> Juss. 1804								+	*	Rituals*

+ Ruffo *et al.* (1989),* Luoga *et al.* (2000)**Bold** type – Opportunistic collection¹Species also recorded in the regeneration layer.

Appendix 6: Medicinal plants

Summary of Medicinal Plants recorded in Bombo I FR from Ruffo *et al* (1989) & Luoga *et al.* (2000).

Family	Species	Local name (kisambaa)	Treatments
ANACARDIACEAE	<i>Lannea schweinfurthii</i> var. <i>stuhlmannii</i> (Engl.) J.D. Kokwaro 1980*	Mumbu	Wounds and ulcers
	<i>Rhus natalensis</i> Bernh. ex. Krauss 1844	Mhunguu	Infertility
ANNONACEAE	<i>Uvaria acuminata</i> Oliver.	Mshofu	convulsions
ARALIACEAE	<i>Cussonia arborea</i> Hocht. ex. A. Rich	Mtindi	Bewitchment
BIGNONIACEAE	<i>Kigelia africana</i> Benth.	Mlegea	Infertility, Gonorrhoea
	<i>Stereospermum kunthianum</i> Cham. 1832	Mkande	Infertility
BALANITEACEAE	<i>Balanites aegyptiaca</i> Wall.	Mkonga	General
BURSERACEAE	<i>Commiphora africana</i> Sensus Auct*	Mbambaa	Mammary glands, hernia
COMBRETACEAE	<i>Pteleopsis myrtifolia</i> Engl. & Diels*	Mgoje	Chest pain
	<i>Combretum schumannii</i> Engl. 1894	Mkongolo	Epilepsy
COMPOSITAE	<i>Brachylaena huillensis</i> D. Hoffm 1902*	Mkarambati, Muhuhu	Schistosomiasis
EUPHORBIACEAE	<i>Spirostachys africana</i> Sond 1850*	Mshaaka	Purgative
LEGUMINOSAE subfamily: CAESALPINOIDEAE	<i>Cassia abbreviata</i> Oliver*	Mzangazi	Hernia

Appendix 6 continued

LEGUMINOSAE subfamily: MIMOSOIDEAE	<i>Acacia nilotica</i> Delile.*	Mtusi	Diarrhorea, menstrual pain, hernia
	<i>Acacia polyacantha</i> Willd.*	Munga	Fever
	<i>Albizia anthelmintica</i> Brongn. 1860*	Mfusetta	Cough, chest pain
LEGUMINOSAE: subfamily PAPILIONACEAE	<i>Dalbergia melanoxylon</i> Guill & Perr*	Mpingo	Hernia, worms, stomach disorders
	<i>Dichrostachys cinerea</i> (L.) Wight & Arn*	Kukulagembe	Snake bites, diarrhorea, male libido
LOGANIACEAE	<i>Strychnos innocua</i> Delile*	Mtonga	Infertility
SAPOTACEAE	<i>Afrosersalicia cerasifera</i> (Welw.) Aubrev.	Muhoe	
SAPINDACEAE	<i>Deinbollia borbonica</i> Scheff 1869*	Mtamba	Heart problems, abdominal boils
SIMAROUBACEAE	<i>Harrisonia abyssinica</i> Oliver.	Mdadai	Kidney troubles especially in women
TILIACEAE	<i>Grewia forbesii</i> Harv. ex. Mast.		General
UMBELLIFERAE	<i>Steganothaenia araliacea</i> Hochst 1844*	Mnyongampembe	Tissue inflammation, frigidity

Bold type – Opportunistic collection

* Uses defined by Luoga *et al.* (2000)

Appendix 7: Regeneration plot descriptions

Summary of regeneration plot descriptions in Bombo I FR.

