

**TECHNICAL PAPER 58**

**Bombo East II Forest Reserve**

**A biodiversity survey**

**Frontier Tanzania  
2002**

# **East Usambara Conservation Area Management Programme**

## **Technical Paper 58**

### **Bombo East II Forest Reserve**

#### **A biodiversity survey**

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### **East Usambara Conservation Area Management Programme (EUCAMP)**

The East Usambara rain forests are one of the most valuable conservation areas in Africa. Several plant and animal species are found only in the East Usambara mountains. The rain forests secure the water supply of 200,000 people and the local people in the mountains depend on these forests. The East Usambara Conservation Area Management Programme has established the Amani Nature Reserve and aims; at protecting water sources; establishing and protecting forest reserves; sustaining villager's benefits from the forest. The programme is implemented by the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism with financial support from the Government of Finland, and implementation support from the 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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## EXECUTIVE SUMMARY

Bombo East II Forest Reserve, located to the north of the main East Usambara Mountain range of north-eastern Tanzania, covers an area of just over 4 km<sup>2</sup> (404 ha), situated in Korogwe and Muheza District, Tanga Region. Altitude ranges from 440 m to 840 m above sea level (asl). The Forest Reserve contains lowland forest and open wooded grassland. Bombo East II was gazetted as a Forest Reserve in 1993. A small part in the north-west was de-gazetted in 2000. Bombo East II 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 FRs 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%, the zoological survey was focused on 2 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

<b>Taxon</b>	<b>Total no. of species</b>	<b>% forest dependent</b>	<b>No. of non-forest species</b>	<b>No. of endemic species</b>	<b>No. of near-endemic species</b>	<b>No. of forest dependent endemics and near-endemics</b>
Trees and shrubs	47* 5** 37***	4.3%	11	0	5	0
Mammals	23	17%	7	0	1	1
Birds	123	6%	95	1	2	2
Reptiles	4	0%	1	0	3	0
Amphibians	4	0%	1	0	1	0
Butterflies	83	23%	15	0	3	1
<b>Total</b>	<b>326</b>	<b>n/a</b>	<b>130</b>	<b>1</b>	<b>15</b>	<b>4</b>

\* 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 II FR has a low floral and faunal diversity. The high number of non-forest dependent species can be explained by the very open nature of the habitat within the FR.

In terms of flora, Bombo East II FR is made up open woodland and lowland forest. A large proportion of species recorded within Bombo East II FR were categorised as non-forest dwelling (Table 1). No plant species endemic to the East Usambara mountains were recorded within Bombo East II FR, but five plant species are near-endemic.

Despite its small size, Bombo East II FR supports a high diversity of mammal and butterfly species. The reserve is home to 4 vulnerable species according to IUCN categories.

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

Although a considerable amount of biological information exists from the East Usambara Mountains 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. The surveys are conducted by Frontier Tanzania, a joint venture between the University of Dar es Salaam and the Society for Environmental Exploration, together with EUCAMP. The aim of the surveys is to provide systematic baseline information on the biological values of different forests as a basis for management planning and long-term monitoring, 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.

---

Mr Mathias Lema  
Project Manager

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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 mountains' 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
<b>TOTAL</b>	<b>45,137.6</b>	

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 FRs (Broadley, 1995) and a recently described amphibian species; *Stephopaedes usambarae* (Poynton and Clarke, 1999) has been recorded by the surveys in Mtai and Kwamgumi FRs.

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 II Forest Reserve (Bombo East II 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](http://www.mobot.org) (TROPICOS database in University of Missouri, Botanical Garden)

[www.ipni.org](http://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 II FR was conducted between 9<sup>th</sup> January and 20<sup>th</sup> 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 II Forest Reserve (Kisambaa - *Kilimamwarabu*)  
Muheza and Korogwe District, Tanga Region, Tanzania.

Area: 404 ha

Status: Forest Reserve

Maps: Ordnance Survey topographic maps 1: 50 000 Series Y742 (DOS 422)  
Sheet 110/3 'Hemagoma' of 1988

##### 3.1.2 Location

Lat/Long: S 04°43'30.3'' – S 4°49'17.3'', E 38°39'39.4'' – E 38°41'05.6''

UTM/UPS: 94 68555 – 94 67056 S 04 62404 - 04 65059 E

Elevation: 440 m – 840 m above sea level

Bombo East II Forest Reserve (Bombo East II 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 II FR is near the villages of Makorokoro, Mnazi Moja and Bombo Maji Moto.

##### 3.1.3 Topography

Bombo East II FR is made up mainly of woodland, west of the villages Makorokoro and Mnazi Moja (Figure 1). The reserve has two peaks, in the north-east and north west, with the easterly one rising to an altitude of 840 m. In the valley between the two peaks and in most dry riverbeds within the reserve, denser lowland forest grows. The eastern border follows the road leading to Mashewa. FArns are found right up to the border surrounding the whole of the reserve.

##### 3.1.4 Land use

Bombo East II 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 II 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 FR is surrounded by villages and fArns 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).

<b>Bombo East II FR</b>	<b>Area (hectares)</b>	<b>% of area</b>
Poorly Stocked Lowland forest	404	100
<b>Total</b>	<b>404</b>	<b>100</b>

### 3.1.5 History and Status

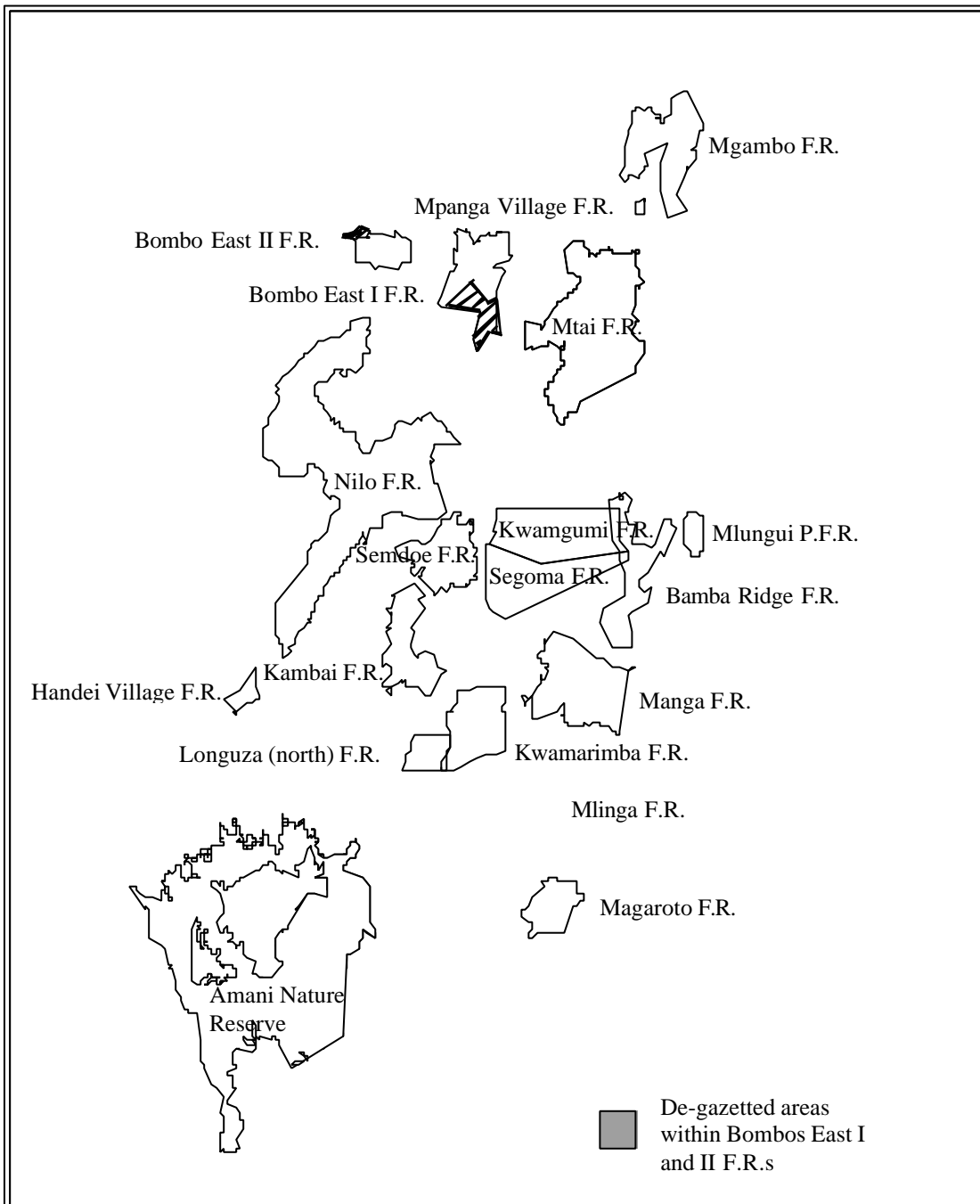
Humans have settled in the East Usambara Mountains for at least 2000 years. In the 19<sup>th</sup> Century, it appears populations were markedly lower in the East Usambara Mountains relative to the West Usambara Mountains with much of the area remaining forested due to less human pressure.

Bombo East II FR, or Kilimamwarabu, as it is locally known, was gazetted as a forest reserve in 1993. A small part in the north-west of the reserve was de-gazetted again in 2000 to give surrounding villages more farmland.

There has been human pressure in the East Usambara Mountains for at least 2000 years. In the 19<sup>th</sup> 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.

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 recently and destroyed most of the lower lying parts of the reserve. Fire and logging are thought to be the most serious danger to the reserve.

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



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

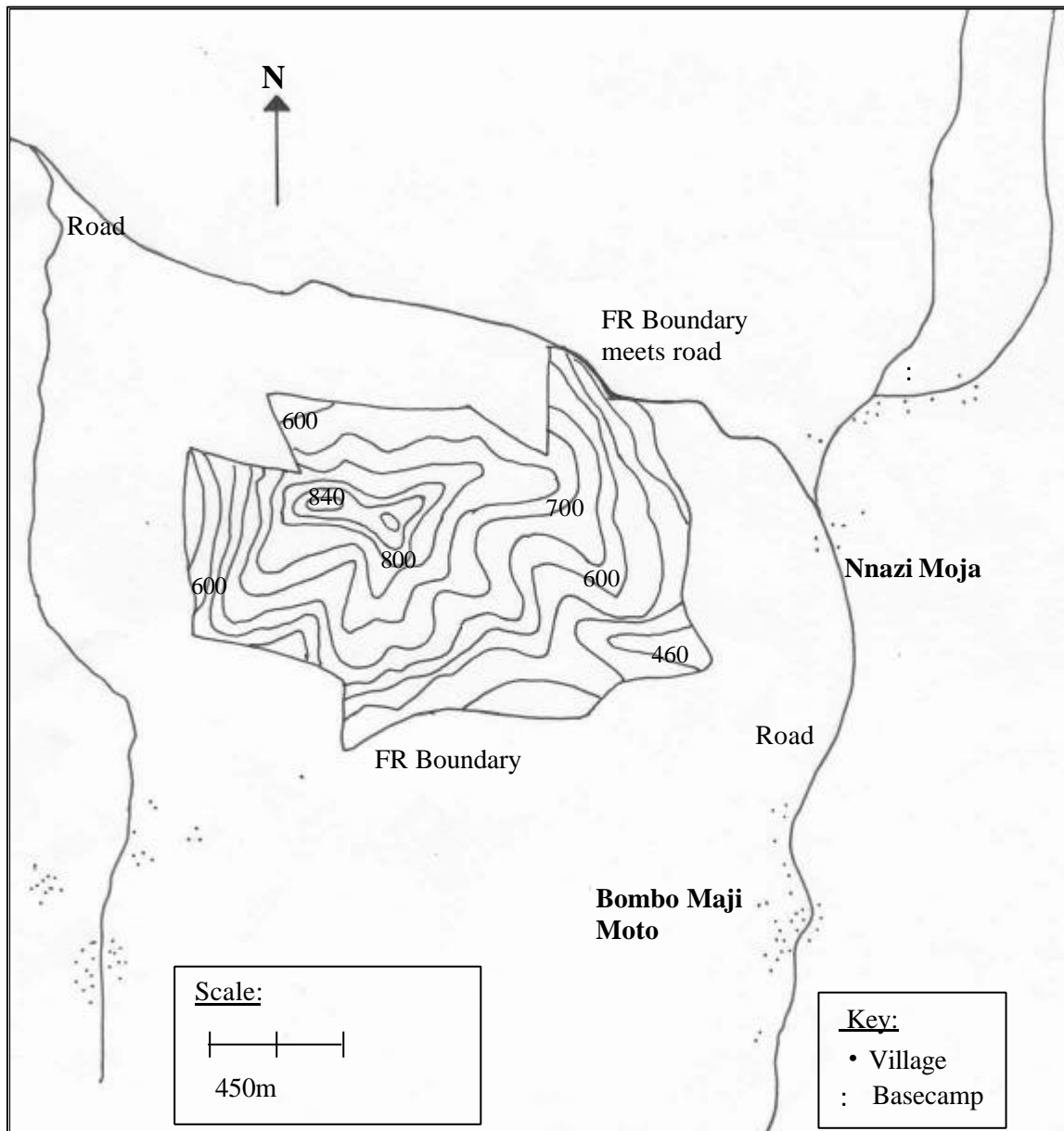


Figure 2 Topographical sketch map of Bombo East II FR.

## 4.0 VEGETATION

Authors: Salter, R.F. Ntemi, A.S. Svoboda, N.S. Staddon, S. & Bracebridge, C. pp. 11-42

### 4.1 Introduction

A species inventory was compiled of the trees and shrubs found within Bombo East II Forest Reserve. 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 450 m x 450 m 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.

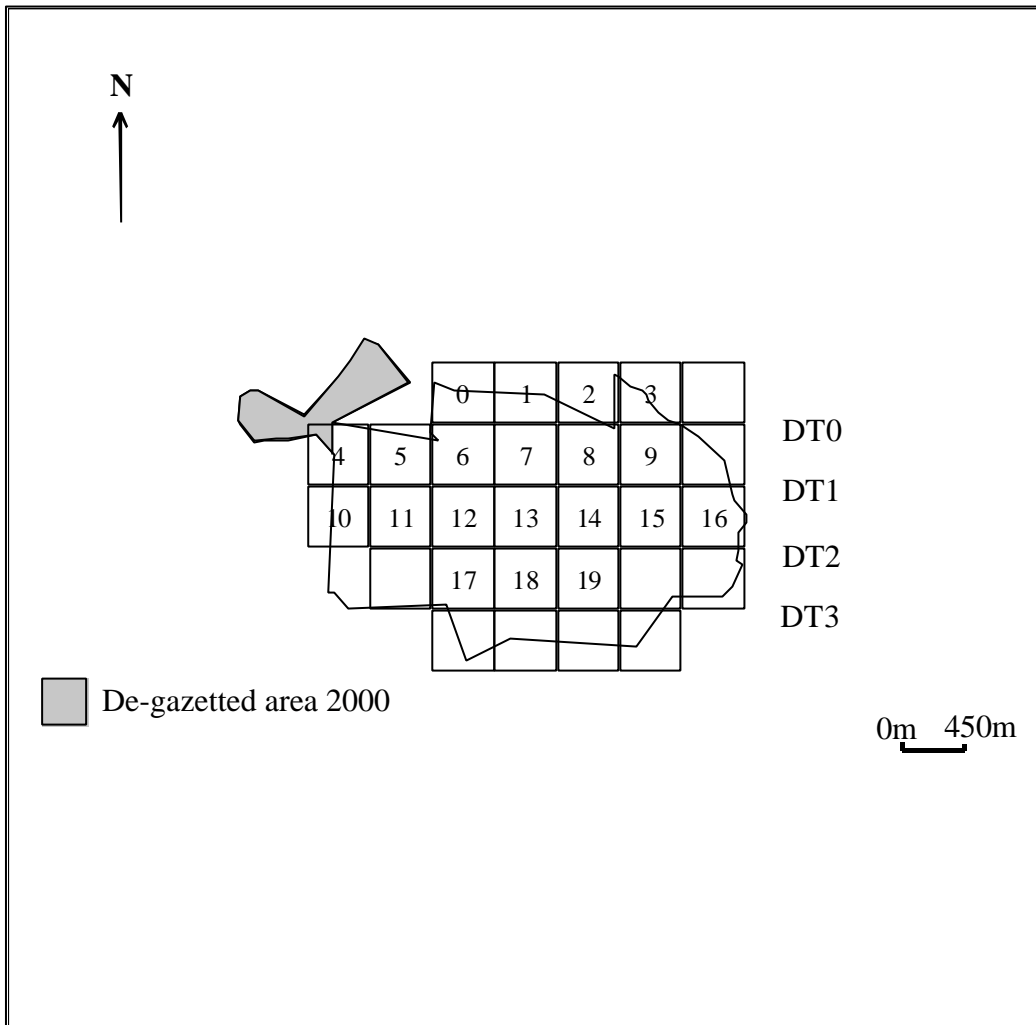
#### **4.2.1.3 Disturbance transects**

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 to 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 (diameter at breast height) 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 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 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 a table and maps. The most disturbed plots were calculated using pole and timber cutting counts and incidence figures for 'other signs of disturbance'. Pole and timber cutting counts were combined, summed and then ranked, with the most disturbed plot ranked 1. All incidence records of 'other signs of disturbance' were summed and ranked, with the most disturbed plot ranked 1. The top three plots in each data set were combined to give the top six disturbed plots.





**Figure 3** Location of vegetation plots and disturbance transects (DT) in Bombo East II 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 19 20 m x 50 m vegetation plots were established. The dominant vegetation types within vegetation plots were open woodland (53% of plots) and lowland forest (47% of plots). 79% of all vegetation plots had an average canopy height of less than 10 m. Only four vegetation plots were recorded with canopy heights greater than 10 m. 68% of vegetation plots had been affected by fire. The average slope for all accessible vegetation plots was moderately steep at 18 degrees. Vegetation plot descriptions are summarised in Appendix 3 and a vegetation map shown in Figure 4.

