

TECHNICAL PAPER 34

Longuza (north) Forest Reserve

A biodiversity survey

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

East Usambara Catchment Forest Project

Technical Paper 34

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A biodiversity survey

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East Usambara Catchment Forest Project (EUCFP)

The East Usambara rain forests are one of the most valuable conservation areas in Africa. Several plant and animals 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 Catchment Forest Project aims at establishing the Amani Nature Reserve; protecting water sources; establishing and protecting forest reserves; sustaining villager's benefits from the forest; and rehabilitating the Amani Botanical Garden. The project 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.

The Society for Environmental Exploration (SEE)

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

Frontier Tanzania Forest Research Programme (FT FRP)

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

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FOREWORD

The East Usambara forests in north-eastern Tanzania are part of the Eastern Arc mountains. More than one hundred years of biological interest and research has shown that these forests have a unique diversity of flora and fauna, and an exceptionally high degree of endemism. They are globally listed as one of the biodiversity hotspots and centres of plant diversity, and recognized as among the most valuable conservation areas in Africa. Since 1990, the East Usambara Catchment Forest Project (EUCFP) has worked in the East Usambaras 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 implementation support from the Finnish Forest and Park Service (FPS).

Although a considerable amount of biological information exists from the East Usambaras much of this is restricted to the Amani area and systematic surveys are few. In order to get more comprehensive information on the forests biodiversity surveys were initiated and contracted by EUCFP 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 EUCFP. 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 of priorities in the conservation of this valuable area.

The surveys have been carried out over ten-week field phases. The programme involves short-term expatriate volunteer research assistants, permanent EUCFP, Frontier, 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 Usambaras. EUCFP 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 will be entered in this database, which is linked to the national biodiversity database and will become operational in 1997.

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 a better management and conservation of the East Usambaras so that the beauty of the area will continue to amaze coming generations and that the light in the tunnel will become the bright future.

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Abstract

Longuza forest reserve is situated in the East Usambara mountains in north-east Tanzania. The East Usambaras form part of the mountain chain called the Eastern Arc which ranges from southern Kenya to southern Tanzania. These mountains are known for their high levels of species endemism and rich floral and faunal diversity (Hamilton, 1989). To investigate further this biodiversity, a biological survey of Longuza forest reserve was conducted with a socio-economic component between October and December 1995 for a total of 51 research-days.

This report summarises the findings of the survey in terms of floral and faunal inventories. Notes on ecological requirements and degree of endemism for each species is presented to provide an indication of the number of (a) forest dependent species as opposed to forest non-dependent and non-forest species; (b) threatened and rare species (based on IUCN 1994 criteria¹) and (c) endemics and near-endemics² to the Usambara mountains. These are presented so as to highlight the importance of Longuza forest reserve in a national and international context. These three categories are then combined to assess which species are considered at high risk of becoming locally extinct if the forest continues to be further degraded and fragmented.

The survey identified 106 species of tree and shrub, 10 species of mammal, 9 species of reptile and 1 species of amphibian.

Flora

No species were recorded which are endemic to the Usambara mountains but 25 have restricted ranges limited to the Eastern Arc and/or East African lowland forests. Twenty species were found to be dependent on primary forest, and of these species, nine are also near-endemic to the Usambara mountains. Eighteen non-forest tree and shrub species are established within the reserve boundaries.

Species of particular interest encountered during this survey include:

- *Nesogordonia holtzii* is considered a coastal endemic tree (Hawthorne, 1993). The occurrence of this species in the Usambaras may represent a range extension however the full description of this species has yet to be published.

1 All IUCN notes are based on IUCN 1994 criteria for species as compiled by the National Biodiversity Database in the Department of Zoology and Marine Biology, UDSM, Dar es Salaam. Definitions are as follows:
Endangered - a species facing a very high risk of extinction in the wild in the near future.
Vulnerable - a species facing a high risk of extinction in the wild in the medium-term future.
Near threatened - species which are close to qualifying for the status 'Vulnerable.'

2 Endemic - Species occurring only in the Usambara mountains
Near-endemic - Species with limited ranges in the Eastern Arc mountains and/or the East African lowlands between Somalia and Mozambique (Iversen, 1991b).