Regen. plot	Habitat	Ground cover (%)				Dominance (%)				Soil Texture	Soil Colour	No. Individuals		No. species	
		Herbaceous vegetation	Bare soil	Litter	Rocks	Grasses	Forbs	Mosses /lichens	Ferns			3x3m	6x6m	3x3m	6x6m
1	Open woodland	30	45	15	10	70	30	0	0	Sandy-clay	Red brown	8	23	1	1
2	Lowland forest	20	10	70	0	10	90	0	0	Sandy-clay	Brown	30	53	2	3
3	Lowland forest	20	40	40	0	70	30	0	0	Sandy-clay	Brown	2	6	1	4
4	Open woodland	80	20	0	0	90	10	0	0	Loamy-clay	Black	1	2	1	1
5	Open woodland	50	50	0	0	90	10	0	0	Sandy-loam	Dark brown	0	0	0	0
6	Lowland forest	60	40	10	0	30	70	0	0	Sandy-loam	Red brown	0	0	0	0
7	Lowland forest	30	50	20	0	30	70	0	0	Sandy-loam	Brown	3	5	1	2
8	Thicket	60	0	20	20	90	10	0	0	Sandy-loam	Dark brown	5	7	2	4
9	Open woodland	20	60	0	20	90	10	0	0	Rocky	Red brown	0	0	0	0
10	Open woodland	20	80	0	0	80	20	0	0	Loamy-clay	Dark brown	2	3	2	3
11	Open woodland	40	50	0	10	90	10	0	0	Sandy-loam	Brown	0	8	0	3
12	Open woodland	10	60	20	10	80	20	0	0	Sandy-loam	Brown	3	6	2	3
13	Open woodland	40	50	0	10	80	20	0	0	Sandy-loam	Red brown	4	13	3	3
14	Open woodland	40	60	0	0	85	15	0	0	Sandy-loam	Dark brown	0	4	0	3
15	Open woodland	40	40	0	20	90	10	0	0	Sandy-loam	Dark brown	0	0	0	0
16	Open woodland	50	0	30	20	95	5	0	0	Sandy-loam	Red brown	0	0	0	0
18	Lowland forest	40	20	40	0	90	10	0	0	Loamy-clay	Red brown	2	2	1	1
19	Open woodland	50	40	0	10	80	20	0	0	sandy-loam	Dark brown	13	34	5	6
20	Open woodland	40	45	15	0	80	20	0	0	Sandy-clay	Brown	2	7	2	6
21	Open woodland	20	80	0	0	50	50	0	0	Sandy-clay	Brown	4	5	3	4

Appendix 7 continued.

Regen. plot	Habitat	Ground cover (%)				Dominance (%)				Soil Texture	Soil Colour	No. Individuals		No. species	
		Herbaceous vegetation	Bare soil	Litter	Rocks	Grasses	Forbs	Mosses /lichens	Ferns			3x3m	6x6m	3x3m	6x6m
22	Lowland forest	10	10	80	0	0	100	0	0	Loamy-clay	Brown	4	14	1	5
24	Open woodland	30	40	0	30	80	20	0	0	Sandy-loam	Brown	0	0	0	0
25	Open woodland	20	50	0	30	70	30	0	0	Sandy-loam	Brown	5	14	2	5
26	Open woodland	30	20	50	0	10	90	0	0	Clay	Brown	0	1	0	1
27	Open woodland	20	50	10	20	10	90	0	0	Sandy-clay	Brown	1	1	1	1
28	Open woodland	50	50	0	0	95	5	0	0	Clay	Brown	2	3	2	2
30	Lowland forest	60	40	0	0	70	30	0	0	Sandy-loam	Dark brown	8	7	3	4
31	Lowland forest	80	20	0	0	90	10	0	0	Clay	Red brown	0	0	0	0
32	Lowland forest	60	40	0	0	95	5	0	0	Clay	Brown	0	0	0	0
33	Open woodland	50	50	0	0	90	10	0	0	Sandy-loam	Light grey	3	7	2	3
34	Lowland forest	60	40	0	0	20	80	0	0	Loamy-clay	Brown	4	6	3	5

Appendix 8: Mammal capture data

8a Summary of small mammal capture at zoological trapsites in Bombo East I FR (refer to Tables 19 and 20 for trapsite locations, descriptions and sampling intensity).

Species	Number of individuals caught in trapsites 1-3 (sampling intensity in Sherman trap nights)			No. of individuals captured (2990)	No. of recaptures
	1 (997)	2 (994)	3 (999)		
CRICETOMYINAE					
<i>Beamys hindei</i>	-	-	2	2	3
GERBILLINAE					
<i>Tatera robusta</i>	-	1	2	3	-
MURIDAE					
<i>Acomys spinosissimus</i>	8	1	7	16	10
<i>Grammomys cf. dolichurus</i>	4	-	5	9	9
<i>Mus cf. minutoides</i>	-	1	-	1	-
<i>Rattus rattus</i>	-	-	1	1	-
SCIURIDAE					
<i>Paraxerus palliatus palliatus</i>	1	-	-	1	-
<i>Paraxerus ochraceus</i>	-	1	-	1	-
SORICIDAE					
<i>Crocidura cf. hildegardae</i>	-	1	1	2	-
TOTAL	13	5	18	36	22

8b Summary of bat capture at bat-netting sites in Bombo East I FR and base camp (refer to Table 22).