A total of 304 individuals, representing 23 families and 47 species were recorded in 19 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). Up to date synonyms were obtained from www.ipni.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
<b>Angiospermae – Dicotyledonae</b>					
<b>ANACARDIACEAE</b>					
<i>Lannea schweinfurthii</i> var. <i>stuhlmannii</i> (Engl.) J.D. Kokwaro 1980	f	L&S&M <sup>1</sup>	W	15	6
<i>Ozoroa insignis reticulata</i> (Bak. F) J. B. Gillet 1980	f	L&S&M <sup>1</sup>	W	2	2
<i>Rhus natalensis</i> Bernh. ex. Krauss	f	L&S&M <sup>2</sup>	W	2	1
<b>BIGNONIACEAE</b>					
<i>Markhamia lutea</i> K. Schum 1895	f	L&S	W	2	1
<i>Stereospermum kunthianum</i> Cham. 1832	f	L&S	W	4	1
<b>BIXACEAE</b>					
<i>Ludia mauritiana</i> J.F.Gmel.	f	L&S&M <sup>1</sup>	W	1	1
<b>BOMBACACEAE</b>					
<i>Ceiba pentandra</i> (L.) Gäertn 1791	f	S	W	6	1
<b>BURSERACEAE</b>					
<i>Commiphora africana</i> (A.Rich) Engl.*	O	L&S <sup>1</sup>	W	15	6
<i>Commiphora emini</i> zimmermanni (Engl.) J.B. Gillet 1991 (basonym. <i>C Zimmermannii</i> Engl.)	f <sup>1</sup>	L&S <sup>1</sup>	W <sup>1</sup>	1	1
<b>CAPPARIDACEAE</b>					
<i>Boscia salicifolia</i> Oliver*	f	L&S	W	5	4
<b>CELASTRACEAE</b>					
<i>Maytenus undata</i> (Thunb.) Blakelock	f	L&S&M <sup>2</sup>	W	2	1
<b>COMBRETACEAE</b>					
<i>Combretum exalatum</i> Engl. 1895	O	L&S <sup>1</sup>	N	2	1
<i>Combretum molle</i> R.Br. ex. G. Don 1827*	O	L	W	28	7
<i>Combretum schumannii</i> Engl. 1894	f	L&S <sup>2</sup>	W	3	3

Table 4 continued

	Ecolog. Type	Habitat	End. Status	Total no. of individuals	Present in n plots
COMBRETACEAE continued					
<i>Combretum zeyheri</i> Sond. 1850	f	L&S <sup>1</sup>	W	13	3
<i>Terminalia prunioides</i> M.Laws	O	L&S&M <sup>1</sup>	W	3	1
COMPOSITAE					
<i>Blepharispermum</i> sp. DC	?	?	?	1	1
<i>Brachylaena huillensis</i> O. Hoffm. 1902	f	L&S&M <sup>1</sup>	W	6	1
EUPHORBIACEAE					
<i>Croton polytrichus</i> Pax 1893	f	L&S <sup>1</sup>	W	4	1
<i>Margaritaria discoidea</i> (Baill) Webster 1967	f	S	W	1	1
<i>Spirostachys africana</i> Sond 1850	f	L&S <sup>1</sup>	W	3	2
LEGUMINOSAE subfamily: CAESALPINOIDEAE					
<i>Scorodophloeus fischeri</i> (Taub.) J. Leonard. (basionym. <i>Theodora fischeri</i> Taub 1895)*	f	L&S&M <sup>2</sup>	N	24	3
<i>Tamarindus indica</i> Linn.	O	L&S&M	W	1	1
LEGUMINOSAE subfamily: MIMOSOIDEAE					
<i>Acacia hockii</i> De Wild 1913	f	L&S&M <sup>1</sup>	W	24	8
<i>Acacia mellifera</i> Benth <sup>1</sup> 1842	O	S	W	5	3
<i>Acacia nilotica</i> Delile.	f	S <sup>1</sup>	W	11	3
<i>Acacia sieberiana</i> DC.	f	S <sup>1</sup>	W	56	9
<i>Albizia anthelmintica</i> Brongn. 1860	O	L&S	W	2	1
LEGUMINOSAE subfamily: PAPILIONOIDEAE					
<i>Dalbergia melanoxylon</i> Guill & Per*	f	L&S&M <sup>1</sup>	W	8	3
<i>Dichrostachys cinerea</i> (L.) Wight & Arn*	f	L&S	W	5	3
<i>Lonchocarpus bussei</i> Harms (basionym. <i>Philenoptera bussei</i> (Harms) B.D. Schrine)	O	L&S&M	W	1	1
<i>Ormocarpum kirkii</i> S. Moore	O	L&S	W	2	2
MELIACEAE					
<i>Turraea holstii</i> Guerke 1894	F	L&S&M	W	5	4
MORACEAE					
<i>Ficus</i> sp.	?	?	?	1	1
OLACACEAE					
<i>Ximenia americana</i> Linn.	O	L&S	W	1	1
RUBIACEAE					
<i>Rothmannia manganjae</i> (Hiern) Garcia 1958	F	L&S&M	W	1	1
RUTACEAE					
<i>Vepris trichocarpa</i> Engl.	?	?	?	3	1
SAPINDACEAE					
<i>Haplocoelum foliolosum</i> (Hiern) Bullock 1931*	f	L&S&M	W	1	1
<i>Haplocoelum inopleum</i> Radlk	f <sup>1</sup>	L <sup>1</sup>	N <sup>1</sup>	2	2

Table 4 continued

	Ecolog. Type	Habitat	End. Status	Total no. of individuals	Present in n plots
SAPINDACEAE continued					
<i>Lecaniodiscus fraxinifolius</i> Baker*	f	L&S&M	W	5	4
SAPOTACEAE					
<i>Manilkara sulcata</i> Dubard 1915	f	L <sup>2</sup>	W	6	4
<i>Mimusops</i> sp.	?	?	?	7	1
STERCULIACEAE					
<i>Dombeya shupangae</i> K.Schum 1900*	f	L <sup>2</sup>	N	4	2
<i>Sterculia africana</i> (Lour.) Fiori 1911	O	S	W	1	1
TILIACEAE					
<i>Grewia bicolor</i> Juss	f	S	W	4	2
<i>Grewia holstii</i> Burret 1804*	f	L&S <sup>1</sup>	N	4	4
UMBELLIFERAE					
<i>Steganotaenia araliacea</i> Hochst 1844*	f	L&S&M	W	1	1

<sup>1</sup> Information is based on FTEA

<sup>2</sup> 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 x 450m.

#### 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.

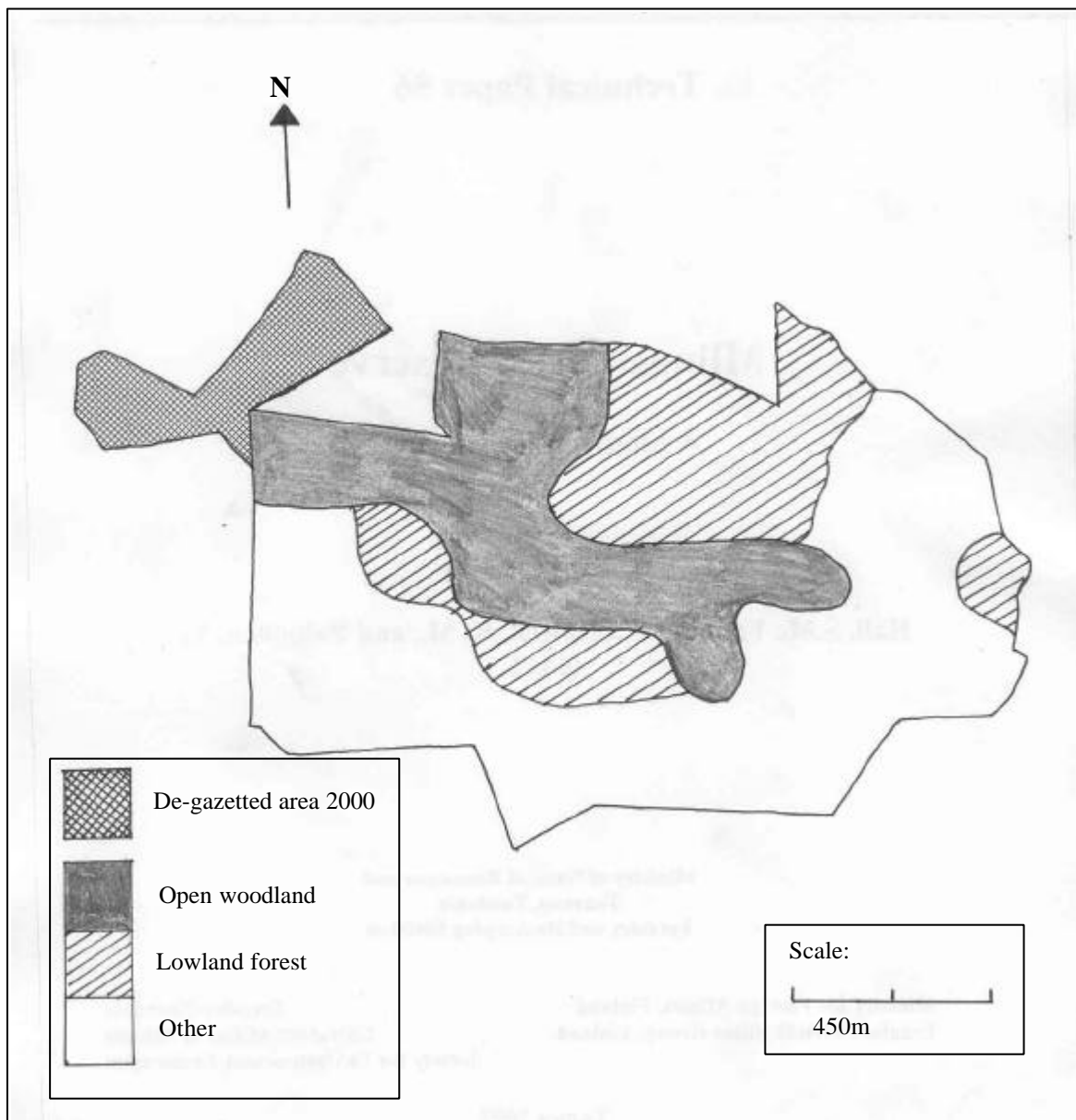
If species occur in more than one habitat range, this has been recorded (e.g. L&S – this species has been recorded at altitudes between 0 and 850m above sea level).

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 II FR.

#### 4.3.1.2 Species Abundance

The most abundant species within vegetation plots was *Acacia sieberiana* representing 18.5% of all individuals sampled. This species was present within 29% of vegetation plots (Table 5). *Acacia sieberiana* is a common open woodland species often found regenerating in areas affected by fire. *Combretum molle* was ranked as the second most abundant species within vegetation representing 9.3% of all individuals sampled. This species was found in 22.6% of vegetation plots in lowland forest and disturbed open woodland plots (Table 5).

*Acacia sieberiana* and *Acacia hockii* were present in the greatest number of plots (Table 6). Both were commonly found regenerating in areas that had been disturbed by fire.

*Combretum molle* was commonly found in vegetation plots throughout the reserve and was ranked third in Table 6.

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

		Rank	Total no. of individuals (n=304)	% of total individuals	In x plots (n=19)	% of total no. plots
LEGUMINOSAE	<i>Acacia sieberiana</i>	1	56	18.5	9	29.0
subfamily:						
MIMOSOIDEAE						
COMBRETACEAE	<i>Combretum molle</i>	2	28	9.3	7	22.6
LEGUMINOSAE	<i>Scorodophloeus fischeri</i> *	3	24	7.9	3	9.7
subfamily:						
CAESALPINOIDEAE						
LEGUMINOSAE	<i>Acacia hockii</i>	3	24	7.9	8	25.8
subfamily:						
MIMOSOIDEAE						
ANACARDIACEAE	<i>Lannea schweinfurthii</i> var. <i>stuhlmannii</i>	5	15	5.0	6	19.4
BURSERACEAE	<i>Commiphora africana</i> .	5	15	5.0	6	19.4
COMBRETACEAE	<i>Combretum zeyheri</i>	7	13	4.3	3	9.7
LEGUMINOSAE	<i>Acacia nilotica</i>	8	11	3.6	3	9.7
subfamily:						
MIMOSOIDEAE						
LEGUMINOSAE	<i>Dalbergia melanoxylon</i>	9	8	2.6	3	9.7
subfamily:						
PAPILIONOIDEAE						
SAPOTACEAE	<i>Mimusops</i> sp.	10	7	2.3	1	3.2
BOMBACACEAE	<i>Ceiba pentandra</i>	11	6	2.0	1	3.2
COMPOSITAE	<i>Brachylaena huillensis</i>	11	6	2.0	1	3.2
SAPOTACEAE	<i>Manilkara sulcata</i> *	11	6	2.0	4	12.9
CAPPARIDACEAE	<i>Boscia salicifolia</i> r	14	5	1.7	4	12.9
LEGUMINOSAE	<i>Acacia mellifera</i>	14	5	1.7	3	9.7
subfamily:						
MIMOSOIDEAE						
	<i>Dichrostachys cinerea</i>	14	5	1.7	3	9.7
MELIACEAE	<i>Turraea holstii</i>	14	5	1.7	4	12.9
SAPINDACEAE	<i>Lecaniodiscus fraxinifolius</i> *	14	5	1.7	4	12.9

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

		Rank	In x plots (n=19)	% of total no. plots	Total no. of individuals (n=304)	% of total individuals
LEGUMINOSAE	<i>Acacia sieberiana</i>	1	9	29.0	56	18.5
subfamily:						
MIMOSOIDEAE						
	<i>Acacia hockii</i>	2	8	25.8	24	7.9
COMBRETACEAE	<i>Combretum molle</i>	3	7	22.6	28	9.3
ANACARDIACEAE	<i>Lannea schweinfurthii</i> var. <i>stuhlmannii</i>	4	6	19.4	15	5.0
BURSERACEAE	<i>Commiphora africana</i>	4	6	19.4	15	5.0
SAPOTACEAE	<i>Manilkara sulcata</i> *	6	4	12.9	6	2.0
CAPPARIDACEAE	<i>Boscia salicifolia</i>	6	4	12.9	5	1.7
MELIACEAE	<i>Turraea holstii</i>	6	4	12.9	5	1.7
SAPINDACEAE	<i>Lecaniodiscus fraxinifolius</i> *	6	4	12.9	5	1.7
TILIACEAE	<i>Grewia holstii</i>	6	4	12.9	4	1.3
LEGUMINOSAE	<i>Scorodophloeus fischeri</i> *	11	3	9.7	24	7.9
subfamily:						
CAESALPINOIDEAE						

Table 6 continued

		Rank	In x plots (n=19)	% of total no. plots	Total no. of individuals (n=304)	% of total individuals
COMBRETACEAE	<i>Combretum zeyheri</i>	11	3	9.7	13	4.3
LEGUMINOSAE	<i>Acacia nilotica</i>	11	3	9.7	11	3.6
subfamily:						
MIMOSOIDEAE						
LEGUMINOSAE	<i>Dalbergia melanoxylon</i>	11	3	9.7	8	2.6
subfamily:						
PAPILIONOIDEAE						
LEGUMINOSAE	<i>Acacia mellifera</i>	11	3	9.7	5	1.7
subfamily:						
MIMOSOIDEAE						
	<i>Dichrostachys cinerea</i>	11	3	9.7	5	1.7
COMBRETACEAE	<i>Combretum schumannii</i>	11	3	9.7	3	1.0

#### 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). The curve is constantly rising and it is therefore likely that the accumulation of species would increase with even greater sampling intensity.

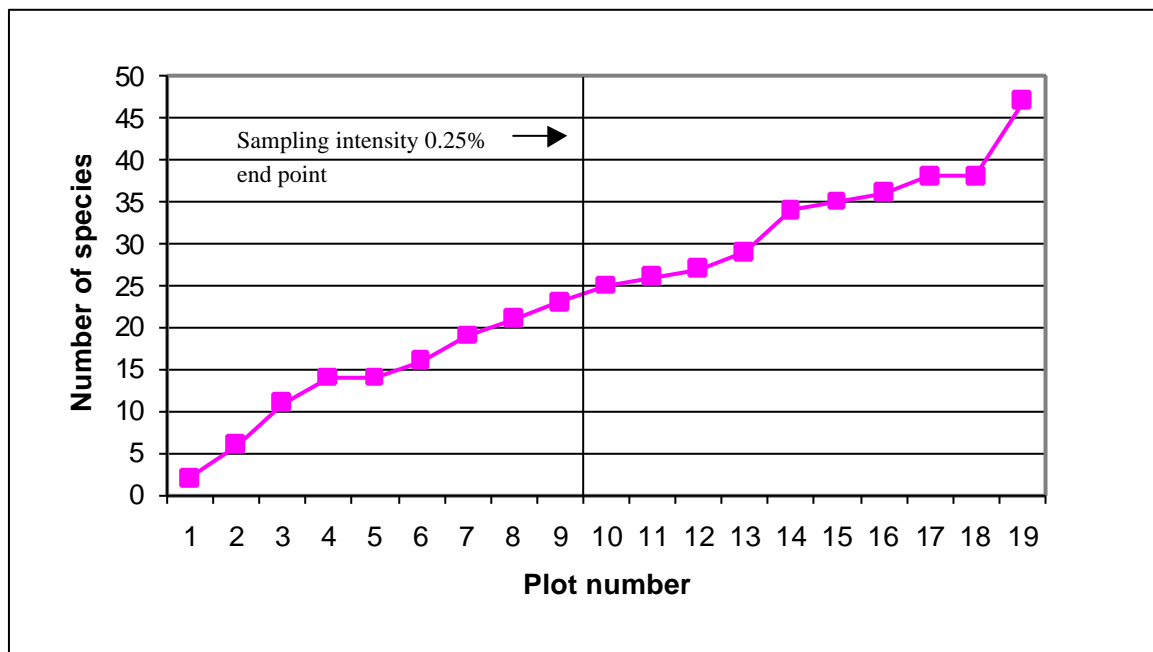


Figure 5 Species accumulation rates of trees and shrubs (10cm dbh and larger) by vegetation plot for 0.5% sampling intensity.

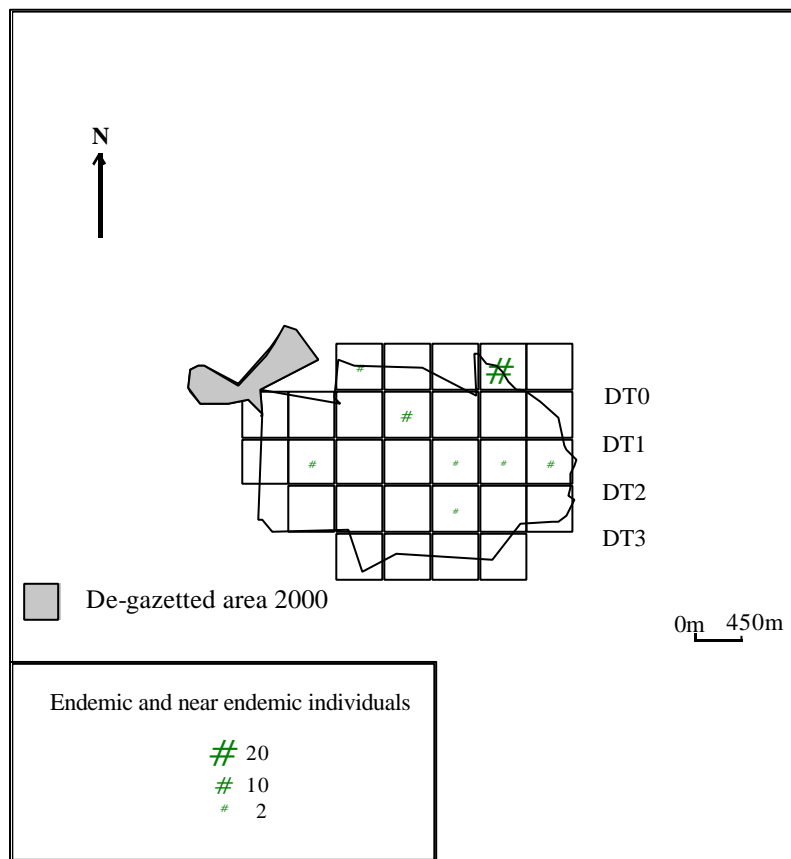
**4.3.1.4 Endemic Status**

No species in Bombo East II were found to be endemic to the East Usambara Mountains. Five species (10.6%) and 36 individuals (11.8%) were recorded as near endemic. The majority of species recorded 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** Summary of endemism for tree and shrub species recorded in the 20 m x 50 m vegetation plots (based on Table 4).