Fauna

No species were recorded which are endemic and only one species was recorded as near-endemic to the Usambara mountains. Three species are dependent on primary forest. One species is established inside the forest reserve that is a non-forest species. This is *Rattus rattus*.

Species of particular interest encountered during this survey include:

- The Nile monitor, *Varanus niloticus*, was observed. This species, as are all members of the Varanidae, is on the CITES Appendix II list of endangered animals;
- *Eptesicus flavescens*, collected in Longuza, is a first record for Tanzania. It has only previously been recorded in Angola and Burundi;
- *Crotaphopeltis tornieri*, is listed as 'Vulnerable' by IUCN.

Soils

Human disturbance and proximity to a permanent water course appear to be major contributing factors affecting soil type. The differences between areas sampled relate to their relative nutrient status thus changes, especially from human disturbance, will likely affect the vegetation it is able to support.

Disturbance

Pole extraction appears to be a low threat to the reserve as the highest level occurs in an area which is already heavily degraded. Past resource extraction most likely accounts for the present degradation observed.

Timber extraction is likely to be the greatest threat to the ecology of the small remnant of forest remaining in the central area of the reserve as the highest level of timber extraction was recorded in this region.

Few faunal specimens were captured so it is not possible to relate disturbance to the distribution of forest dependent, endemic and near-endemics species. However, the invasive species, the common rat, *Rattus rattus*, appeared in forest as well as previously disturbed areas.

Socio-economics

Longuza forest is a low altitude reserve. Because of this, it is an easily accessible area for the local people in terms of utilising forest resources. Encroachment is occurring from all sides leaving a small remnant patch in the middle of the reserve. Even this forested area however is under pressure. Some alternatives have been introduced to nearby areas such as tree planting but these efforts are small in scale and have only recently been implemented. Such projects are important though for providing alternatives to forest products especially in light of the growing population.

1.0 INTRODUCTION: EAST USAMBARA AND FOREST DIVERSITY

The East Usambara mountains are situated in north-east Tanzania, close (40 km) to 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 which 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 uplift (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 south-east of the mountains, increasing from 1,200 mm annually in the foothills to over 2,200 mm at the higher altitudes. Because of the topographical and climatic interactions, the western slopes are drier compared to the eastern slopes. Due to their age, isolation and their function as condensers of the moisture from the Indian Ocean, they support ancient and unique forests, rich in endemic species (Hamilton, 1989).

Research in the East Usambara mountains began in the late 1890's with substantial botanical collections being undertaken. Later, in 1928, surveys were undertaken on amphibians and by the 1930's detailed ornithological work had begun. Biological research in the mountains has steadily increased over the years since. More recently, work in the area has also included an attempt to understand the drainage and catchment value of the mountain's forests (Bruen, 1989; Litterick, 1989).

The East Usambara forests have been likened to the African equivalent of the Galapagos Islands in terms of their endemism and biodiversity (Rogers & Homewood, 1982; Howell, 1989). They are considered to be one of the most important forest blocks in Africa, if not the most important (Tye, 1994). Currently, around 2,800 taxa of plants have been recorded of which it is suggested that over one quarter are endemic or near-endemic (Iversen, 1991). Many are threatened (Rodgers, 1996).

In addition to the biodiversity value is the drainage and catchment value of the East Usambara forests. The forests play an important role in maintaining the hydrological cycle which feeds the Sigi River. The Sigi 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 more irregular run off and in a deterioration in water quality due to siltation.

The latest survey of the area, conducted by Johansson & Sandy (1996) shows that approximately 45,137 ha of the East Usambaras 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 850 m.

Hyytiäinen (1995) classifies these two forest types into three categories³: (1) dense forest; (2) poorly stocked forest; and (3) cultivated forest, according to the density of the forest and the degree of human involvement. In the East Usambaras, submontane forest occupies 12,916.6 ha (30.7%), lowland forest occupies 29,497.4 ha (62.9%), and forest plantations occupy 2,723.6 ha (6.5%). 21,900 ha are presently gazetted forest reserves. The remainder, 35,909 ha (43%) of the East Usambaras is classified as agricultural land; woodland; grassland; ponds; rivers; barren land; and settlements (Johansson & Sandy, 1996).