Species	Number of individuals caught in bat net sites 1 and 2 (sampling intensity in net square meter hours)		Total no. individuals captured (550.5)
	1 (135)	2 (415.5)	
PTEROPODIDAE			
<i>cf. Stenonycteris lanosus</i>	1	-	1
<i>Lissonycteris angolensis</i>	3	-	3
NYCTERIDAE			
<i>Nycteris theibaica</i>	-	1	1
RHINOLOPHIDAE			
<i>Rhinolophus clivosus</i>	-	3	3
<i>Rhinolophus hildebrandtii</i>	-	3	3
<i>Rhinolophus landeri</i>	-	1	1
VESPERTILIONIDAE			
<i>Myotis bocagei</i>	1	-	1
<i>Nycticeius (Scotoecus) hirundo hindei</i>	-	2	2
TOTAL	5	10	15

Appendix 9: Reptile capture data

9 Summary of reptile capture at zoological trapsites and during opportunistic collection in Bombo East I FR (refer to Tables 19 and 20 for trapsite locations, descriptions and sampling intensity).

Species	Number of individuals caught in traps at trapsites 1-3 (Sampling intensity per trapsite; bucket pitfall nights)			Casual collections	Total no. individuals captured (Sampling intensity)
	1 (330)	2 (330)	3 (330)		
COLUBRIDAE					
<i>Aparallactus capensis</i>	-	-	1	-	1
<i>Aparallactus weneri</i>	-	-	1	-	1
<i>Lamprophis capensis</i>	1	-	-	-	1
<i>Lycophidion capense loveridgei</i>	1	-	-	-	1
<i>Thelotornis "usambaricus" sp. nov.</i>	-	1	-	-	1
GEKKONIDAE					
<i>Hemidactylus mabouia</i>	-	1	-	1	2
<i>Hemidactylus squamulatus</i>	1	1	-	-	2
<i>Lygodactylus luteopicturatus</i>	-	-	-	1	1
GERROSAURIDAE					
<i>Gerrosaurus major</i>	-	-	1	1	2
<i>Lygodactylus picturatus</i>	-	1	-	-	1
LACERTIDAE					
<i>Helibolus spekii spekii</i>	1	-	1	-	2
<i>Nocrus boulengeri</i>	1	-	-	-	1
SCINCIDAE					
<i>Mabuya macuilabris</i>	1	-	-	-	1
<i>Mabuya planifrons</i>	1	-	-	-	1
<i>Mabuya striata</i>	1	-	-	1	2
<i>Mabuya varia</i>	-	-	3	-	3
TOTAL	8	4	7	4	23

Appendix 10: Amphibian capture data

10: Summary of amphibian capture at zoological trappingsites and during opportunistic collection in Bombo East I FR (refer to Tables 19 and 20 for trappingsite locations, descriptions and sampling intensity).

Species	Number of individuals caught in traps at trappingsites 1-3 (Sampling intensity per trappingsite; bucket pitfall nights)			Casual collections	Total no. individuals captured* (Sampling intensity)
	1 (330)	2 (330)	3 (330)		
ARTHROLEPTIDAE					
<i>Arthroleptis stenodactylus</i>	2	-	-	-	2
BUFONIDAE					
<i>Bufo gutturalis</i>	1	-	-	-	1
HYPEROLIIDAE					
<i>Hyperolius viridiflavus</i>	-	-	-	1	1
TOTAL	3	-	-	1	4

*May include recaptures

Appendix 11: Butterfly capture data

11: Summary of butterfly capture in canopy traps at zoological trapsites 1 to 3 in Bombo East I FR (refer to Tables 19 and 20 for trapsite locations, descriptions and sampling intensity).