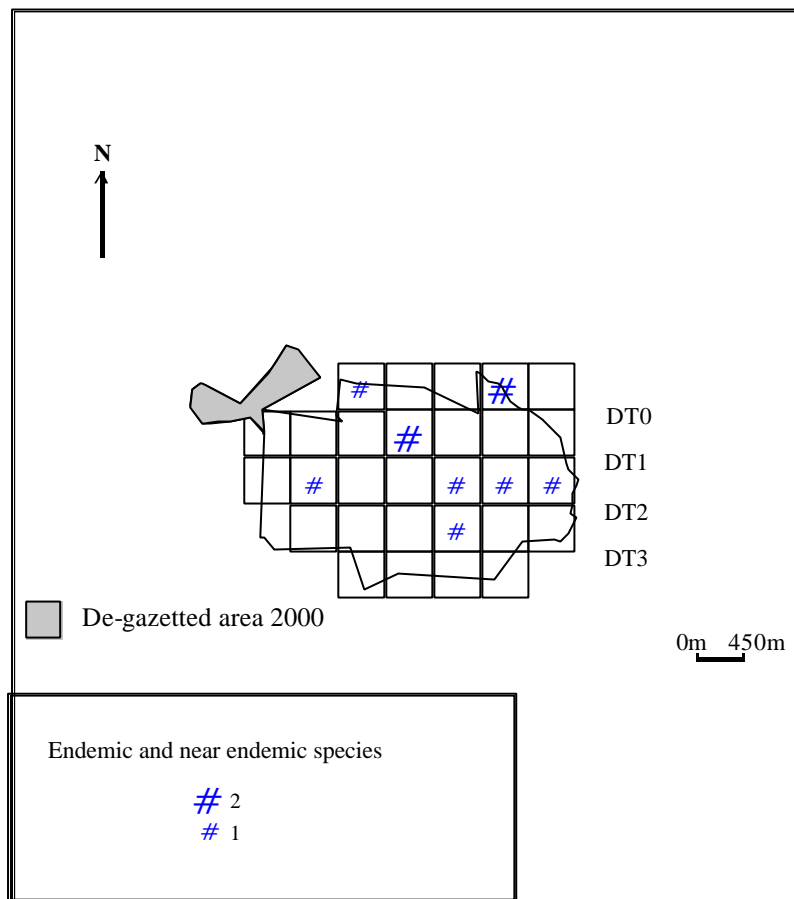
Figures from 0.25% sampling intensity are shown in brackets.

	Number of species	% of species	Number of individuals	% of individuals
Near endemic (N)	5 (3)	10.6 (12.5)	36 (30)	11.8 (13)
Widespread (W)	38 (21)	80.9 (87.5)	256 (201)	84.2 (87)
Unknown (?)	4 (0)	8.5 (0)	12 (0)	4 (0)
<b>Total</b>	<b>47 (24)</b>	<b>100 (100)</b>	<b>304 (231)</b>	<b>100 (100)</b>



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





**Figure 7** Distribution of endemic and near endemic tree and shrub species in Bombo East II FR

#### 4.3.1.5 Ecological type

A total of two (4.3%) species and six (2%) individuals recorded within vegetation plots were forest dependent (Table 8). The majority of species and individuals are forest dwelling (Table 8). Eleven species (23.4%) and 61 individuals (20.1%) were non-forest dependent. Figures 8 and 9 show the distribution of forest dependent individuals and species, and give an indication of the distribution of tall closed canopy forest within Bombo East II FR (refer to Figure 4). Forest dependent species show a similar but less extensive distribution throughout Bombo East II FR to the endemic and near endemic species (Figures 6, 7, 8 and 9).

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

At 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 but the number of individuals was significantly higher for the 0.25 % sampling intensity (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.

<b>Ecological Type</b>	<b>Number of species</b>	<b>% of total species</b>	<b>Number of individuals</b>	<b>% of total individuals</b>
Forest dependent (F)	2 (1)	4.3 (4.2)	6 (1)	2 (0.4)
Forest dwelling (f)	30 (18)	63.8 (75)	225 (179)	74 (77.5)
Other (O)	11 (5)	23.4 (20.8)	61 (51)	20.1 (22.1)
Unknown (?)	4 (0)	8.5 (0)	12 (0)	4 (0)
<b>Total</b>	<b>47 (24)</b>	<b>100 (100)</b>	<b>304 (231)</b>	<b>100 (100)</b>

#### 4.3.1.6 Habitat

A total of 17 species (36.2%) and 102 individuals (33.5%) 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 II FR were most commonly categorised within this habitat type (*ie* all three forest types). A total of 4 (8.5%) species and 12 (4%) individuals were categorised as unknown. Seven (14.9%) species and 84 (27.6%) individuals were solely categorised as submontane forest species (S) Figures 12 and 13 present the distribution of submontane forest species throughout the FR. Submontane and montane individuals and species are present throughout Bombo East II FR (Figures 12 and 13).

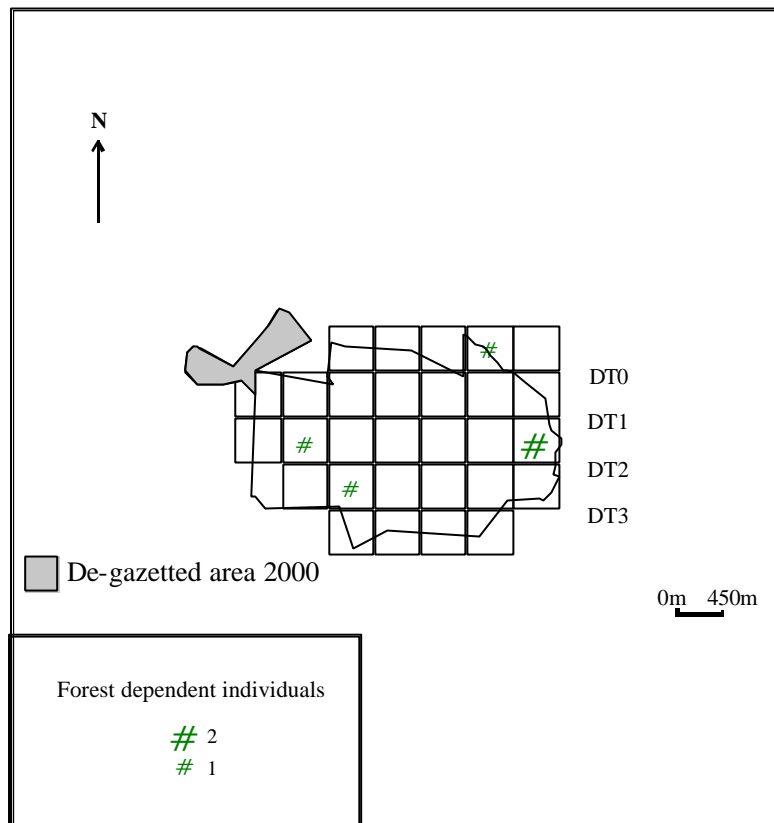


Figure 8 Distribution of forest dependent tree and shrub individuals in Bombo East II FR.

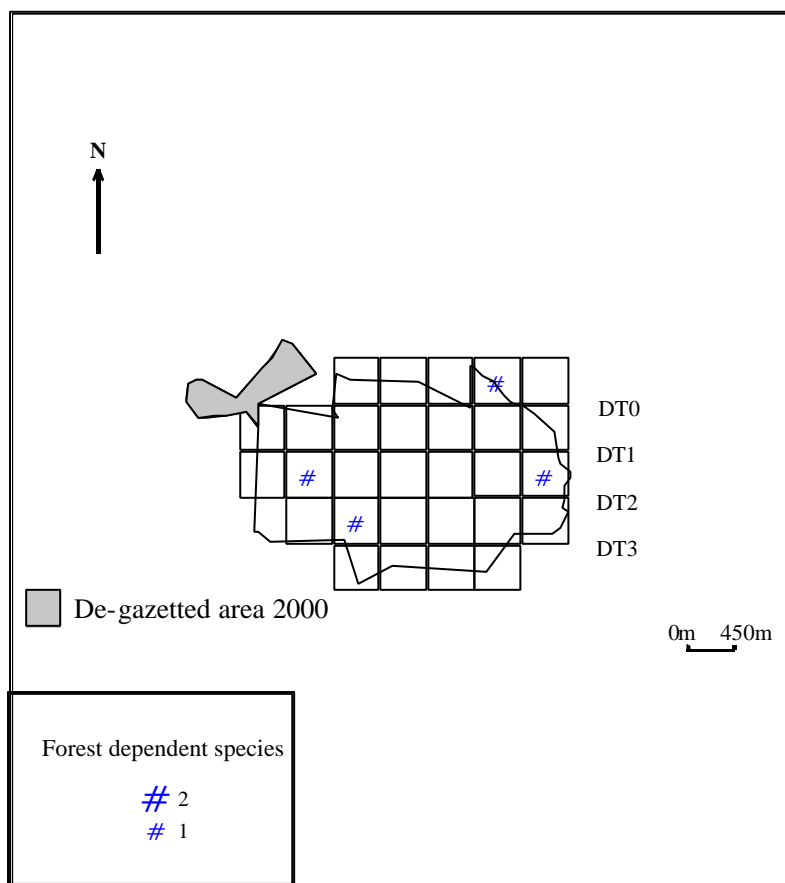


Figure 9 Distribution of forest dependent tree and shrub species in Bombo East II FR.

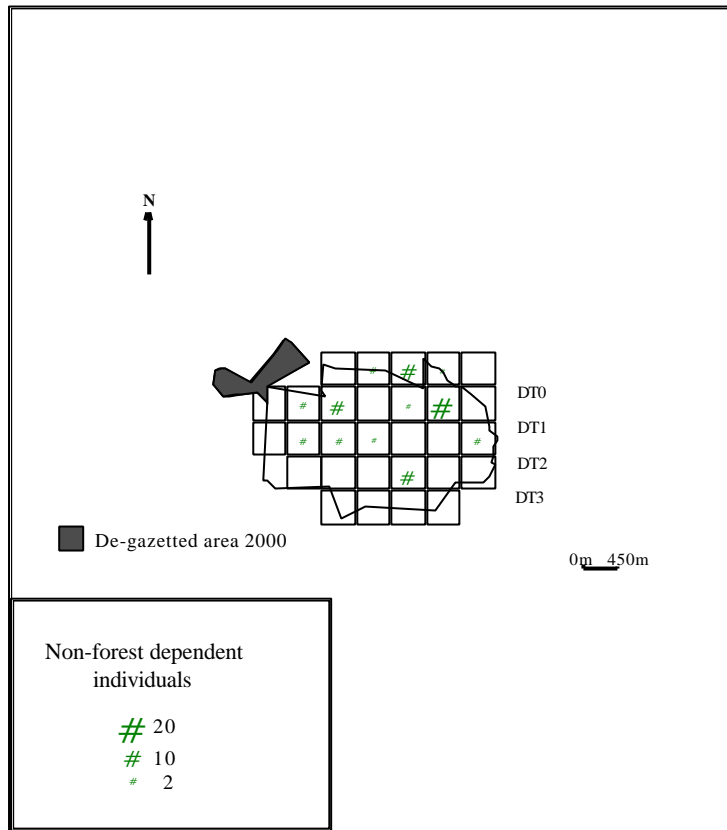


Figure 10 Distribution of non-forest tree and shrub individuals in Bombo East II FR.

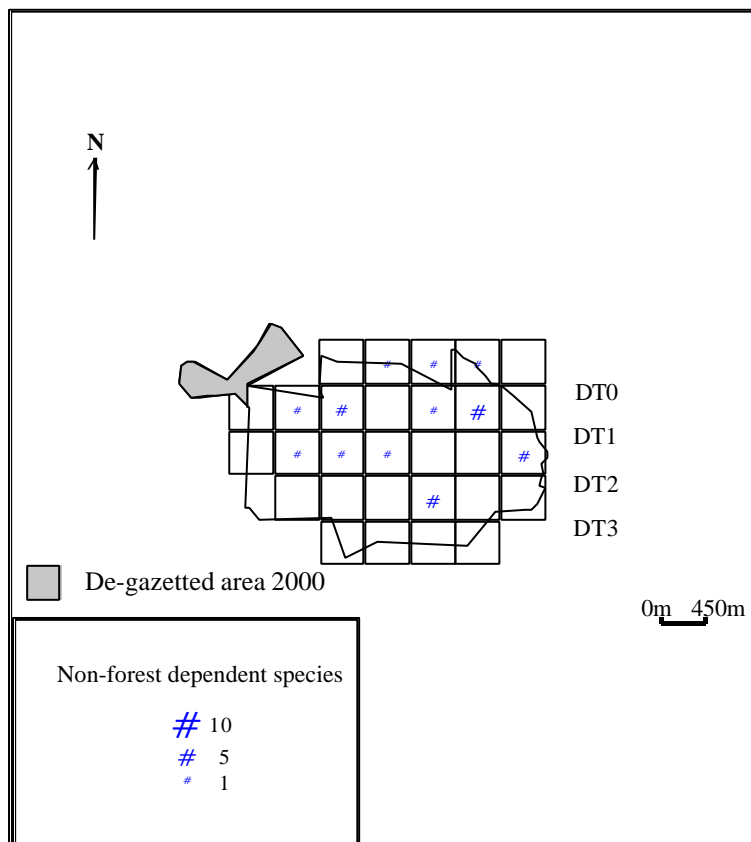


Figure 11 Distribution of non-forest tree and shrub species in Bombo East II FR.

**Table 9** Summary of habitat type for 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.

Habitat	No. of species	% of total species	No. of individuals	% of total individuals
Submontane (S)	7 (2)	14.9 (8.3)	84 (61)	27.6 (26.4)
Lowland, submontane & montane (L&S&M)	17 (11)	36.2 (45.9)	102 (80)	33.5 (34.6)
Lowland & submontane (L&S)	15 (8)	31.9 (33.3)	66 (50)	21.7 (21.6)
Lowland (L)	4 (3)	8.5 (12.5)	40 (40)	13.2 (17.4)
Unknown (?)	4 (0)	8.5 (0)	12 (0)	4 (0)
<b>Total</b>	<b>47 (24)</b>	<b>100 (100)</b>	<b>304 (231)</b>	<b>100 (100)</b>

A total of 7 species are submontane forest species were found within lowland forest habitats in Bombo East II FR.

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

Family	Species	Altitude (masl)
Bombacaceae	<i>Ceiba pentandra</i>	600
Euphorbiaceae	<i>Margaritaria discoidea</i>	680
Leguminosae subfamily: Mimosoideae	<i>Acacia mellifera</i>	460, 490, 500
Leguminosae subfamily: Mimosoideae	<i>Acacia nilotica</i>	460, 700, 670
Leguminosae subfamily: Mimosoideae	<i>Acacia sieberiana</i>	490, 520, 600, 640, 670, 680, 700, 801, 780,
Sterculiaceae	<i>Sterculia africana</i>	560
Tiliaceae	<i>Grewia bicolor</i>	600, 640

Altitude (masl): metres above sea level

#### 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 47 additional species were recorded in Bombo East II FR during the present survey, only five of these were recorded by Ruffo *et al.* (1989) at other locations in the East Usambaras, whilst 41 species were not recorded at all by Ruffo *et al.* (1989). Table 11 lists these new records for Bombo East II FR.

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

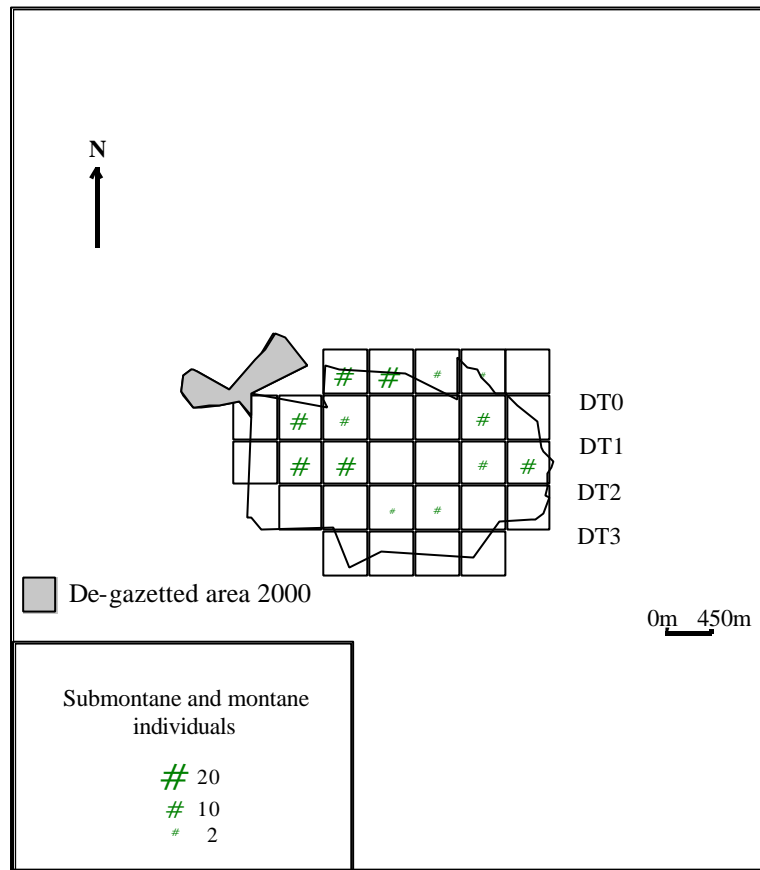


Figure 12 Distribution of sub-montane and montane individuals in Bombo East II FR

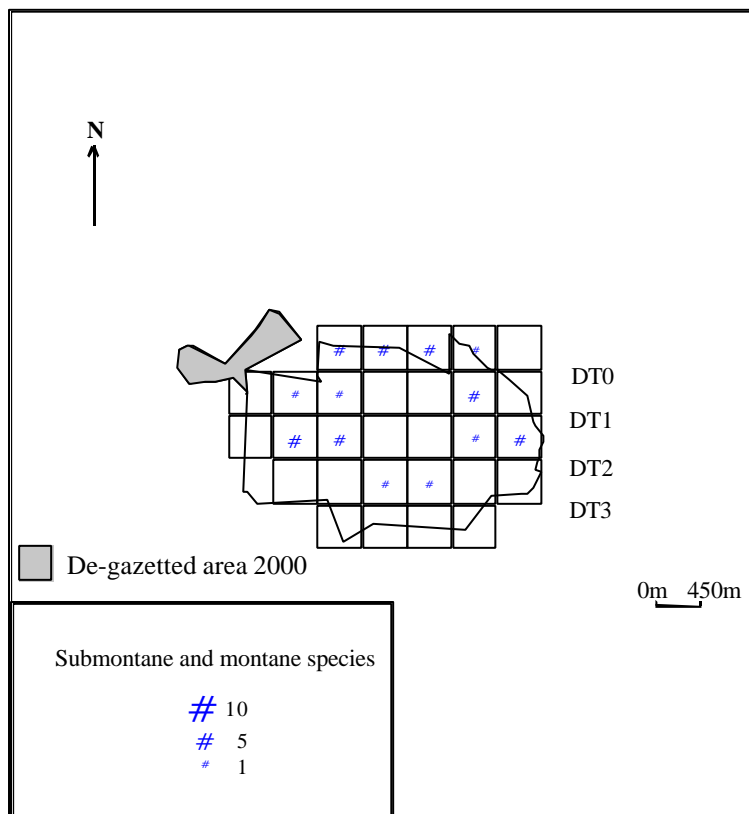


Figure 13 Distribution of submontane and montane species in Bombo East II FR

**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
<b>Angiospermae – Dicotyledonae</b>	
ANACARDIACEAE	
<i>Lannea schweinfurthii</i> var. <i>stuhlmannii</i> (Engl.) J.D. Kokwaro 1980	Not listed
<i>Ozoroa insignis reticulata</i> (Bak. F) J.B. Gillet 1980	Not listed
<i>Rhus natalensis</i> Bernh. ex. Krauss*	Not listed
BIGNONIACEAE	
<i>Markhamia lutea</i> K. Schum 1895*	Kilanga/Lutindi, Longuza/Marimba, Mlinga, Kwamgumi/Segoma, Mtai
<i>Stereospermum kunthianum</i> Cham. 1832*	Not listed
BIXACEAE	
<i>Ludia mauritiana</i> J.F. Gmel	Not listed
BOMBACACEAE	
<i>Ceiba pentandra</i> (L.) Gäertn 1791	Not listed
BURSERACEAE	
<i>Commiphora africana</i> (A.Rich) Engl.	Not listed
<i>Commiphora eminii zimmermanni</i> (Engl.) J.B. Gillet 1991 (basionym. <i>C. Zimmermannii</i> Engl.)	Not listed
CAPPARIDACEAE	
<i>Boscia salicifolia</i> Oliver.	Not listed
CELASTRACEAE	
<i>Maytenus undata</i> (Thunb.) Blakelock	Lutindi, Kilanga, Kizara/Kizerui
COMBRETACEAE	
<i>Combretum exalatum</i> Engl. 1895	Not listed
<i>Combretum molle</i> R.Br. ex. G. Don 1827	Not listed
<i>Combretum schumannii</i> Engl. 1894	Kwamsambia/Kihuhwi, Kilanga, Lutindi, Longuza, Marimba, Kwamgumi/Segoma
<i>Combretum zeyheri</i> Sond. 1850	Not listed
<i>Terminalia prunioides</i> M. Laws	Not listed
COMPOSITAE	
<i>Blepharispermum</i> sp. DC	Not listed
<i>Brachlaena huillensis</i> O. Hoffm. 1902	Not listed
EUPHORBIACEAE	
<i>Croton polytrichus</i> Pax 1893	Not listed
<i>Margaritaria discoidea</i> (Baill) Webster 1967	Not listed
<i>Spirostachys africana</i> Sond 1850	Not listed
LEGUMINOSAE subfamily: CAESALPINOIDEAE	
<i>Scorodophloeus fischeri</i> (Taub.) J.Leonard. (basionym. <i>Theodora fischeri</i> Taub 1985)*	Longuza
<i>Tamarindus indica</i> Linn.	Not listed