The mammals of the East Usambaras show limited endemism (Collar & Stuart, 1987). However, there are several species of special interest. These include: the restricted Black and Rufous Elephant Shrew, *Rhynchocyon petersi*, which is common in the Usambaras (Collar & Stuart, 1987) yet listed as globally 'Endangered' by IUCN due to a decline in habitat extent and quality; Abbott's Duiker, *Cephalophus spadix*, listed as 'Vulnerable' (Groombridge, 1993); and the Lesser Pouched Rat, *Beamys hindei* about which insufficient information is available to determine its status (IUCN 1996).

There are at least 24 species of reptiles and amphibians endemic to the East Usambaras (Rodgers & Homewood, 1982). This series of surveys provide further information on new species and species' range extensions. A new species of snake, *Prosymna semifasciata*, was recently found in Kwamgumi forest reserve (Broadley, 1995), and a range extension for the endemic frog, *Hoplophryne rogersi*, was recorded at Bamba Ridge forest reserve (Cunneyworth & Stubblefield, 1996b).

The forest avifauna of the East Usambaras is remarkable in its diversity with 110 species, the highest recorded in this part of Africa (Stuart, 1989). Six species occurring in the lowland forests are considered threatened with global extinction: Sokoke Scops Owl, *Otus ireneae*; the endemic Usambara Eagle Owl, *Bubo vosseleri*; Swynnerton's Robin, *Swynnertonia swynnertoni*; East Coast Akalat, *Sheppardia gunningi*; Amani Sunbird, *Anthreptes pallidigaster*; and the Banded Green Sunbird, *Anthreptes rubritorques* (Collar *et al.*, 1994).

The East Usambaras are essentially forest 'islands' (Lovett, 1989). There has been natural forest in the area for thousands, if not millions, of years. These forests have been under continuous exploitative human pressure for at least 2,000 years (Schmidt, 1989). Until recently, especially in the past 50 years, (Kikula, 1989), this pressure has been 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 (Collar & Stuart, 1987). The Usambaras harbour many species which 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

³

1. Dense forest: uneven-aged, more or less disturbed natural forest which has a species composition characteristic to the original forest type & has an unbroken crown cover.
2. Poorly stocked forest: a variety of primary or secondary forests which are poorly stocked because of various natural or man-made reasons. They are forests with low density, fairly open crown cover, modest volume and dominant height less than in dense forests belonging to the same forest type.
3. Cultivation under forest: encroached areas which still have at least moderate forest cover.

After Hyytiäinen (1995)

extinct over much of their former area (Iversen, 1991). The conservation and preservation of this unique area of biodiversity should be given high priority.

2.0 AIMS OF THE SURVEY

The specific aims of the survey as outlined in the Terms of Reference between Frontier Tanzania Forest Research Programme and the East Usambara Catchment Forest Project are:

- to conduct biological baseline surveys in selected gazetted forests and in forests which are proposed for gazettement;
- 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 develop a system for monitoring aspects of forest biodiversity, both on a general as well as a forest-specific level.

Furthermore, the aims of the survey methods applied are:

- to sample the vegetation and tree species composition of six forests of the East Usambaras using systematic sampling techniques along systematically located vegetation transects, which sample approximately 0.5% in 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 standard and repeatable methods to record biodiversity values of the forest in terms of small mammal species, reptiles, amphibians, and invertebrate species;
- to collect opportunistic data on all other groups of vertebrate and invertebrates. Species lists resulting from this will be compared against standard appraisals of species rarity and other values in order to assess the overall biodiversity values of each forest.
- to undertake a socio-economic appraisal of the impact of resource-use activities by human communities in the vicinity of each forest and produce a brief assessment of how these activities affect the integrity of the forests.

Consequently, this survey will provide standardised and repeatable methods to assess the biodiversity values of the forests to enable their importance to be determined and permit biodiversity value to be monitored through time.

3.0 DESCRIPTION OF THE FOREST

3.1 General description

Longuza forest reserve is located in the East Usambara Mountains, Tanzania at the grid reference 38°41'E 5°02'S. Administratively, Longuza falls under the Muheza district.