Species	Number of individuals caught in canopy traps Trapsites 1-3 (sampling intensity in butterfly trap days)			No. of specimens taken	Total no. individuals captured (Sampling intensity)
	1 (50)	2 (50)	3 (50)		
LYCAENIDAE					
Unknown sp.	7	0	1	5	8
<i>Anthene cf. lasti</i>	1	0	0	1	1
<i>Anthene otacilia kikuyi</i>	0	0	1	0	1
<i>Anthene sp.</i>	0	1	0	1	1
<i>Axiocerses harpax ugandana</i>	1	1	0	2	2
<i>Euthrysops nandemsis nandemsis</i>	0	1	0	1	1
<i>Lepidochysops sp.</i>	2	0	0	2	2
<i>Leptotes sp.</i>	1	0	0	1	1
<i>Ornipholidotos peucetia</i>	0	1	0	1	1
<i>Pentila sp.</i>	0	2	0	2	2
<i>Pentila tropicalis/pauli</i>	1	0	0	1	1
<i>Pentila tropicalis mombasa</i>	0	1	0	1	1
<i>Teriominia subpunctata</i>	0	1	0	1	1
NYMPHALIDAE					
Unkonwn Sp.	1	0	0	1	1
<i>Acraea sp.</i>	11	2	2	8	15
<i>Acraea anemosa</i>	4	1	1	3	6
<i>Acraea caecilia</i>	1	0	0	0	1
<i>Acraea encedon encedon</i>	0	0	1	1	1
<i>Acraea esebria esebria</i>	1	0	0	1	1
<i>Acraea insignis insignis</i>	1	0	0	1	1
<i>Acraea natalica natalica</i>	14	1	0	3	15
<i>Acraea pardopsis punctatissima</i>	1	0	0	1	1
<i>Acraea cf. zetes zetes</i>	6	0	0	3	6
<i>Bicyclus safitza safitza</i>	5	1	4	4	10
<i>Byblia sp.</i>	0	0	1	1	1
<i>Byblia anvatara acheloia</i>	1	2	3	2	6
<i>Byblia ilithyia</i>	5	5	14	2	24
<i>Charaxes sp. 1 (black and white)</i>	0	38	12	3	50
<i>Charaxes sp. 2 (sp. 119)</i>	10	0	0	1	10
<i>Charaxes sp. 3</i>	6	0	1	5	7
<i>Charaxes achaemenes</i>	0	0	1	0	1
<i>Charaxes berkeley</i>	0	1	0	1	1
<i>Charaxes bohemani</i>	0	0	3	1	3
<i>Charaxes brutus angustus</i>	1	2	0	2	3
<i>Charaxes candiope candiope</i>	5	10	0	1	15
<i>Charaxes castor</i>	1	0	0	1	1
<i>Charaxes chepalungu</i>	1	0	0	1	1
<i>Charaxes cf. cithaeron</i>	1	0	0	0	1

Appendix 11: cont.

Species	Number of individuals caught in canopy traps Trapsites 1-3 (sampling intensity in butterfly trap days)			No. of specimens taken	Total no. individuals captured (Sampling intensity) (150)
	1 (50)	2 (50)	3 (50)		
NYMPHALIDAE cont.					
<i>Charaxes cithaeron nairobicus</i>	1	0	2	1	3
<i>Charaxes contrarius contrarius</i>	17	15	5	3	37
<i>Charaxes etesipe gordonii</i>	0	1	1	1	2
<i>Charaxes etheocles envansi</i>	0	1	3	1	4
<i>Charaxes jahlusa kenyensis</i>	4	17	1	2	22
<i>Charaxes cf. usambarae maridadi</i>	1	0	0	1	1
<i>Charaxes varanes</i>	0	1	0	1	1
<i>Charaxes varanes vologese</i>	0	1	0	0	1
<i>Charaxes viola picta</i>	0	0	1	0	1
<i>Charaxes xiphares walwandi</i>	1	0	0	1	1
<i>Charaxes cf. zoolina zoolina</i>	3	3	3	4	9
<i>Euphaedra neophron littoralis</i>	1	1	0	2	2
<i>Eurytela dryope angulata</i>	0	2	5	2	7
<i>Hamanumida daedalus</i>	0	1	2	1	3
<i>Henotesia persicus</i>	0	1	0	0	1
<i>Hypolimnas cf. hisippus</i>	1	0	0	1	1
<i>Junonia oenone oenone</i>	0	3	1	2	4
<i>Junonia hierta cebrene</i>	0	1	0	1	1
<i>Junonia natalica natalica</i>	2	1	0	2	3
<i>Melantis leda</i>	0	2	1	2	3
<i>Neptis sp.</i>	1	1	0	1	2
<i>Neptis rogersi</i>	0	1	0	1	1
<i>Neptis cf. serena serena</i>	1	0	0	1	1
<i>Neptis saclava marpessa</i>	0	0	1	1	1
<i>Pseudacraea sp.</i>	0	0	1	1	1
<i>Pseudacraea lucretia protracta</i>	2	0	0	1	2
<i>Pseudacraea lucretia expansa</i>	2	0	0	1	2
<i>cf. Salamis cacta cacta</i>	0	0	1	0	1
<i>Sallya garega garega</i>	0	0	1	1	1
<i>Sallya moranti moranti</i>	1	0	0	1	1
PAPILIONIDAE					
<i>Catopsilia florella</i>	1	2	2	1	5
<i>Graphium sp.</i>	1	2	0	2	3
<i>Graphium antheus</i>	0	2	3	2	5
<i>Graphium philonoe philonoe</i>	0	0	1	1	1
<i>Papilio constaninus constaninus</i>	2	5	5	2	12
<i>Papilio dardanus polytrophus</i>	2	2	2	1	6
<i>Papilio demodocus demodocus</i>	0	1	3	3	4
<i>Papilio hornimani</i>	0	1	0	0	1
<i>Papilio ophidicephalus ophidicephalus</i>	0	1	1	1	2
PIERIDAE					
Unknown sp.	4	1	0	4	5
<i>Belenois sp. 1</i>	1	2	2	5	5
<i>Belenois sp. 2</i>	0	2	0	1	2