**Table 11** continued

LEGUMINOSAE subfamily: MIMOSOIDEAE	
<i>Acacia hockii</i> De Wild 1913	Not listed
<i>Acacia mellifera</i> Benth 1842	Not listed
<i>Acacia nilotica</i> Delile.	Not listed
<i>Acacia sieberiana</i> DC.	Not listed
<i>Albizia anthelmintica</i> Brongn 1860	Not listed
LEGUMINOSAE subfamily: PAPILIONOIDEAE	
<i>Lonchocarpus bussei</i> Harms (basionym. <i>Philnoptera bussei</i> (Harms) B.D. Schrine)	Not listed
<i>Dalbergia melanoxyton</i> Guill & Per	Not listed
<i>Dichrostachys cinerea</i> (L.) Wight & Arn	Not listed
<i>Ormocarpum kirkii</i> S.Moore	Not listed
MELIACEAE	
<i>Turraea holstii</i> Guerke 1894	Not listed
MORACEAE	
<i>Ficus</i> sp.	?
OLACACEAE	
<i>Ximenia americana</i> Linn.	Not listed
RUBIACEAE	
<i>Rothmannia manganjae</i> (Hiern) Garcia 1958	Not listed
RUTACEAE	
<i>Vepris trichocarpa</i> Engl.	Not listed
SAPINDACEAE	
<i>Haplocoelum foliolosum</i> (Hiern) Bullock 1931	Not listed
<i>Haplocoelum inopleum</i> Radlk	Not listed
<i>Lecaniodiscus fraxinifolius</i> Baker*	
SAPOTACEAE	
<i>Manilkara sulcata</i> Dubard 1915*	Lutindi/Longuza
<i>Mimusops</i> sp.	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.	Not listed
<i>Grewia holstii</i> Burret 1804	Not listed
UMBELLIFERAE	
<i>Steganotaenia araliacea</i> Hochst.1844	Not listed



#### 4.3.1.8 Timber species

Bombo East II FR has not been subjected to such extensive commercial logging as other more accessible and resource rich areas such as Amani Nature Reserve and Nilo FR. 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 II FR.

One tree species recorded within the vegetation plots was listed by Ruffo *et al.* (1989) as useful for timber use. This species was 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=304)	No. plots (n=19)
<b>Timber only</b>				
Combretaceae	<i>Combretum schumannii</i> Engl.	Timber only	3	3

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 Kwangumi FR it is affected by cutting for building material. Six individuals of this species were recorded in one vegetation plot in Bombo East II FR. The main threats to this tree in Bombo II 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 and for ethnoveterinary and human medicines. Eight individuals of this species were recorded within three vegetation plots. Surprisingly this species does not appear to have been exploited in Bombo II FR.

Appendices 5 and 6 provide further lists of useful plant species found within Bombo 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	19	9
Total number of individuals sampled	304	194
Total number of species sampled	47	23
Mean no. of trees per plot (St. Dev.)	12.33 (6.86)	19.40 (7.72)
Mean no. of species per plot (St Dev.)	4.56 (1.81)	7.40 (3.20)
No. of endemic species (E(EU))	0	0
No. of near endemic species (N)	5	3
No. of forest dependent species (F)	2	1

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 five species were recorded solely in the regeneration layer three within the 3 m x 3 m sample plots and four 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). None of the species present in the regeneration layer were recorded during the survey performed by Ruffo *et al.* (1989).

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

Herbaceous vegetation dominated the ground layer in 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 1.59 and 1.41 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
<b>COMBRETACEAE</b>			
<i>Combretum</i> sp.	?	?	?
<b>EUPHORBIACEAE</b>			
<i>Croton pseudopulchellus</i> Pax. <sup>1</sup>	f	L&S	W
<b>LEGUMINOSAE subfamily MIMOSOIDEAE</b>			
<i>Acacia</i> sp.	?	?	?
<b>OCHNACEAE</b>			
<i>Ochna thomasiana</i> Engl. & Gilg ex Gilg. <sup>1</sup>	?	L	N <sup>1</sup>
<b>RUTACEAE</b>			
<i>Zanthoxylum</i> sp.	?	?	?

<sup>1</sup> Additional species recorded as a consequence of intensifying sampling effort by increasing regeneration plots to 6 m x 6 m in size.

#### 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 II FR, the increase in the size of sample plot during regeneration sampling from 3m x 3m to 6m x 6m produced an additional species (Table 15). An additional 65 individuals were recorded, 33 stems of dbh 1 to 9.5cm and 33 stems of dbh smaller 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	16	15
Total number of individuals	133	68
Total number of stems (1-9.5cm)	51	18
Total number of stems (<1cm)	82	49
Mean number of individuals per plot	7	3.6
Standard Deviation (s) (degree of variance)	13.26	6.85
Mean no. sp. per plot	0.8	0.8
Standard Deviation (s) (degree of variance)	1.59	1.41

#### 4.3.1.12 Opportunistic plant collection and observation

A total of 37 species were opportunistically recorded within Bombo East II FR, which were not otherwise found in vegetation or regeneration plots. These represented 25 families. An additional near endemic species was 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 II FR

	Ecol. Type	Habitat	End. Status
<b>Angiospermae – Dicotyledonae</b>			
<b>ACANTHACEAE</b>			
<i>Dyschoriste hildebrandtii</i> Lindau. ex. O.B.Clark	?	L&S&M <sup>2</sup>	W <sup>2</sup>
<i>Thunbergia holstii</i> Lindau 1893	?	S&M <sup>2</sup>	W <sup>2</sup>
<b>ANNONACEAE</b>			
<i>Asteranthe asterias</i> Eng & Diels	f	L	N
<b>APOCYNACEAE</b>			
<i>Carissa tetramera</i> (Sacl) Stapf	?	?	?
<i>Saba comorensis</i> (Bojer) Pichon 1953	f	L&S	W
<b>BIGNONIACEAE</b>			
<i>Kigelia africana</i> Benth.	f	S	W
<b>CAPPARACEAE</b>			
<i>Capparis tomentosa</i> Lam	f	L&S	W
<i>Capparis sepiaria</i> var <i>stuhlmannii</i> (Gilg) De Wolf	f <sup>1</sup>	L <sup>1</sup>	W <sup>1</sup>
<b>CAPPARIDACEAE</b>			
<i>Maerua triphylla</i> A.Rich	f	L&S	W

Table 16 continued

	Ecol. Type	Habitat	End. Status
<b>COMBRETACEAE</b>			
<i>Combretum apiculatum</i> Sond. 1850	O	L&S	W
<b>COMMELINACEAE</b>			
<i>Commelina schliebenii</i> Mildbr 1932	?	?	?
<b>CYCADACEAE</b>			
<i>Encephalartos hildebrandtii</i> A.Br & Bouché 1874	?	L <sup>2</sup>	W <sup>2</sup>
<b>CYPERACEAE</b>			
<i>Cyperus niveus</i> Retz. 1791	?	?	?
<b>EBENACEAE</b>			
<i>Euclea natalensis</i> A. DC.	f	L&S	W
<b>EUPHORBIACEAE</b>			
<i>Acalypha</i> sp.	?	?	?
<i>Excoecaria madagascariensis</i> Muell Arg	f <sup>1</sup>	L&S&M <sup>1</sup>	W <sup>1</sup>
<i>Phyllanthus guineensis</i> Pax.	f <sup>1</sup>	L&S&M <sup>1</sup>	W <sup>1</sup>
<i>Ricinus communis</i> L.	f	L&S	W
<b>ICACINACEAE</b>			
<i>Pyrenacantha kaurabassana</i> Baill. 1872	f	L&S	W
<b>LABIATAE</b>			
<i>Hoslundia opposita</i> Vahl	f	?	W
<b>LEGUMINOSAE subfamily:</b>			
<b>CAESALPINACEAE</b>			
<i>Afzelia quanzensis</i> Welw 1858	f <sup>2</sup>	L&S&M <sup>2</sup>	W <sup>2</sup>
<b>LEGUMINOSAE subfamily:</b>			
<b>PAPILIONOIDEAE</b>			
<i>Mundulea sericea</i> (Wild) A.Cheval	f <sup>1</sup>	L&S <sup>1</sup>	W <sup>1</sup>
<i>Tephrosia</i> sp.	?	?	?
<b>MENISPERMACEAE</b>			
<i>Stephania abyssinica</i> Walp	O	?	W
<b>OLACACEAE</b>			
<i>Ximenia caffra</i> Sond.	O <sup>1</sup>	L&S&M <sup>1</sup>	W <sup>1</sup>
<b>PASSIFLORACEAE</b>			
<i>Adenia rumicifolia</i> Engl.	f	L&S	W
<b>POACEAE</b>			
<i>Digitaria abyssinica</i> (Hochst) Stapf 1907	?	L&S&M <sup>2</sup>	W <sup>2</sup>

Table 16 continued

	Ecolog. Type	Habitat	End. Status
<b>RUBIACEAE</b>			
<i>Coffea zanguebariae</i> Lour.	O <sup>1</sup>	L <sup>1</sup>	W <sup>1</sup>
<i>Rytigynia</i> sp	?	?	?
<b>SALVADORACEAE</b>			
<i>Azima tetracantha</i> Lam.	O <sup>1</sup>	L&S <sup>1</sup>	W <sup>1</sup>
<b>SAPINDACEAE</b>			
<i>Deinbollia borbonica</i> Scheff 1869	O	L&S	W
<b>STERCULIACEAE</b>			
<i>Dombeya kirkii</i> Mast	O	M	W
<b>TILIACEAE</b>			
<i>Grewia forbesii</i> Harv. ex. Mast.	f	L&S	W
<i>Grewia microcarpa</i> K.schum	f <sup>1</sup>	L&S <sup>1</sup>	W <sup>1</sup>
<b>VERBENACEAE</b>			
<i>Clerodendrum</i> sp	?	?	?
<i>Lantana camara</i> L. 1753	f	L&S	W
<i>Lantana trifolia</i> L.	f <sup>1</sup>	L&S&M <sup>1</sup>	W <sup>1</sup>

**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* Burrett \*: 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

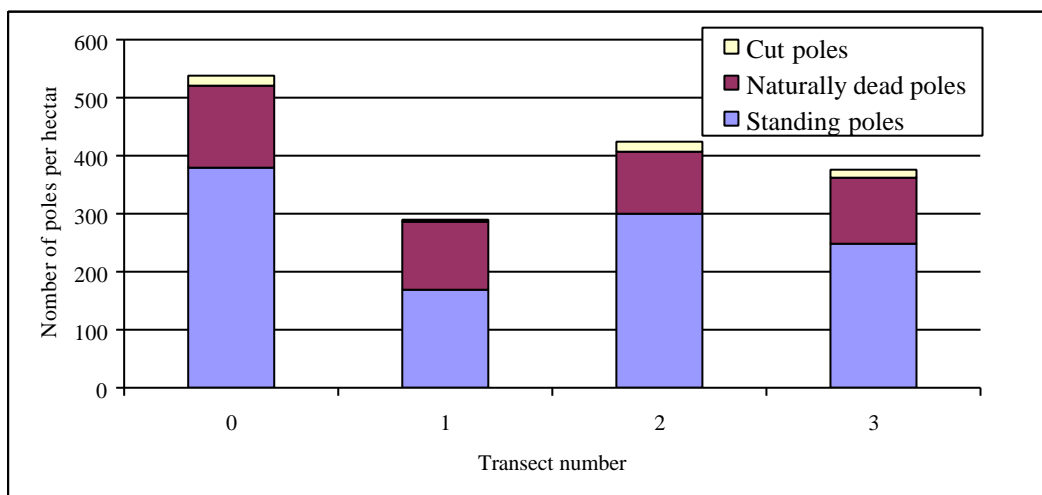
Pole and timber extraction was recorded along all four transects. The results are summarised in Table 17 for poles and Table 18 for timber. The term pole refers to all stems 5 – 15 cm dbh, the term timber refers to stems larger than 15 cm dbh.

The occurrence of pole extraction in Bombo East II FR is not very prominent. The highest percentage of cut poles along a disturbance transect is only 4% of all recorded poles on disturbance transect 2, the second longest. Most poles were recorded on transects 0 and 1, 1074 and 1041 respectively.

**Table 17** Disturbance transect results for pole counts in Bombo East II 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	2000	1074	763 (71%)	381.50	279 (26%)	139.50	32 (3%)	16.00
1	2850	827	483 (58%)	169.47	332 (40%)	116.49	12 (2%)	4.21
2	2450	1041	739 (71%)	301.63	257 (25%)	104.90	45 (4%)	18.37
3	1400	525	348 (66%)	248.57	160 (31%)	114.29	17 (3%)	12.14
Total	8700	3467	2333 (67%)		1028 (30%)		106 (3%)	
Average				275.29		118.79		12.68
(Standard deviation)				(+ 89.23)		(+ 14.69)		(+ 6.20)

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



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

Figure 15 illustrates the occurrence of pole extraction per hectare within Bombo East II FR. The most pole extraction was recorded in the sections of vegetation plots 3, 11, 16 and from 17 to the western border of the FR, all of which are close to the border of the FR.

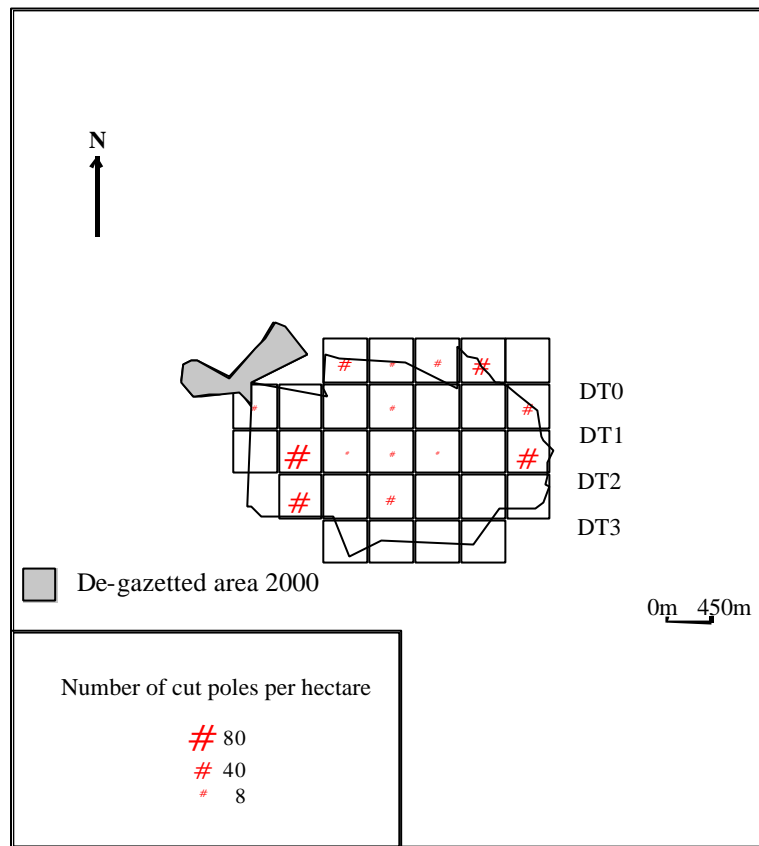


Figure 15 Pole extraction in Bombo East II FR (including those old and newly cut).

Table 18 and Figure 16 show the extend of timber extraction from Bombo East II FR. Even less cut timber was recorded than poles. Generally, fewer timbers were recorded, about one-third of the number of poles, reflecting less abundance. Most timbers were recorded on disturbance transect 0, which also, least of disturbance transect 3. Most extraction of timber occurred on disturbance transect 3 when comparing total number of timbers sampled.

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

Transect number	Length of transect (m)	Total timbers sampled	Standing timbers	Standing timbers per ha	Naturally dead timbers	Naturally dead timbers per ha	Cut timbers	Cut timbers per ha
0	2000	432	318 (73%)	159.00	102 (24%)	51.00	12 (3%)	6.00
1	2850	315	212 (67%)	74.39	95 (30%)	33.33	8 (3%)	2.81
2	2450	246	202 (82%)	82.45	42 (17%)	17.14	2 (1%)	0.82
3	1400	235	182 (77%)	130.00	45 (19%)	32.14	8 (4%)	5.71
<b>Total</b>	<b>8700</b>	<b>1228</b>	<b>914 (74%)</b>		<b>284 (23%)</b>		<b>30 (2%)</b>	
Average				111.46		33.40		3.83
(Standard deviation)				(+ 40.08)		(+ 13.85)		(+ 2.48)

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

Figure 17 illustrates timber extraction in Bombo East II FR in relation to its position within the FR. It is evident that most timber extraction was recorded along the reserve borders, most prominently in the section from vegetation plot 17 to the western border of the reserve.