Longuza forest reserve is situated in the Sigi valley in the central area of the East Usambaras (Figure 1). Longuza is a relatively flat area with an altitudinal range between 95 m at the east side of the reserve to 345 m near the western boundary. The Sigi river, Tanga town's main source of water, is the reserve's eastern boundary. Several seasonal rivers also flow through the reserve (Figure 2). The reserve has been under high exploitative pressure and consequently is degraded with large areas of bush, thicket and woodland. Only a small remnant mature forest patch still exists. Longuza north is contiguous with the teak plantation of the southern part of the reserve. Longuza north only is considered in this report.

The most recent survey of the area, was carried out by Hyytiäinen (1995), and updated by Johansson & Sandy (1996). The results for Longuza north and south are summarised in Table 1 below. Longuza north can be classified as 'poorly stocked forest', forest with low density, fairly open crown cover due to various natural and artificial factors.

Table 1. Land use distribution (Johansson & Sandy, 1996).

Forest Class	Area (ha)	Percent (%)
Dense lowland forest	271.3	17.2
Poorly stocked lowland forest	725.8	45.9
Cultivation under lowland forest	0.6	0.0
Teak plantations	543.8	34.4
Peasant cultivation	2.9	0.2
Ponds and rivers	32.4	2.1
Settlement	3.1	0.2
Total for the reserve	1,579.9	100.0%

3.1.1 History and status

Once part of the extensive forest ecosystem covering most of the East Usambara mountain range, Longuza has steadily been encroached (Hamilton, 1989). Longuza Estate was established on the site and later, in 1954, the area was gazetted as a forest reserve. Between 1961 and 1979, over 1603 hectares in the area, including the southern part of the forest reserve, was converted to teak (*Tectona grandis*) plantation and limited numbers of *Terminalia*, managed by the Longuza Forest Project. Planting of teak and *Terminalia ivorensis* was suspended in 1979 (FINNIDA, 1985) and thinning begun.

Table 2. Status of Longuza forest reserve.

Name	Status	Current Size (ha)	Gazettment Notice and Date	Maps
Longuza	Forest Reserve	1579.9	GN 194. 1954	JB.172, 115

No Figure / Map Currently Available in Digital Format

Figure 1. The location of Longuza forest reserve in relation to other East Usambara forests.

No Figure / Map Currently Available in Digital Format

Figure 2. Topographical map.

4.0 SOILS

By Leigh Stubblefield

4.1 Introduction

On a separate contract, the National Soil Service (NSS) carried out a combined soil and vegetation survey of Longuza forest reserve. The objectives of the study were to assess the nature and distribution of different soil types (Shaka and Msangi, 1996).

4.2 Methods

A total of 18 vegetation analysis plots were established in a grid system, each measuring 450 m x 450 m. Soil samples were taken from the south-west corner of each of these vegetation plots between altitudes of 165 m and 345 m. The floristic composition of a 50 m x 20 m subplot, also located in the south-west corner of the larger vegetation plot, was analysed in terms of tree species density and tree species dominance.

A total of 18 soil-auger hole observations were made to a depth of 150 cm where possible. Data was recorded on the soil cores extracted by the auger according to FAO (1977) guidelines for describing soil profiles. Furthermore, soil colour was described using the 'Munsell notation'. Soil samples were taken from the surface horizon at a depth between 0-25 cm, and from the subsoil, at a depth between 25-50 cm. These samples were analysed at the NSS Central Laboratory to determine the following properties: soil texture; pH; total nitrogen; organic carbon; available phosphorus; cation exchange capacity; and exchangeable calcium, potassium, magnesium and sodium.

4.3 Results

Altitudinal variation was limited in the reserve and topography varied between undulating lower slopes with slope gradients ranging from 10-20% to steeper upper slopes ranging, on average, from between 25-35%. In general, there appeared to be no relationship between soil type and catenary position. Soils on steeper slopes were very prone to severe erosion if vegetation cover had previously been removed.

The soil depths in Longuza ranged from shallow (<20 cm) to very deep (>120 cm) though the majority were moderately deep (40-80 cm). All were well drained. As would be expected, the deeper soils were found on mid- to lower slopes. The shallow soils were not correlated with catenary position but were found in flat, rocky areas. Rock outcrops were common throughout the reserve. Soil texture was dominantly clay. Sandy clay loams grading to clays were commonly found down the profile. Soils were variable from dark reddish brown to dark red or red.