Appendix 11: cont.

Species	Number of individuals caught in canopy traps Trapsites 1-3 (sampling intensity in butterfly trap days)			No. of specimens taken	Total no. individuals captured (Sampling intensity) (150)
	1 (50)	2 (50)	3 (50)		
PIERIDAE cont.					
<i>Belenois aurota aurota</i>	1	1	8	1	10
<i>Belenois gidica</i>	0	0	1	1	1
<i>Belenois thysa thysa</i>	0	2	1	1	3
<i>Colotis</i> sp.	9	1	0	1	10
<i>Colotis anatus anatus</i>	1	0	0	1	1
PIERIDAE cont.					
<i>Colotis antivippe zera</i>	0	0	2	0	2
<i>Colotis aurigneus</i>	0	17	3	2	20
<i>Colotis</i> cf. <i>aurigneus</i> / <i>uesta manningtoni</i>	0	0	1	1	1
<i>Colotis auxoincretus</i>	0	0	1	1	1
<i>Colotis danae eupompe</i>	0	7	3	2	10
<i>Colotis</i> cf. <i>dana jacksoni</i>	3	0	1	2	4
<i>Colotis evagore antigone</i>	18	1	2	3	21
<i>Colotis</i> cf. <i>eucharis evarne</i>	0	0	1	1	1
<i>Colotis evippe omphale</i>	0	2	3	1	5
<i>Colotis ione</i>	1	3	1	1	5
<i>Colotis pallene</i>	0	1	0	1	0
<i>Dixeia</i> sp.	0	1	1	1	2
<i>Dixeia charina</i>	0	0	2	1	2
<i>Dixeia</i> cf. <i>orbona violua</i>	0	0	1	1	1
<i>Eurema</i> sp. 1	1	0	1	2	2
<i>Eurema</i> sp. 2	0	0	1	1	1
<i>Eurema brigitta brigitta</i>	0	1	7	1	8
<i>Eurema</i> cf. <i>dejardinsi oberthri</i>	1	0	0	0	1
<i>Eurema hecabe solifera</i>	1	0	0	1	1
<i>Eurema</i> cf. <i>regularis</i>	2	4	0	4	6
<i>Eurema senegalensis</i>	1	0	0	1	1
<i>Pinacopteryx eriphia melanarge</i>	0	0	1	1	1

Appendix 12: Weather Data

12: Rainfall and Temperature data for Bombo I FR

Trap no.	Date	Rain (mm)	Temperature (°c)	
			Min	Max
TS1	1/18/02	0	24	33
TS1	1/19/02	0	23	34
TS1	1/20/02	0	23	39
TS1	1/21/02	0	23	38
TS1	1/22/02	0	23	39
TS1	1/23/02	0	23	42
TS1	1/24/02	0	23	37
TS1	1/25/02	31	21	37
TS1	1/26/02	0	23	32
TS1	1/27/02	0	23	38
TS1	1/28/02	0	19.5	39
	1/29/02			
	1/30/02			
TS2	1/31/02	0	23	39
TS2	2/1/02	0	21	39
TS2	2/2/02	0	22	39
TS2	2/3/02	0	21	38
TS2	2/4/02	0	21	39
TS2	2/5/02	0	21	40
TS2	2/6/02	0	20	41
TS2	2/7/02	0	20	40
TS2	2/8/02	0	20	41
	2/9/02			
	2/10/02			
TS3	2/11/02	0	22	40
TS3	2/12/02	0	21	41
TS3	2/13/02	0	23	37
TS3	2/14/02	0	22	39
TS3	2/15/02	0	22	39
TS3	2/16/02	0		
TS3	2/17/02	35	22	37
TS3	2/18/02	0	21	36
TS3	2/19/02	0	22	38
TS3	2/20/02	0	21	37

Appendix 13: 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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