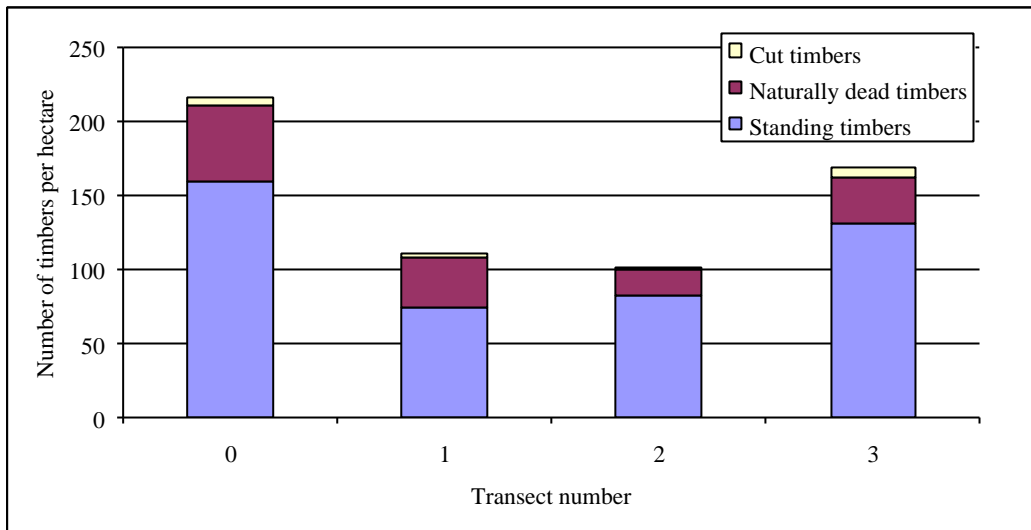


Figure 16 Relative abundance of live, naturally dead and cut timbers in Bombo East II FR.

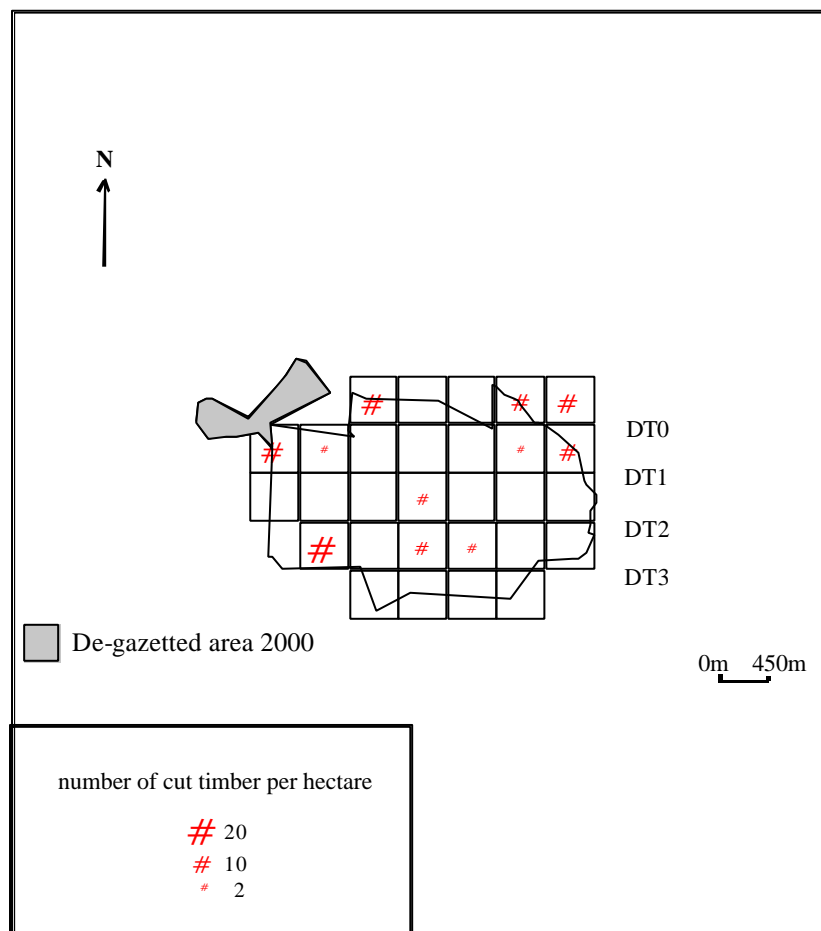


Figure 17 Timber extraction in Bombo East II FR.

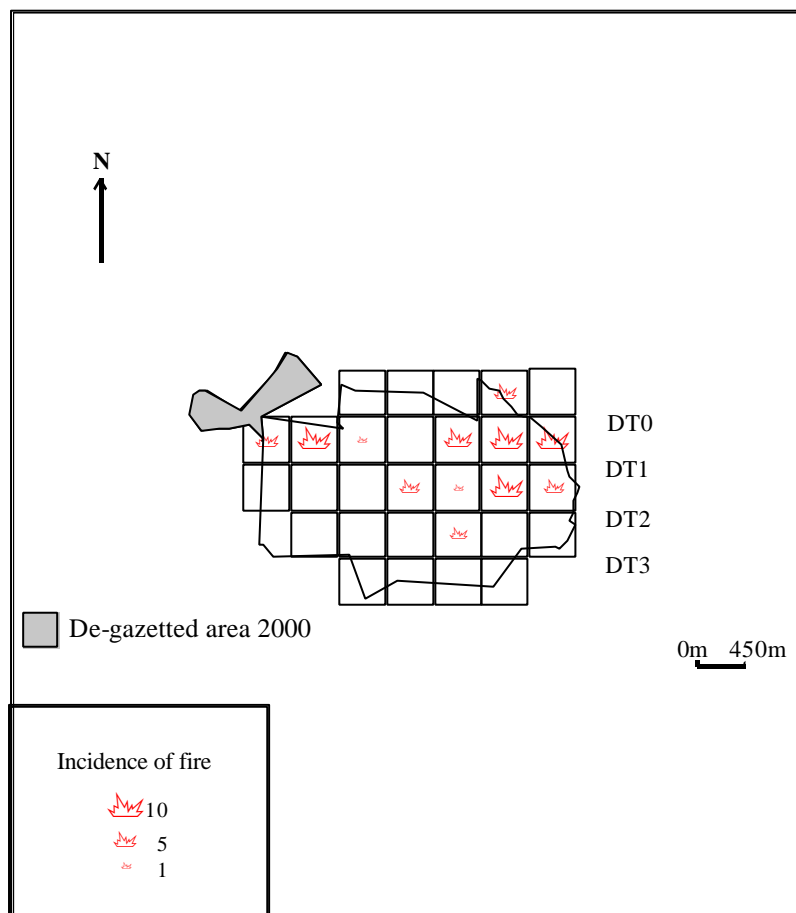


**4.3.2.2 Fires**

Fires represent a significant threat to sites within Bombo East II FR. In December 2001, just a few months prior to the survey, fire spread throughout much of the FR. Figure 18 clearly shows the main areas affected by fire. It is apparent that the east is much more affected especially the sections of vegetation plots 8, 9 and up to the eastern border on disturbance transect 1 and section 15 of disturbance transect 2.

**4.3.2.3 Animal Trapping and other Disturbances**

No animal traps were recorded during disturbance transect work although pitfall traps designed to capture bushpig were evident near the eastern reserve borders. However, paths through the FR and goat grazing were recorded in the centre of the FR, in the sections of vegetation plot 11, 12, 13 and 14 of disturbance transect 2. Figure 19 illustrates these.



**Figure 18** Records of fire in Bombo East II FR.

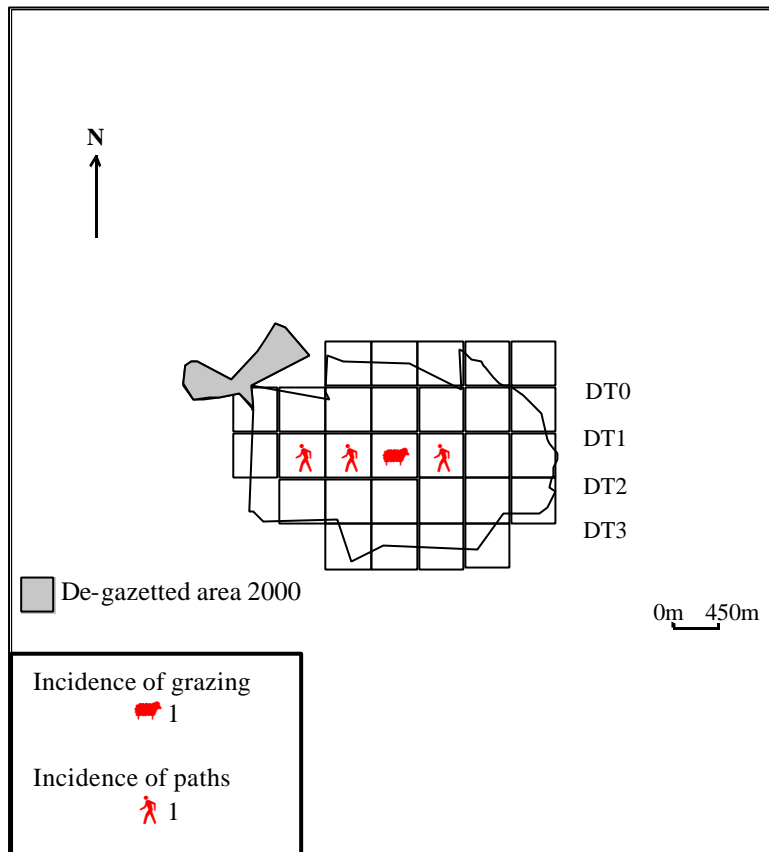


Figure 19 Records of various disturbance types in Bombo East II FR.

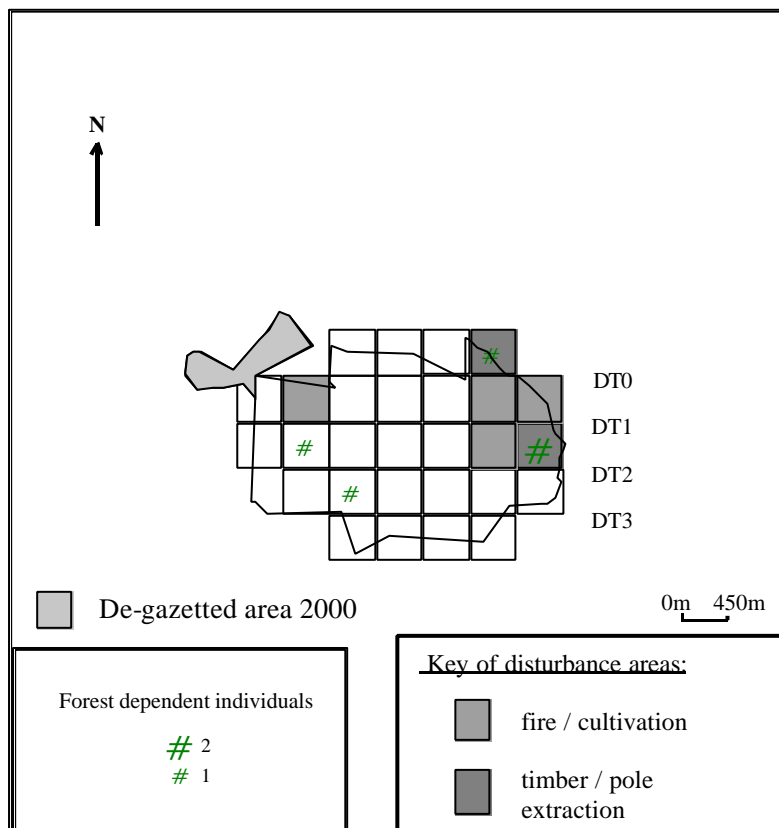
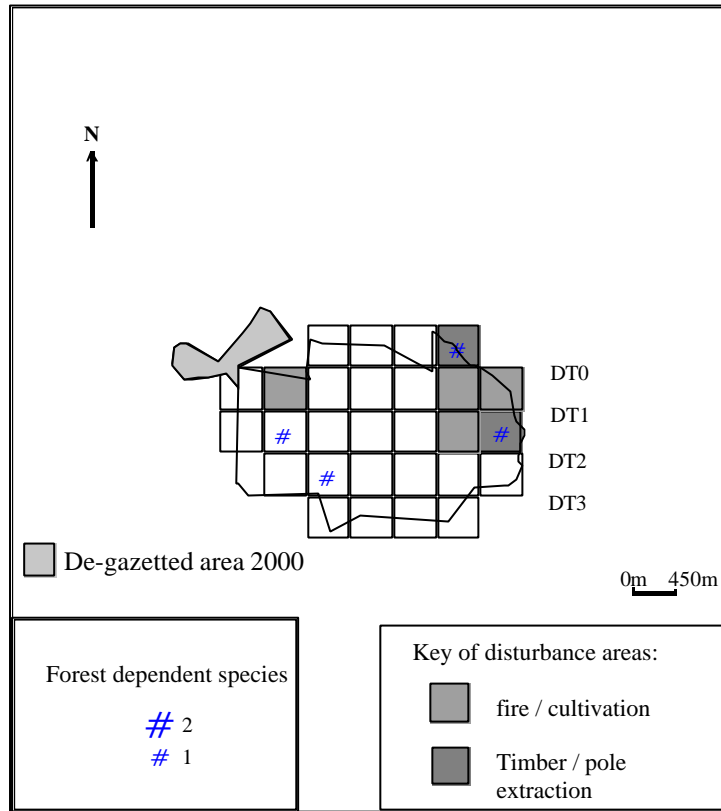


Figure 20 Areas of highest disturbance (shaded) in relation to the distribution of tree and shrub individuals that are forest dependent in Bombo East II FR.



**Figure 21** Areas of highest disturbance (shaded) in relation to the distribution of tree and shrub species that are forest dependent in Bombo East II FR.

Two of the most disturbed plots by pole and timber extraction (vegetation plots 3 and 16) also hold the highest numbers of forest dependent individuals (Figure 20) and species (Figure 21).

## 4.4 Discussion

Bombo East II FR covers an area of 404 hectares with an altitudinal range of 440 m to 840 m a.s.l. The FR has been heavily affected by fire disturbance and is therefore predominately species-poor open woodland.

### 4.4.1 Habitat

Of the 19 vegetation plots surveyed systematically the dominant vegetation types within vegetation plots were open woodland (53% of plots) and lowland forest (47% of plots). 79% of all vegetation plots had an average canopy height of less than 10 m. Only four vegetation plots were recorded with canopy heights greater than 10 m. 68% of vegetation plots had been affected by fire.

### 4.4.2 Species richness

In the systematic vegetation plots 304 trees and shrubs were surveyed, representing 47 species from 23 families. An additional five species were recorded in the regeneration plots. Opportunistic observations and collections recorded an additional 37 plant species from 25 families. In total 89 plant species from 39 families were recorded.

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

The most abundant species in vegetation plots, representing 18.4% of individuals was the woodland species *Acacia sieberiana* (Leguminosae: subfamily Mimosoideae), which dominated within nine plots. The most commonly encountered species throughout vegetation plots were *Acacia sieberiana* (Leguminosae: subfamily Mimosoideae), *Acacia hockii* (Leguminosae: subfamily Mimosoideae) and *Combretum molle* (Combretaceae).

### 4.4.3 Species Accumulation Rates

The accumulation of species records throughout the systematic vegetation survey showed a general increase with sampling intensity. The accumulation curve did not level off (Figure 5) significantly, indicating that the accumulation of species would probably increase with greater sampling intensity. Opportunistic collection of flora supplemented the botanical checklist significantly.

### 4.4.4 Endemic Status

The majority of species recorded in vegetation plots (80.9%) had widespread distributions. No species were recorded as endemic to the East Usambara Mountains but five species were near endemic.

The most commonly recorded near-endemic tree and shrub species in the reserve were: *Scorodophloeus fischeri* (Leguminosaceae: subfamily Caesalpinoideae) (24 individuals), *Dombeya shupangae* (Sterculiaceae) (4 individuals) and *Grewia bicolor* (Tiliaceae) (4 individuals). All near endemic species were restricted to less than four plots each and never abundant with the exception of *Scorodophloeus fischeri*. The species were located throughout the FR, even in open woodland and disturbed habitats

Of the five near-endemic species, four species were forest dwelling but non-forest dependent. One near-endemic species, *Combretum exalatum* (Combretaceae) was a non-forest species. An additional endemic species was recorded opportunistically *Asteranthe asterias* (Annonaceae). This species is thought to be forest dwelling but non-forest dependent.

#### 4.4.5 Ecological Type

Two species (4.3%) recorded in vegetation plots were classified as forest dependent defined as 'limited to primary or closed canopy forest only'. The most commonly recorded forest dependent tree species was *Turraea holstii* (Meliaceae) represented by 5 individuals in 4 vegetation plots with limited or no disturbance.

Thirty species (63.8%) were recorded in vegetation plots as forest dwelling and eleven species (23.4%) non-forest dwelling. *Acacia sieberiana* (Leguminosae: subfamily Mimosoideae), was the most abundant forest dwelling species represented by 56 individuals in nine open woodland and disturbed lowland forest habitats. *Combretum molle* (Combretaceae), represented by 28 individuals in seven plots was the most abundant non-forest species present in open woodland and disturbed lowland forest habitats.

#### 4.4.6 Habitat

Of the tree species surveyed with known altitudinal preferences, 31.9% were considered to be solely typical of lowland forest and 14.9% of submontane forest. The remainder were considered to be typical of a combination of habitats, the majority (36.2% of species) present with lowland, submontane and montane habitats. The most commonly recorded submontane species was *Acacia sieberiana* (Leguminosae: subfamily Mimosoideae), represented by 56 individuals in nine vegetation plots.

#### 4.4.7 Range Extensions

A total of 47 additional species were recorded in Bombo East II FR during the present survey, only five of these were recorded by Ruffo *et al.* (1989) at other locations in the East Usambaras, whilst 41 species were not recorded at all by Ruffo *et al.* (1989).

Five new species were found in the vegetation plots in Bombo East II FR that were new to the East Usambara Biodiversity Database.

#### 4.4.8 Regeneration

Twenty three per cent 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 five 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 were useful to humans, *Ochna thomasi* for ornamental use and *Acacia* sp., *Zanthoxylum* sp., and *Combretum* sp., for various uses including honey production, charcoal, building poles, medicinal uses and food depending on the species (Ruffo, 1989 & Luoga *et al.*, 2000).

#### 4.4.9 Sampling Intensity

An increase in sampling intensity from 0.25% to 0.5% increased the value of the vegetation survey significantly. An additional ten vegetation plots were established, recording an additional 110 individuals representing 24 species. An additional two near endemic and one forest dependent species were 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 sampled in the regeneration layer, but did not increase species numbers significantly enough to be able to recommend its use in future. This however, may not be the case for large, more species diverse reserves such as Amani Nature Reserve or Nilo FR.

#### 4.5 Disturbance

Evidence of fire was observed in 12 plots, clustered into two main areas. The eastern side of the reserve was damaged during fires in late 2001. Fires have also affected the north western area of the reserve. In these areas there is little forest canopy and grassland dominates. It is noticeable from Figure 10 and Figure 11 that these areas have the highest concentrations of non-forest tree and shrub species. Also it is noticeable that there are fewer forest dependent species and individuals (see Figures 20 and 21) in the most severely fire affected areas.

Pole cutting and timber cutting show similar patterns of extraction, with particular plots (e.g. 0, the sections from vegetation plots 3 and 9 to the eastern border of the FR, and the section to the western border from vegetation plot 17) having high rates of both pole and timber cutting. Most of the highest extraction rates were recorded near the borders of the FR, close to roads. However, extraction of poles and timbers were also recorded within the FR (e.g. in plots 13 and 18).

Evidence of other disturbances was rare. No evidence of pitsawing were found within the FR. Goat grazing and paths were recorded in the FR in plots 11 to 14, not correlating to the recently burnt areas now covered in grassland.

## 5.0 FAUNA

Authors: Svoboda, N. S. Staddon, S. Salter, R. F. & Bracebridge, C. pp. 43-64

### 5.1 Introduction

The fauna of Bombo East II Forest Reserve (Bombo East II 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 II 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 two different locations in Bombo East II FR. Trappingsites were strategically positioned to incorporate a range of habitats reflective of the reserve. The location of trappingsites within Bombo East II FR are shown in Figure 22.

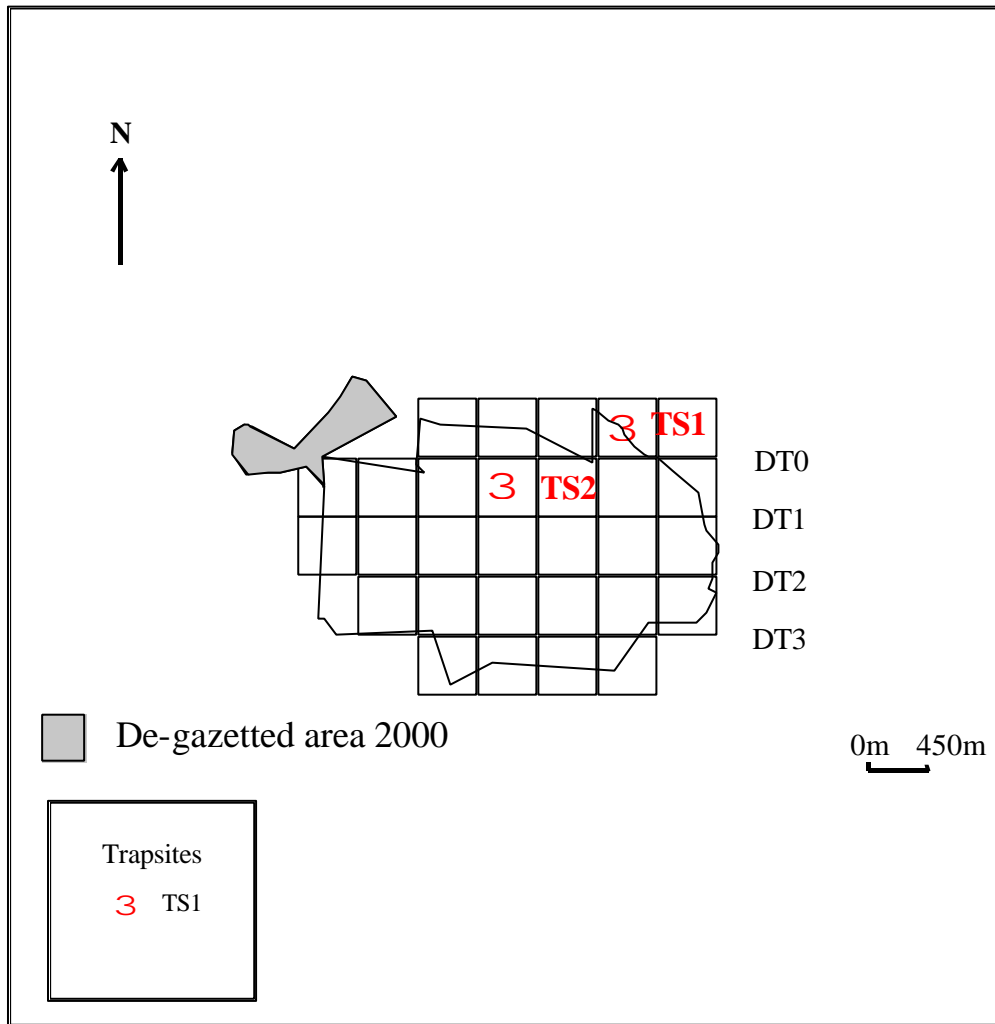


Figure 22 Location of trappingsites in Bombo East II FR.

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 II FR.

Trapsite Number	Duration (nights)	Vegetation type	Altitude (masl)	Topography	Co-ordinates
1	10	Lowland Forest	510	Gentle Middle Slope	S 04° 48' 30.7" E 038° 40' 50.4"
2	10	Lowland Forest and Open Woodland	640	Steep Middle Slope	S 04° 48' 44.3" E 038° 40' 26.0"

**Table 20** Zoological sampling intensities in Bombo East II 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	25.02.02-06.03.02	999	330	50	20	3	3
2	09.03.02-18.03.02	992	330	50	20	3	3
<b>TOTAL</b>		<b>1991</b>	<b>660</b>	<b>100</b>	<b>40</b>	<b>6</b>	<b>6</b>

**Table 21** Bat mist-netting sites and sampling intensities in Bombo East II 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 2, Satellite Camp	On top of hill, in dry gully, and on forest edge. Steep upper and middle slope.	S 04° 48' 44.3" E 038° 40' 26.0"	740	198
<b>TOTAL</b>					<b>333</b>

## 5.4 Results

### 5.4.1 Mammals

#### 5.4.1.1 Small mammals (not including bats)

A total of 22 small mammals were captured during 1991 Sherman trapping nights in Bombo East II FR. Of these, 9 specimens were retained for taxonomic purposes. Identifications in this report remain tentative while awaiting taxonomic verifications from Frankfurt Zoological Museum (refer to Appendix 1). The specimens collected represent at least 9 species from 3 families. A summary of trapping data is 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 II Forest Reserve.

Species	Ecol. type	End. status	Treat Status			Total nos. captured
			IUCN 2000	UDSM 1997	CITES 2001	
<b>CRICETOMYINAE</b>						
<i>Beamys hindei</i> (Lesser Pouched Rat)	F	N	VU	DD		2
<i>Taterillus emini</i> (Taterillus Gerbil)	O	W				2
<b>ERINACEIDAE</b>						
<i>Aterelix albiventris</i> (White-bellied Hedgehog)	O	W				1
<b>MURIDAE</b>						
<i>Acomys spinosissimus</i> (Spiny Mouse)	f	W				6
<i>Grammomys</i> cf. <i>dolichurus</i> (Narrow-footed Woodland Mouse)	O	W				3
<i>Mus minutoides</i> (Common Mouse)	O	W				3
<b>SORICIDAE</b>						
<i>Crocidura</i> sp.	-	-				1
<i>Crocidura</i> cf. <i>hildegardae</i> (White-toothed Shrew)	f	W				1
<i>Crocidura</i> cf. <i>hirta</i> (White-toothed Shrew)	O	W				3
<i>Crocidura</i> cf. <i>tansaniana</i> (White-toothed Shrew)	-	-				1
<b>TOTAL</b>						<b>22</b>

#### 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, as a tentative identification, was *Taterillus emini* (Taterillus Gerbil), as this is a new record for the East Usambaras. *Taterillus* is more characteristic of dry habitats, which reflects the predominance of dry open areas within Bombo II East.

By far the most commonly recorded species was *Acomys spinosissimus* (Spiny Mouse), constituting 27% of all small mammal captures. In addition, three other species were locally abundant: *Crocidura cf. hirta* (White-toothed Shrew), *Grammomys cf. dolichurus* (Narrow-footed Woodland Mouse) and *Mus minutoides* (Common Mouse). All three made up 13% of all small mammal captures with three individuals each. One species captured is forest dependent, *Beamys hindei* (Lesser Pouched Rat) (Hilton-Taylor, 2000) (Table 22) and is classed as vulnerable by IUCN. Two species are forest dwelling *Crocidura cf. hildegardae* (White-toothed Shrew) and *Acomys spinosissimus* (Spiny Mouse). Of interest is also the capture of *Aterelix albiventris* (White-bellied Hedgehog) at trapsite 2. It was captured in a bucket pitfall trap and is classed as widespread. The hedgehog has, however, not been recorded in the Usambara Mountains before. It usually prefers more open and arid habitat and has previously been recorded more commonly in north-central Tanzania (Kingdon, 1997).

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

#### 5.4.1.2 Dung survey

Dung from 5 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 23. Maximal number of occurrence per 50 m transect section is one.

**Table 23** Summary of dung survey in Bombo East II FR.

Species	Common Name	Ecol. type	End. status	IUCN 2000	CITES 2001	No. of Occurrences	Altitudinal Ranges (m)
<b>ANTILOPINAE</b>							
<i>Madoqua</i> sp.	Dikdik	-	-			5	460 – 500
<b>CAPRINI</b>							
<i>Capra hircus</i>	Domestic Goat	-	-			5	590 – 720
<b>CERCOPITHECIDAE</b>							
<i>Papio cynocephalus</i>	Yellow Baboon	f	W		II	1	810
<b>SUIDAE</b>							
<i>Potamochoerus larvatus</i>	Bush Pig	O	W			1	630
<b>THRYONOMYIDAE</b>							
<i>Thryonomys</i> sp.	Cane-Rat	O	W			5	470 – 600

For key to abbreviations, see Table 22.

Cane-rat, dik-dik and goat dung was recorded most frequently (29% of all dung occurrences each). Goat dung was most abundant near the edge of the FR, however some was found within the FR, suggesting livestock grazing taking place within the FR.

### 5.4.1.3 Mammal observations

A total of 10 species from 8 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 II FR.

Species	Ecol. type	End. status	Threat Status		Evidence
			IUCN 2000	CITES 2001	
<b>CAPRINI</b>					
<i>Capra hircus</i> (Domestic Goat)	-	-			sp; pa
<b>CERCOPITHECIDAE</b>					
<i>Papio cynocephalus</i> (Yellow Baboon)	f	W		II	pa; voc
<b>COLOBIDAE</b>					
<i>Colobus angolensis palliatus</i> (Angola Pied Colobus)	F	W	DD	II	obs; voc
<b>GALAGONIDAE</b>					
<i>Otolemur crassicaudatus</i> (Thick-tailed Greater Galago)	f	W		II	voc; obs
<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
<b>HERPESTIDAE</b>					
Unknown sp. (Mongoose)	-	-			sk, bns
<b>SUIDAE</b>					
<i>Potamochoerus larvatus</i> (Bush Pig)	O	W			pa
<b>THRYONOMYIDAE</b>					
<i>Thryonomys</i> sp. (Cane-Rat)	O	W			tr
<b>VIVERRIDAE</b>					
<i>Genetta</i> sp. (Genet)	f	W			sk

#### KEY TO ABBREVIATIONS FOR TABLE 24

##### Ecological (Ecol.) type:

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

##### Endemic (End.) status:

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

##### IUCN status:

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

##### CITES listings:

- I – Appendix One listed species  
 II – Appendix Two listed species  
 III – Appendix Three listed species

##### Evidence:

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

Of particular interest were the aural accounts of three cryptic nocturnal primates, *Otolemur garnettii* (Small-eared Greater Galago), *Otolemur crassicaudatus* (Thick-tailed Greater Galago) and *Galagoides zanzibaricus* (Zanzibar Galago) at trapsite 2. *Galagoides zanzibaricus* (Zanzibar Galago), a near endemic, lower risk/near threatened species (Hilton-Taylor, 2000), was heard on trapsite 2. 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. *Otolemur garnettii* and *O.*

*crassicaudatus* were both heard at trap site 2. The record of *O. crassicaudatus* indicates that habitat in Bombo East II FR is very open, as this species prefers *Miombo*-type woodland and is usually found much further south and west in Tanzania in drier and lower-lying habitat. *O. garnettii* was also heard and observed around base camp, living in cultivated land. Based on contact calls heard every dusk and dawn, the group at base camp was estimated to include 10-15 individuals.

**5.4.1.4 Bats**

Six individuals, representing four species and two families, were caught over 333 net-metre-hours of trapping at trap site 2 in Bombo East II FR and basecamp. They were retained for taxonomic purposes. A summary of trapping data is shown in Appendix 8 and a species list presented in Table 25. Identification remains 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 II FR

Species	Common name	Ecol. type	End. status	Threat Status			Total nos. captured
				IUCN 2000	UDSM 1997	CITES 2001	
<b>PTEROPODIDAE</b>							
cf. <i>Stenonycteris lanosus</i>	Mountain Fruit Bat	F	W				1
<i>Lissonycteris angolensis</i>	Angola Fruit Bat	f	W				3
<b>VESPERTILIONIDAE</b>							
<i>Myotis bocagei</i>	Hairy Bat	O	W				1
<i>Scotophilus nigrita</i>	Yellow House Bat	f	W				1
<b>TOTAL</b>							<b>6</b>

**KEY TO ABBREVIATIONS FOR TABLE 25**

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

Of interest was the capture of cf. *Stenonycteris lanosus* (Mountain or Long-haired Fruit Bat), which is a forest dependent species. Two forest dwelling species were also caught, *Myotis bocagei* (Hairy Bat) and *Lissonycteris angolensis* (Angola Fruit Bat), as well as one individuals which does not depend on the forest for its survival, *Scotophilus nigrita* (Yellow House Bat).

### 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 II 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 II FR.

Species	Common name	Ecol. type	End. status	Threat Status	
				IUCN 2000	CITES 2001
<b>ACCIPITRIDAE</b>					
<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. caerulens</i>	Black-shouldered Kite	f	W		II
<i>Gypohierax angolensis</i>	Palm-nut Vulture	f	W		II
<i>Hieraaetus pennatus</i>	Booted Eagle	f	W		II
<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>Terathopus ecaudatus</i>	Bateleur	f	W		II
<b>ALCEDINIDAE</b>					
<i>Halcyon albiventris orientalis</i>	Brown-hooded Kingfisher	f	W		
<i>Halcyon c. chelicuti</i>	Striped Kingfisher	f	W		
<i>Halcyon l. lencocephala</i>	Grey-headed Kingfisher	f	W		
<b>APODIDAE</b>					
<i>Cypsiurus parvus laeostigma</i>	African Palm Swift	f	W		
<i>Telacanthura ussheri stictilaema</i>	Mottled Spine Tail	F1	W		
<b>ARDEIDAE</b>					
<i>Bubulcus i. ibis</i>	Cattle Egret	f	W		III
<b>BUCEROTIDAE</b>					
<i>Bycanistes bucinator</i>	Trumpeter Hornbill	F2	W		
<i>Tokus alboterminatus</i>	Crowned Hornbill	f1	W		
<b>CAPITONIDAE</b>					
<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		
<b>CICONIIDAE</b>					
<i>Ciconia epis copusruicroscelis</i>	Woolly Necked Stork	f	W		
<b>COLIIDAE</b>					
<i>Colinus striatus kikuyuensis</i>	Speckled Mousebird	f	W		

Table 26 continued

Species	Common name	Ecol. type	End. status	Threat Status	
				IUCN 2000	CITES 2001
<b>COLUMBIDAE</b>					
<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 tympanistris</i>	Tambourine Dove	F1	W		III
<b>CORACIIDAE</b>					
<i>Coracias g. garrulus</i>	Eurasian Roller	f	W		
<i>Eurystomus glaucurus suahelicus</i>	Broad Billed Roller	f	W		
<b>CUCULIDAE</b>					
<i>Centropus superciliosus</i>	White-browed Coucal	f	W		
<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		
<b>DICRURIDAE</b>					
<i>Dicrurus a. adsimilis</i>	Common Drongo	f	W		
<i>Dicrurus ludwigii sharpei</i>	Square-tailed Drongo	F3	W		
<b>EMBERIZIDAE</b>					
<i>Emberiza cabanisi</i>	Cabanis' Bunting	F	E		
<b>ESTRILDIDAE</b>					
<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		
<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>Logonosticta 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
<b>EURYLYLAIMIDAE</b>					
<i>Smithornis capensis meinertzhageni</i>	African Broadbill	FF3	W		
<b>FALCONIDAE</b>					
<i>Falco peregrinus minor</i>	Peregrin Falcon	f	W		I
<b>FRINGILLIDAE</b>					
<i>Serinus mozambicus</i>	Yellow-fronted Canary	f	W		III
<b>INDICATORIDAE</b>					
<i>Indicator indicator</i>	Greater/Black-throated Honeyguide	f	W		
<i>Indicator meliphiles</i>	Pallid Honeyguide	f1	W		



Table 26 continued

Species	Common name	Ecol. type	End. status	Threat Status	
				IUCN 2000	CITES 2001
HIRUNDINIDAE					
<i>Hirundo abyssinica unitatis</i>	Lesser Striped Swallow	f	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		
MEROPIIDAE					
<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		
MUSOPHAGIDAE					
<i>Tauraco fischeri</i>	Fischer's Turaco	F2	N*	LR/NT	II
NECTARINIIDAE					
<i>Anthreptes collaris garguensis</i>	Collared Sunbird	F1	W		
<i>Anthreptes reichenowi yohanae</i>	Plain-backed Sunbird	FF3	W	LR/NT	
<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		

Table 26 continued

Species	Common name	Ecol. type	End. status	Threat Status	
				IUCN 2000	CITES 2001
<b>PLOCEIDAE</b>					
<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. rubiginosus</i>	Chestnut Weaver	f	W		
<i>Ploceus subaureus aureoflavus</i>	African Golden Weaver	f	W		
<b>PRIONOPIDAE</b>					
<i>Prionops retzii garculina</i>	Retz's Helmet-shrike	<b>f1</b>	W		
<i>Prionops scopifrons kirki</i>	Chestnut-fronted Helmet-shrike	<b>F2</b>	W		
<b>PYCNONOTIDAE</b>					
<i>Andropadus importunus</i>	Zanzibar Sombre Greenbul	f	W		
<i>Chlorocichla flaviventris centralis</i>	Yellow-bellied Greenbul	<b>F1</b>	W		
<i>Nicator gularis</i>	Eastern Nicator	<b>F</b>	W		
<i>Phyllastrephus debilis</i>	Tiny Greenbul	<b>FF3</b>	W		
<i>Phyllastrephus fischeri</i>	Fischer's Greenbul	<b>FF3</b>	W		
<i>Phyllastrephus strepitans</i>	Northern Brownbul	<b>f</b>	W		
<b>SCOPIIDAE</b>					
<i>Scopus u. umbretta</i>	Hamerkop	f	W		
<b>STURNIDAE</b>					
<i>Cinnyricinclus leucogaster verreauxi</i>	Violet-backed Starling	<b>f</b>	W		
<i>Lamprotornis c. chloropterus</i>	Lesser blue-eared Starling	f	W		
<i>Lamprotornis corruscus mandanus</i>	Black-bellied Starling	<b>F2</b>	W		
<b>SYLVIIDAE</b>					
<i>Apalis flavida</i>	Yellow-breasted Apalis	f	W		
<i>Apalis melanocephala</i>	Black-headed Apalis	<b>FF2</b>	W		
<i>Camaroptera brachyura</i>	Grey-backed Camaroptera	<b>f2</b>	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		
<b>TROGONIDAE</b>					
<i>Apaloderma n. narina</i>	Narina's Trogon	<b>F3</b>	W		
<b>TURDIDAE</b>					
<i>Cercotrichas g. guttata</i>	Spotted Morning Thrush	f	W		
<i>Cercotrichas leucophrys</i>	White-browed Scrub Robin	<b>F</b>	W		
<i>Cercotrichas q. quadrivirgata</i>	Eastern Bearded Scrub Robin	<b>f1</b>	W		
<i>Cossypha h. henglini</i>	White-browed Robin Chat	f	W		
<i>Cossypha natalensis</i>	Red-capped Robin Chat	<b>F1</b>	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 visitorsForest 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 II 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 II 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 5 reptile individuals representing 4 species and 3 families were captured in Bombo East II FR. Reptiles were captured over 660 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 II FR.

Family	Common Name	Ecol. type	End. status	Threat Status			No. of individuals captured
				IUCN 2000	UDSM 1997	CITES 2001	
<b>COLUBRIDAE</b>							
<i>Aparallactus weneri</i>	Usambara Centipede Eater	f	N				1
<i>Hemirrhagerrhis nototaenia</i>	Bark Snake	f	N				1
<b>CORDYLIDAE</b>							
<i>Cordylus tropidosternum</i>	Tropical Girdled Lizard	f	W			II	1
<b>GEKKONIDAE</b>							
<i>Lygodactylus luteopicturatus</i>	Yellow-headed Dwarf Gecko	O	N				2
<b>TOTAL</b>							<b>5</b>

#### 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  
 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

Three species captured were categorised as forest dwelling; *Cordylus tropidosternum* (Tropical Girdled Lizard), *Aparallactus weneri* (Usambara Centipede Eater) and *Hemirrhagerrhis nototaenia* (Bark Snake), two of which are near endemic as well. In addition to these two, *Lygodactylus luteopicturatus* (Yellow-headed Dwarf Gecko) is near endemic to the East Usambaras as well (UDSM, 1997, Spawls *et al*, 2002).

Additional observations were made outside, but near Bombo East II 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 31 amphibians were captured during 660 pitfall trapping nights. These individuals represent 4 species and 3 families. Five 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 II 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				16
BUFONIDAE							
<i>Bufo gutturalis</i>	Square-marked Toad	O	W				12
cf. <i>Mertensophryne micranotis</i>	Dwarf Toad	f	NE				1
HEMISOTIDAE							
<i>Hemisis Marrnoratus</i>	Shovel-nosed Frog	f	W				2
<b>TOTAL</b>							<b>31</b>

#### 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

By far the most common capture were the forest dwelling, *Arthroleptis stenodactylus* (Shovel-nosed Squeaker) with over 50% of all captures (52%). Also abundant were *Bufo gutturalis* (Square-marked Toad) (39%). If formally identified, cf. *Mertensophryne micranotis* (Dwarf Toad) a forest dwelling, near endemic species, is an interesting capture.

An additional 5 individuals were captured at base camp, representing three families and four species; *Bufo gutturalis* (Guttural Toad), *Hyperolius tuberilinguis* (Reed Frog), *Afraxalus* 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 are non-forest dependent and widespread species.

#### 5.4.5 Invertebrates

### 5.4.5.1 Butterflies

A total of 83 species of butterflies were captured in Bombo East II FR, using sweep-nets and canopy traps. These species represent 3 families. Forty-one 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 II 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 II FR.

Species	Ecol. type	End. status
NYMPHALIDAE		
Unknown sp. (black and white)	-	-
Unknown sp.	-	-
<i>Acraea</i> sp.	-	-
<i>Acraea esebria esebria</i>	f	W
<i>Acraea natalica natalica</i>	O	W
<i>Bicyclus cf. ena / campinus</i>	F	W
<i>Bicyclus safitza safitza</i>	f	W
<i>Byblia anvatarata acheloia</i>	f	W
<i>Byblia ilithyia</i>	O	W
<i>Charaxes</i> sp.	-	-
<i>Charaxes achaemenes</i>	f	W
<i>Charaxes anticlea suna</i>	F	W
<i>Charaxes aubny aubny</i>	F	W
<i>Charaxes aubny ecletti</i>	F	W
<i>Charaxes berkeley</i>	F	W
<i>Charaxes blanda kenya</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 castor</i>	f	W
<i>Charaxes chepalungu</i>	F	W
<i>Charaxes cithaeron nairobiensis</i>	F	W
<i>Charaxes contrarius</i>	f	NE
<i>Charaxes ethalion</i>	f	W
<i>Charaxes ethalion kikuyensis</i>	f	W
<i>Charaxes etheocles evansi</i>	f	W
<i>Charaxes fionae</i>	O	W
<i>Charaxes hansali baringana</i>	O	W
<i>Charaxes jahlusa kenyensis</i>	f	W
<i>Charaxes tavetensis tavetensis</i>	f	W
<i>Charaxes varanes vologese</i>	f	W
<i>Charaxes viola picta</i>	O	W
<i>Charaxes violetta</i>	f	W
<i>Charaxes zoolina zoolina</i>	O	W
<i>Eurytela dryope angulata</i>	f	W
<i>Hamanumida daedalus</i>	f	W
<i>Hypolimnastis anthedon anthedon</i>	F	W
<i>Libythea labdaca laius</i>	F	W
<i>Melantia leda leda</i>	f	W

Table 31 continued

Species	Ecol.	End. status
---------	-------	-------------

	type	
NYMPHALIDAE continued		
<i>Neptis</i> sp.	-	-
<i>Pentila</i> sp	-	-
<i>Phalanta phalantha aethiopicus</i>	f	W
<i>Pseudacraea lucretia expansa</i>	f	W
<i>Pseudacraea lucretia protracta</i>	f	W
<i>Sallya</i> sp.	-	-
<i>Sallya garega garega</i>	f	W
PAPILIONIDAE		
<i>Catopsilia florella</i>	O	W
<i>Graphium antheus</i>	f	W
<i>Graphium kirbyi</i>	F	W
<i>Graphium leonidas leonidas</i>	O	W
<i>Graphium cf. policeses</i>	F	W
<i>Graphium polistratus</i>	f	W
<i>Graphium portaon mackiei</i>	F	W
<i>Papilio bromius</i>	F	W
<i>Papilio constaninus constaninus</i>	f	W
<i>Papilio dardanus polytrophus</i>	f	W
<i>Papilio dardanus tibullus</i>	F	W
<i>Papilio demodocus demodocus</i>	f	W
<i>Papilio hornimani</i>	F	NE
<i>Papilio jacksoni jacksoni</i>	F	W
<i>Papilio nireus lyaeus</i>	f	W
PIERIDAE		
<i>Belenois</i> sp.	-	-
<i>Belenois aurota aurota</i>	f	W
<i>Belenois calypso minor</i>	F	W
<i>Belenois creona severina</i>	f	W
<i>Belenois thysa thysa</i>	f	W
<i>Belenois victoria victoria</i>	f	W
<i>Catopsilia florella</i>	O	W
<i>Colotis antivippe zera</i>	f	W
<i>Colotis aurigneus aurigneus</i>	f	W
<i>Colotis hildebrandti</i>	O	W
<i>Colotis regina</i>	O	W
<i>Colotis hetaera ankolensis</i>	O	NE
<i>Colotis eundma flotowi</i>	O	W
<i>Colotis danae eupompe</i>	f	W
<i>Colotis evagore antigone</i>	f	W
<i>Colotis euipe omphale</i>	f	W
<i>Dixeia</i> sp.	-	-
<i>Eronia leda</i>	O	W
<i>Eurema floricola orientis</i>	F	W
<i>Eurema hecaba solifera</i>	f	W
<i>Nephronia argia argia</i>	F	W
<i>Nepheronia thalassina</i>	f	W

**KEY TO ABBREVIATIONS FOR TABLE 31**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.

Eighty-six percent of all butterfly species captured in Bombo East II FR were widespread in distribution with only 4% species of near endemic status. Eleven percent are of unknown distribution. Twenty-three percent of butterfly species were forest dependent, 48% forest dwelling, 18% non-forest species, and 11% are of unknown ecological type.

**5.4.5.2 Molluscs**

A total of 175 molluscs were collected in zoological trapsites and opportunistically. Taxonomic determinations were not available at the time of publication. Specimens were deposited at the Zoological Museum of Copenhagen (refer to Appendix 1).

**5.4.5.3 Millipedes**

A total of 58 millipedes were collected in zoological trapsites and opportunistically. Taxonomic determinations were not available at the time of publication. Specimens were deposited at the Zoological Museum of Copenhagen (refer to Appendix 1).

**5.4.6 Distribution of endemic and forest dependent species**

As most endemic and forest dependent species were found within zoological trapsites, their distribution cannot be extrapolated for the whole of the FR. However, fire was the most significant form of disturbance in Bombo East II 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 II FR encompasses 404 ha, thus a small FR. The biodiversity survey nevertheless yielded some interesting results. Species composition within most taxa suggests an open and dry habitat, with few forest dependent and dwelling species recorded. Bombo East II FR maintains a very different habitat 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 (identified to date) and inclusive of casual observations, dung surveys etc.

Taxon	Number of families	Number of species
Mammals (not including bats)	11	19
Bats	2	4
Birds	41	123
Reptiles	3	4
Amphibians	3	4
Butterflies	3	83
<b>TOTAL</b>	<b>63</b>	<b>237</b>

### 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 assume 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 was *Acomys spinosissimus* (Spiny Mouse, 6 individuals captured). Nearly all were captured at trapsite 2 (5 of 6 individuals). In general, trapsite 2 yielded more captures than trapsite 1. Possible reason for this include the beginning of the rainy season when commenced at trapsite 2 and differences in habitat. Trapsite 2 was situated at the edge of the forest and gaps within it close to the top of the FRs highest peak (720 m).

Of the larger mammals, direct sightings of *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 all throughout the FR included *Thryonomys* sp. (Cane Rat) and *Madoqua* sp. (Dikdik).

At trapsite 2, the only trapsite where nocturnal surveys were conducted, *Otolemur crassicaudatus* (Thick-tailed Greater Galago), *Otolemur garnettii* (Small-eared Greater Galago) and *Galagoides zanzibaricus* (Zanzibar Galago) were frequently heard and recorded on tape. All three species were recorded at the edge of lowland forest near the highest point of the FR (720 m). Cryptic nocturnal species are most readily differentiated through their distinct contact and alarm calls.

Only one species of bat was captured within the FR, *Scotophilus nigrita*, whilst three species were captured at basecamp, *Stenonycteris lanosus*, *Lissonycteris angolensis* and *Myotis bocagei*. The most frequently caught species was *Lissonycteris angolensis* with three individuals. The other species were captured once only.

### 5.5.2.2 Birds

Birds encountered more than 3 times during the bird survey are assumed to be abundant and include *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. In fact, at trap site 1 no reptiles were captured at all. Of the four species captured, two were casual observations with *Lygodactylus luteopicturatus* (Yellow-headed Dwarf Gecko) found in a butterfly canopy trap. The onset of the rainy season while surveying Bombo East II FR could be a reason for the temporary absence of reptiles (see Appendix 12: Weather Data).

### 5.5.2.4 Amphibians

Two of the four species captured within the FR were very abundant, whereas the other two were very rare. *Arthroleptis stenodactylus* (Shovel-footed Squeaker) represents the most commonly caught species with 16 individuals captured followed by *Bufo gutturalis* (Square-marked Toad) with 12 individuals. This reflects the onset of the rainy season while survey the FRs fauna (see Appendix 12: Weather Data).

## 5.5.3 Endemics and near-endemics

Of all recorded animals, *Beamys hindei* (Lesser Pouched Rat), *Lygodactylus luteopicturatus* (Yellow-headed Dwarf Gecko) *Aparallactus wernerii* (Usambara Centipede Eater) *Hemirrhagerrhis nototaenia* (Bark Snake) and cf. *Mertensophryne micranotis* (Dwarf Toad) are endemic or near-endemic to the Usambara Mountains. Three bird species are classified as endemic or near endemic; *Tauraco f. fischeri* (Fisher's Turaco.), *Erythrocerus holochlorus* (Little Yellow Flycatcher), and *Emberiza cabanisi* (Cabanis' Bunting).

Four are also forest dependent; *Beamys hindei* (Lesser Pouched Rat), *Lygodactylus luteopicturatus* (Yellow-headed Dwarf Gecko) *Aparallactus wernerii* (Usambara Centipede Eater) and *Erythrocerus holochlorus* (Little Yellow Flycatcher).

## 5.5.4 Forest dependent species

Only one species captured at the two trapsites in Bombo East II FR is forest dependent, *Beamys hindei* (Lesser pouched Rat). It was only recorded twice at both trapsites. The fruit bat, cf. *Stenonycteris lanosus*, captured from basecamp, is also a forest dependent species. Of the larger mammals, not targeted in trapsites, three are forest dependent and include *Colobus angolensis palliatus* (Angola Pied Colobus), *Galagoides zanzibarius* (Zanzibar Galago), and *Cephalophus monticola* (Blue Duiker). All were sighted/heard three or more times during the survey. Seven bird species are 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). No reptile or amphibian species are forest dependent.

*Beamys hindei* (Lesser pouched Rat), and *Erythrocerus holochlorus* (Little Yellow Flycatcher), are 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 II FR can be determined. Due to the nature of the FR's habitat, both forest dependent and forest dwelling species are 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 observed infrequently and are both forest dependent or forest dwelling and endemic or near-endemic are as follows; *Beamys hindei* (Lesser Pouched Rat), *Lygodactylus luteopicturatus* (Yellow-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

Most 237 fauna species captured or observed in Bombo East II FR were non-forest species (50%), 6 mammals, 95 birds, 1 reptile, 1 amphibian and 15 butterflies. This again highlights the fact that the habitat was very open. Only 30 species of all taxa were forest dependent (13%), 4 mammals, 7 birds and 19 butterflies. No reptiles or amphibians captured were forest dependent Table 33 summarises the results.

**Table 33** Summary of ecological type of mammal, bird, reptile, amphibian and butterfly species.

Ecological type	No. of species	% of total species recorded
Forest dependent	30	13
Forest dwelling but not forest dependent	75	32
Non-forest species	119	50
Unknown	13	5
<b>TOTAL</b>	<b>237</b>	<b>100</b>

### 5.5.7 Endemic Status

The vast majority, 90%, of all animal species captured in Bombo East II FR have a widespread distribution (14 mammals, 120 birds, 1 reptile, 3 amphibians and 71 butterflies). Four point five percent of all species are recorded as endemics or near-endemics (1 mammal, 3 birds, 3 reptiles 1 amphibian and 3 butterflies). Table 34 summarises the results.

**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	1	0.5
Near-Endemic: ranges in restricted locations	10	4
Widespread	213	90
Unknown	13	5.5
<b>TOTAL</b>	<b>237</b>	<b>100</b>

### 5.5.8 Threat Status

Species recorded within Bombo East II FR and are listed in the IUCN regulations (Hilton-Taylor, 2000) include *Beamys hindei* (Lesser pouched Rat) as vulnerable (VU), *Colobus angolensis palliatus* (Angola Pied Colobus) as data deficient (DD) and *Galagoideus zanzibaricus* (Zanzibar Galago) as lower risk/near threatened (LR/NT). One bird species is classified as lower risk/near threatened (LR/NT), *Anthreptes reichenowi yohanae* (Plain-backed Sunbird).

Species under CITES regulation include the primates *Papio cynocephalus* (Yellow Baboon), *Colobus angolensis palliatus* (Angola Pied Colobus), *Cercopithecus (a.) pygerythrus* (Vervet Monkey), *Cercopithecus (n.) mitis* (Gentle Monkey), *Otolemur crassicaudatus* (Thick-tailed Greater Galago), *Otolemur garnettii* (Small-eared Greater Galago), *Galagoides zanzibaricus* (Zanzibar Galago) and *Cordylus tropidosternum* (Tropical Girdled Lizard), as well as 13 bird species, are all listed under CITES Appendix II. *Civettictis civetta* (African Civet) and 19 bird species are listed under CITES Appendix III (CITES, 2001). One bird species is listed under Appendix I (*Falco peregrinus minor*, Peregrin Falcon).

## 6.0 CONCLUSIONS

**Authors: Salter, R. and Svoboda, N. pp. 65-66**

This report presents data collected during the baseline biodiversity survey of Bombo East II 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 II Forest Reserve was gazetted in its present shape and size in 2000. The gazetted reserve covers an area of 404 ha, with an altitudinal range of 440 m to 840 m. The forest reserve has altered significantly in recent years 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 II FR, and was recorded in two thirds of all vegetation plots sampled. A comparison of present figures with those of Johannson and Sandy (1996) suggest that fire has significantly reduced forest area in Bombo East II FR. Only four vegetation plots surveyed were recorded with canopy heights greater than 10 m. Open grass-/bushland and woodland habitats dominated 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 grazing and associated paths were low in Bombo East II FR. Areas of particularly high levels of disturbance were mainly the eastern and western areas of the forest reserve near to the reserve borders. No evidence of pitsawing was found.

### 6.2 Species Richness

Bombo East II FR was found to contain a minimum of 89 species of plant, 19 mammal, 4 bat, 123 bird, 4 reptile, 4 amphibian and 83 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 Surveys, Bombo East II FR had 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 II 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

No endemic plant species was recorded in the vegetation plots but five had ranges restricted to the Eastern Arc and/or East African lowland forests. Two species were dependent on primary forest, none of which was endemic or near endemic to the Usambara Mountains. Eleven non-forest tree and shrub species were established within the reserve boundaries.

#### 6.4 Fauna

Eleven animal species were listed as endemic or near endemic to the Usambara Mountains. Thirty fauna species were forest dependent, many of which were butterflies.

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

Of particular interest were the records of *Aterelix albiventris* (White-bellied African Hedgehog), the first confirmed record for the Usambara Mountains, and *Taterillus emini* (Taterillus Gerbil), a new record for the East Usambara Mountains.

#### 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 II Forest Reserve and increased protection and discussion with the local communities are required to prevent future disturbance destroying the patches of forest that remain. Further degradation of forest habitats in Bombo East II 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 II 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 II forest reserve is not 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 re-instil a sense of responsibility amongst younger and less knowledgeable generations, to inure the importance of the remaining forest is known. This will go some way towards helping the sustainable management of the forest reserve. Small-scale environmental education activities during the survey went some way to promote such an idea.. Bombo East II FR is thought to be a very suitable location for the implementation of Joint Forest Management activities. Surrounding communities have well organised and active village and environmental committees.

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## 8.0 APPENDICES

### Appendix 1: Taxonomic Verification

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## Appendix 2: GPS Co-ordinates of vegetation plots

Summary of GPS Coordinates of vegetation plots in Bombo II FR.

Vegetation Plot	Longitude	Latitude	Grid Ref. 37M	Grid Ref. UTM
0	03840'07.8''	0448'30.3''	0463279	9468552
1	03840'22.3''	0448'30.3''	0463724	9468554
2	03840'36.6''	0448'30.5''	0464165	9468547
3	03840'51.4''	0443'30.3''	0434620	9468555
4	03839'39.4''	0448'51.8''	0462404	9467891
5	no reading	no reading	no reading	no reading
6	03840'07.7''	0448'49.4''	0463276	9467966
7	03840'22.4''	0448'46.3''	0463726	9468061
8	03840'36.7''	0448'45.4''	0464167	9468089
9	03840'51.4''	0448'44.4''	0464619	9468120
11	03839'54.1''	0449'06.3''	0462856	9467447
12	03840'08.4''	0449'04.7''	0463297	9467497
13	03840'22.4''	0449'02.6''	0463729	9467560
14	3840'36.8''	0449'00.1''	0464172	9467640
15	03840'51.1''	0448'58.9''	0464611	9467677
16	03841'05.6''	0448'57.7''	0465059	9467712
17	03840'16.7''	0449'17.3''	0463550	9467056
18	03840'31.0''	0449'12.7''	0463992	9467196
19	03840'36.8''	0449'14.7''	0464427	9467190

### Appendix 3: General vegetation plot descriptions

Summary of vegetation plot descriptions in Bombo II FR.

Plot Number	Topography	Altitude (masl)	Slope (degrees)	Vegetation Condition	Canopy Height (m)	Disturbance Category	Features of Interest	No. species	No. Indivs	Dominant sp.
0	SMS	640	15	Open woodland	<10	Fire	None	5	18	<i>Acacia sieberiana</i>
1	SUS	670	3	Open woodland	<10	Fire	None	4	20	<i>Acacia sieberiana</i>
2	SUS	70	17	Lowland forest	10-20	Fire	None	8	17	<i>Combretum molle</i>
3	GMS	560	11	Lowland forest	<10	Fire / Cutting	None	6	26	<i>Scorodophloeus fischeri</i>
4	SMS	715	32	Open woodland	<10	Fire	Rock outcrops	2	3	<i>Lecaniodiscus fraxinifolius</i>
5	GMS	801	23	Open woodland	<10	Fire	Rock outcrops	4	13	<i>Acacia sieberiana</i>
6	GUS	780	34	Open woodland	<10	Fire	Rock outcrops	6	15	<i>Combretum molle</i>
7	Gully	670	43	Lowland forest	<10	None	Rock outcrops	4	8	<i>Scorodophloeus fischeri, Manilkara sulcata</i>
8	SUS	660	27	Lowland forest	<10	Fire	Rock outcrops	2	11	<i>Acacia hockii</i>
9	SUS	490	18	Lowland forest	<10	Fire	Rock outcrops	6	20	<i>Commiphora africana</i>
11	Valley floor	600	8	Lowland forest	10-20	Cultivation	Track	10	22	<i>Ceiba pentandra</i>
12	SUS	680	25	Open woodland	<10	None	None	8	20	<i>Acacia sieberiana</i>
13	SMS	600	35	Open woodland	<10	None	Rock outcrops	7	13	<i>Stereospermum kunthianum</i>
14	Gully	450	1	Open woodland	10-20	Fire	Rock out crops	6	13	<i>Lannea stuhlmannii</i>
15	GUS	520	10	Open woodland	<10	Fire	None	5	13	<i>Combretum zeyheri</i>
16	Lowland plain	460	11	Lowland forest	10-20	Cutting	None	14	39	<i>Acacia nilotica</i>
17	GMS	540	14	Lowland forest	<10	None	Gullies	5	6	<i>Scorodophloeus fischeri,</i>
18	GLS	460	0	Lowland forest	<10	Fire	None	5	11	<i>Combretum zeyheri</i>
19	GLS	500	10	Open woodland	<10	Fire	None	7	18	<i>Combretum molle, Acacia hockii</i>

## 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 II FR.

### VEGETATION PLOT TREES AND SHRUBS

ANACARDIACEAE	<i>Ozoroa insignis reticulata</i> (Rak. F) J.B. Gillet 1980
COMBRETACEAE	<i>Combretum exalatum</i> Engl. 1895
EUPHORBIACEAE	<i>Spirostachys africana</i> Sond 1850
LEGUMINOSAE subfamily:	<i>Acacia sieberiana</i> DC.
MIMOSOIDEAE	
UMBELLIFERAE	<i>Steganotaenia araliacea</i> Hochst. 1844

### OPPORTUNISTIC COLLECTION AND OBSERVATION

#### Angiospermae – Dicotyledonae

ACANTHACEAE	<i>Dyschoriste hildebrandtii</i> Lindau. ex. O.B. Clark.
APOCYNACEAE	<i>Carissa tetramera</i> (Sacl) Stapf
CAPPARIDACEAE	<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.
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 II FR defined by Ruffo *et al.* (1989) & Luoga *et al.* (2000).

	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*
<i>Commiphora eminii zimmermanni</i> (Engl.) J.B. Gillet 1991 (basionym. <i>C Zimmermannii</i> Engl.)										Wooden cups
COMBRETACEAE										
<i>Combretum molle</i> R.Br. ex. G. Don 1827		*								Charcoal*
<i>Combretum schumannii</i> Engl. 1894	+	+		+				+		
<i>Combretum zeyheri</i> Sond. 1850		*								Charcoal*
CAPPARIDACEAE										
<i>Maerua triphylla</i> A.Rich									*	
LEGUMINOSAE subfamily:										
CAESALPINACEAE										
<i>Afzelia quanzensis</i> Welw.	*									
LEGUMINOSAE subfamily:										
PAPILIONOIDEAE										
<i>Dalbergia melanoxyton</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	+	+	+			+		+		
MELIACEAE										
<i>Turraea holstii</i> Guerke 1894.						+				

**Appendix 5** continued

OCHNACEAE

*Ochna thomasiana* Engl. & Gilg. ex. Gilg <sup>1</sup> +

RUTACEAE

*Zanthoxylum* sp <sup>1</sup> +

SAPINDACEAE

*Lecaniodiscus fraxinifolius* Baker\* \*

*Deinbollia borbonica* Scheff 1869 Withies

*Haplocoelum inopleum* Radlk. +

TILIACEAE

*Grewia bicolor* Juss. 1804 + \* Rituals\*

+ Ruffo *et al* (1989),

\* Luoga *et al.* (2000)

**Bold type** – Opportunistic collection

<sup>1</sup>Species also recorded in the regeneration layer.

## Appendix 6: Medicinal plants

Summary of Medicinal Plants recorded in Bombo II 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.B. Kokwaro 1980*	Mumbu	Wounds and ulcers
	<i>Rhus natalensis</i> Bernh. ex. Krauss	Mhunguu	Infertility
BIGNONIACEAE	<i>Kigelia africana</i> Benth.	<b>Mlegea</b>	<b>Infertility, Gonorrhoea</b>
	<i>Stereospermum kunthianum</i> Cham. 1832	Mkande	Infertility
BURSERACEAE	<i>Commiphora eminii zimmermannii</i> (Engl.) Gillett 1991	Mnyakwa	Preventing abortion
	<i>Commiphora africana</i> (A.Rich) Engl.*	Mbambaa	Mammary glands, hernia
COMBRETACEAE	<i>Combretum schumannii</i> Engl. 1894	Mkongolo	Epilepsy
	<i>Terminalia sambesiaca</i> Engl. & Diels	Mkurungo	Infertility
COMPOSITAE	<i>Brachylaena huillensis</i> D. Hoffm 1902*	Mkarambati, Muhuhu	Schistosomiasis
EUPHORBIACEAE	<i>Spirostachys africana</i> Sond 1850*	Mshaaka	Purgative
	<i>Margaritaria discoidea</i> (Baill) Webster 1867	Mkwambawa Nyika	Convulsions
LEGUMINOSAE subfamily: MIMOSOIDEAE	<i>Acacia nilotica</i> Delile.*	Mtusi	Diarrhoea, menstrual pain, hernia
	<i>Albizia anthelmintica</i> Brongn 1860*	Mfusetta	Cough, chest pain
	<i>Dichrostachys cinerea</i> (L.) Wight & Arn*	Kukulagembe	Snake bites, diarrhoea, male libido
LEGUMINOSAE: subfamily PAPILIONACEAE	<i>Dalbergia melanoxylon</i> Guill & Perr*	Mpingo	Hernia, worms, stomach disorders



MORACEAE	<i>Ficus</i> sp.	Mkuyu	Preventing abortion
<b>Appendix 6</b> continued			
SAPINDACEAE	<i>Deinbollia borbonica</i> Scheff 1869*	<b>Mtamba</b>	<b>Heart problems, abdominal boils</b>
TILIACEAE	<i>Grewia forbesii</i> <b>Harv.*</b>		<b>Headache &amp; worms</b>
UMBELLIFERAE	<i>Steganotaenia 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 II 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
0	Open woodland	40	50	0	10	90	10	0	0	Sandy-loam	Dark brown	0	0	0	0
1	Open woodland	30	50	0	20	90	10	0	0	Sandy-loam	Dark brown	0	1	0	1
2	Lowland forest	30	30	0	40	95	5	0	0	Sandy-loam	Dark brown	3	4	3	3
3	Lowland forest	10	10	80	0	50	50	0	0	Loamy-clay	Brown	18	48	4	4
4	Open woodland	60	30	0	10	80	20	0	0	Loamy-clay	Dark grey	0	0	0	0
5	Open woodland	30	50	0	20	95	5	0	0	Loamy-clay	Black	0	0	0	0
6	Open woodland	20	20	0	60	90	10	0	0	Loamy-clay	Dark grey	2	5	2	4
7	Lowland forest	60	40	0	0	95	5	0	0	Sandy-loam	Brown	1	1	1	1
8	Lowland forest	50	20	0	30	90	10	0	0	Sandy-loam	Dark grey	3	9	3	3
9	Lowland forest	40	40	0	20	80	20	0	0	Sandy-loam	Black	0	1	0	1
11	Lowland forest	50	20	30	0	70	30	0	0	Loamy-clay	Dark brown	4	3	2	2
12	Open woodland	20	30	0	50	95	5	0	0	Sandy-loam	Dark brown	0	2	0	1
13	Open woodland	20	20	0	60	85	15	0	0	Rocky	Dark grey	2	7	1	2
14	Open woodland	80	20	0	0	95	5	0	0	Loamy-clay	Dark brown	0	0	0	0
15	Open woodland	20	40	0	40	70	30	0	0	Sandy-loam	Black	0	0	0	0
16	Lowland forest	10	40	50	0	20	80	0	0	Clay	Red brown	26	39	3	3
17	Lowland forest	70	30	0	0	85	15	0	0	Loam	Dark brown	0	0	0	0
18	Lowland forest	80	20	0	0	95	5	0	0	Loamy-clay	Brown	3	6	2	4
19	Open woodland	50	25	0	25	80	20	0	0	Sandy-loam	Dark brown	6	7	3	4

## Appendix 8: Mammal capture data

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

Species	Number of individuals caught in trapsites 1 & 2 (sampling intensity in Sherman trap nights)		No. of individuals captured	No. of recaptures
	1	2		
	(999)	(992)	(1991)	
<b>SORICIDAE</b>				
<i>Crocidura</i> sp.	-	1	1	-
<i>Crocidura</i> cf. <i>hildegardeae</i> (White-toothed Shrew)	-	1	1	-
<i>Crocidura</i> cf. <i>hirta</i> (White-toothed Shrew)	2	1	3	-
<i>Crocidura</i> cf. <i>tansaniana</i> (White-toothed Shrew)	1	-	1	-
<b>CRICETOMYINAE</b>				
<i>Beamys hindei</i> (Lesser Pouched Rat)	1	1	2	3
<i>Taterillus emini</i> (Taterillus Gerbil)	-	2	2	-
<b>MURIDAE</b>				
<i>Acomys spinosissimus</i> (Spiny Mouse)	1	5	6	16
<i>Grammomys</i> cf. <i>dolichurus</i> (Narrow-footed Woodland Mouse)	3	-	3	9
<i>Mus minutoides</i> (Common Mouse)	1	2	3	-
<b>TOTAL</b>	<b>9</b>	<b>13</b>	<b>22</b>	<b>28</b>

**8b** Summary of bat capture at bat-netting sites in Bombo East II FR and base camp (refer to Table 21)

Species	Number of individuals caught in bat net sites 1 and 2 (sampling intensity in net square meter hours)		Total no. individuals captured (sampling intensity in net square meter hours)
	1 (135)	2 (198)	
<b>PTEROPODIDAE</b>			
cf. <i>Stenonycteris lanosus</i>	1	-	1
<i>Lissonycteris angolensis</i>	3	-	3
<b>VESPERTILIONIDAE</b>			
<i>Myotis bocagei</i>	1	-	1
<i>Scotophilus nigrita</i>	-	1	1
<b>TOTAL</b>	<b>5</b>	<b>1</b>	<b>6</b>

## Appendix 9: Reptile capture data

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

Species	Number of individuals caught in traps at trapsites 1 & 2 (Sampling intensity per trapsite; bucket pitfall nights)		Casual collections	Total no. individuals captured (Sampling intensity)
	1	2		
	(330)	(330)		
<b>GEKKONIDAE</b>				
<i>Lygodactylus luteopicturatus</i>	-	-	2	2
<b>CORDYLIDAE</b>				
<i>Cordylus tropidosternum</i>	-	1	-	1
<b>COLUBRIDAE</b>				
<i>Aparallactus weneri</i>	-	1	-	1
<i>Hemirrhagerrhis nototaenia</i>	-	-	1	1
<b>TOTAL</b>	-	2	3	5

## Appendix 10 : Amphibian capture data

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

Species	Number of individuals caught in traps at trappingsites 1 & 2 (Sampling intensity per trappingsite)		Casual collections	Total no. individuals captured* (Sampling intensity)
	1 (330)	2 (330)		
<b>ARTHROLEPTIDAE</b>				
<i>Arthroleptis stenodactylus</i>	14	2	-	<b>16</b>
<b>BUFONIDAE</b>				
<i>Bufo gutturalis</i>	10	2	-	<b>12</b>
cf. <i>Mertensophryne micranotis</i>	1	-	-	<b>1</b>
<b>HEMISOTIDAE</b>				
<i>Hemisus mArnoratus</i>	1	1	-	<b>2</b>
<b>Total</b>	<b>26</b>	<b>5</b>	<b>-</b>	<b>28</b>

\*May include recaptures

## Appendix 11: Butterfly capture data

**11:** Summary of butterfly capture in canopy traps at zoological trapsites 1 and 2 in Bombo East II FR (refer to Tables 19 and 20 for trapsite locations, descriptions and sampling intensity).

Species	Number of individuals caught in canopy traps Trapsites 1 & 2 (sampling intensity in butterfly trap days)		No. of specimens taken	Total no. of individuals captured (Sampling intensity) (100)
	1	2		
	(50)	(50)		
<b>NYMPHALIDAE</b>				
Unknown sp.	1	0	1	1
<i>Acraea</i> sp.	1	1	2	2
<i>Acraea esebria esebria</i>	0	1	1	1
<i>Acraea natalica natalica</i>	2	0	0	2
<i>Bicyclus</i> cf. <i>ena</i> / <i>campinus</i>	0	1	1	1
<i>Bicyclus safitza safitza</i>	3	3	0	6
<i>Byblia anvatarachelonia</i>	2	1	0	3
<i>Byblia ilithia</i>	2	4	0	6
<i>Charaxes</i> sp. (black and white)	13	4	0	17
<i>Charaxes</i> sp.	4	0	1	4
<i>Charaxes achaemenes</i>	2	0	1	2
<i>Charaxes anticlaea suna</i>	1	0	0	1
<i>Charaxes aubnyi aubnyi</i>	2	0	1	2
<i>Charaxes aubnyi ecletti</i>	2	0	1	2
<i>Charaxes berkeley</i>	2	0	0	2
<i>Charaxes blanda kenya</i>	3	0	0	3
<i>Charaxes bohemani</i>	3	3	0	6
<i>Charaxes brutus angustus</i>	86	6	0	92
<i>Charaxes candiope candiope</i>	18	0	0	18
<i>Charaxes castor castor</i>	11	1	0	12
<i>Charaxes chepalungu</i>	17	0	0	17
<i>Charaxes cithaeron nairobiensis</i>	1	2	0	3
<i>Charaxes contrarius contrarius</i>	47	2	0	49
<i>Charaxes ethalion</i>	2	0	0	2
<i>Charaxes ethalion kikuyensis</i>	2	0	0	2
<i>Charaxes etheocles evansi</i>	1	0	0	1
<i>Charaxes fionae</i>	1	0	0	1
<i>Charaxes hansali baringana</i>	7	1	0	8
<i>Charaxes jahlusa kenyensis</i>	35	9	0	44
<i>Charaxes tavetensis tavetensis</i>	1	0	1	1
<i>Charaxes varanes vologese</i>	11	3	0	14
<i>Charaxes viola picta</i>	2	0	0	2
<i>Charaxes violetta</i>	1	1	2	2
<i>Charaxes zoolina zoolina</i>	18	0	0	18
<i>Eurytela dryope angulata</i>	5	0	0	5
<i>Hamanumida daedalus</i>	0	4	0	4
<i>Hypolimnias anthedon anthedon</i>	2	0	1	2
<i>Libythea labdaca laius</i>	3	0	2	3

**Appendix 11** cont.

Species	Number of individuals caught in canopy traps Trapsites 1-4 (sampling intensity in butterfly trap days)		No. of specimens taken	Total no. individuals captured
	1 (50)	2 (50)		
<b>NYMPHALIDAE</b> cont				
<i>Melantis leda leda</i>	16	1	1	17
<i>Neptis</i> sp.	1	0	1	1
<i>Pentila</i> sp	0	1	1	1
<i>Phalanta phalantha aethiopicus</i>	0	13	1	13
<i>Pseudacraea lucretia expansa</i>	0	1	1	1
<i>Pseudacraea lucretia protracta</i>	1	2	1	3
<i>Sallya</i> sp.	1	0	0	1
<i>Sallya garega garega</i>	1	0	1	1
<b>PAPILIONIDAE</b>				
<i>Graphium antheus</i>	3	2	0	5
<i>Graphium kirbyi</i>	1	0	0	1
<i>Graphium leonidas leonidas</i>	2	1	1	3
<i>Graphium</i> cf. <i>poliaces</i>	0	10	2	10
<i>Graphium polistratus</i>	1	1	0	2
<i>Graphium portaon mackiei</i>	1	0	1	1
<i>Papilio bromius</i>	1	0	1	1
<i>Papilio constaninus constaninus</i>	6	2	0	8
<i>Papilio dardanus polytrophus</i>	4	2	0	6
<i>Papilio dardanus tibullus</i>	0	1	0	1
<i>Papilio demodocus demodocus</i>	5	13	0	18
<i>Papilio hornimani</i>	1	2	2	3
<i>Papilio jacksoni jacksoni</i>	0	1	1	1
<i>Papilio nireus lyaeus</i>	1	0	1	1
<b>PIERIDAE</b>				
<i>Belenois</i> sp.	0	5	1	5
<i>Belenois aurota aurota</i>	1	0	0	1
<i>Belenois calypso minor</i>	0	1	1	1
<i>Belenois creona severina</i>	5	15	0	20
<i>Belenois thysa thysa</i>	1	0	0	1
<i>Belenois victoria victoria</i>	1	0	1	1
<i>Catopsilia florella</i>	3	0	2	3
<i>Colotis antivippe zera</i>	0	1	0	1
<i>Colotis aurigneus aurigneus</i>	0	2	0	2
<i>Colotis hildebrandti</i>	1	0	0	1
<i>Colotis regina</i>	4	1	0	5
<i>Colotis hetaera ankolensis</i>	3	9	0	12
<i>Colotis eundma flotowi</i>	2	1	0	3
<i>Colotis danae eupompe</i>	2	0	0	2
<i>Colotis evagore antigone</i>	3	0	0	3
<i>Colotis euipe omphale</i>	5	6	0	11
<i>Dixeia</i> sp.	1	0	1	1
<i>Eronia leda</i>	1	0	1	1
<i>Eurema floricola orientis</i>	2	2	0	4

**Appendix 11** cont.

Species	Number of individuals caught in canopy traps Trapsites 1-4 (sampling intensity in butterfly trap days)		No. of specimens taken	Total no. individuals captured
	1 (50)	2 (50)		
PIERIDAE cont.				
<i>Eurema hecaba solifera</i>	0	1	<b>0</b>	<b>1</b>
<i>Nepheronia argia argia</i>	0	2	<b>1</b>	<b>2</b>
<i>Nepheronia thalassina</i>	8	10	<b>2</b>	<b>18</b>



## Appendix 12: Weather Data

12 Rainfall and Temperature data for Bombo II FR

Trap no.	Date	Rain (mm)	Temperature (°c)	
			Min	Max
TS1	2/25/02	5	20	43
TS1	2/26/02	21	31	18
TS1	2/27/02			
TS1	2/28/02	0	21	34
TS1	3/1/02	13	21	33
TS1	3/2/02	4.5	19	31
TS1	3/3/02	18	18	30
TS1	3/4/02	16	23	32
TS1	3/5/02	29	21	30
TS1	3/6/02	15	22	28
	3/7/02			
	3/8/02			
TS2	3/9/02	0	22	32
TS2	3/10/02	5	22	32
TS2	3/11/02	0	22	30
TS2	3/12/02	33	20	29
TS2	3/13/02	<1	22	29
TS2	3/14/02	3	23	27
TS2	3/15/02	0	22	30
TS2	3/16/02	0	22	30
TS2	3/17/02	0	23	34
TS2	3/18/02	0	22	33

## 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.

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