Soil reaction, measured by pH, was variable ranging from very strongly acid (4.5-5.0) to neutral (6.6-7.3). The dominant soil reaction was slightly acid (6.1-6.5). The soils were non-saline. Organic carbon and total nitrogen were found to decrease moving down the soil profile. Levels of organic carbon were variable ranging from very high to high (>3.5-2.5%) in topsoils and decreasing to low levels (0.6-1.25%) in subsoils.

Levels of total nitrogen were found to be medium (0.2-0.5%) decreasing to low (0.1-0.2%) in all soils sampled. The carbon to nitrogen ratio indicates that the organic matter was of sufficient quality to enable net mineralisation. Levels of available phosphorus were found to be low (<7 mg/kg) in all soils sampled.

The cation exchange capacity (CEC) indicates the ability of a soil to retain and supply nutrients for plant uptake. In general the CEC of the soils sampled was found to be medium. In approximately 20% of the soils the CEC was found to be low. These were generally soils with lower clay content or situated in areas of higher human disturbance. This indicates the negative impact of human disturbance on soil nutrient status. In the majority of soils (83%) the level of exchangeable calcium was found to be high or very high. Levels of exchangeable magnesium ranged from high in topsoils, to medium in subsoils. Levels of exchangeable potassium were found to be predominantly medium to low. The level of exchangeable bases decreased markedly with increasing soil depth.

The majority of the sample plots support lowland forest. The eastern boundary of the reserve is marked by the Sigi river with two smaller watercourses passing near the central plots. In these plots the vegetation is dominated by typical riparian elements. The western boundary of the reserve has experienced significant human disturbance, largely in the form of cattle grazing. The floristic composition in this area is therefore significantly different, due to inhibition of regeneration, and is characterised by open woodland and wooded grassland.

4.4 Discussion

The soils sampled from the soil plots in Longuza are largely similar to the soils studied in other East Usambara forests, such as Magoroto, Bamba Ridge and Mlungui (Cunneyworth & Stubblefield, 1996a,b,c). They are moderately deep to deep, well drained, acidic, red clays which can be classified as Ferralsols (FAO, 1988). These soil properties are characteristic of sedentary soils developed on weathered granitoid gneiss (Holmes, 1995), the parent material underlying the soils of Longuza. The results of the pH tests reflect the nature of this parent material. The soils are acidic due to the high quartz content of the gneiss.

The soil surface horizons are generally sandy clay loams in texture which grade into clays down the soil profile. The parent material, gneiss, has contributed to the silty nature of the soil. The soils on the western boundary are sandy clay loams which also grade into clays in the subsoil. These coarser surface elements may be the result of sedimentary deposits from the water courses which run through the reserve.

The soils sampled were reddish brown becoming more red down the profile. This is typical of tropical forest soils, particularly the Rhodic Ferralsols, which are sedentary soils formed *in situ* and subject to heavy weathering. These are characterised by a red colour due to high levels of aluminium and iron sesquioxides since other more soluble bases are washed down the profile (Holmes, 1995), and the inorganic fraction is consequently low in available nutrients.

Soils were darker in colour in the surface horizon. This is due to the natural incorporation of surface organic matter. The incorporated organic matter is important

in maintaining both the soil structure and nutrient levels since the Ferralsols have an inherently low nutrient status due to heavy weathering. For the East Usambaras, the nutrient holding capacity of these soils is directly related to organic matter content (Milne, 1937; Hamilton, 1989). This explains why the level of exchangeable bases was found to decrease markedly on moving down the soil profile.

The organic matter quality of the soils sampled is considered good. However, Hamilton (1989) states that this apparently high soil fertility is misleading since it is sustained by a very fragile cycling of nutrients between soils and vegetation. Any disruption to this cycle, therefore, will result in the rapid loss of nutrients and lead to soil impoverishment. The soils of Longuza generally support forest which have experienced some levels of human disturbance. However, on steeper slopes accelerated soil erosion was observed. This has implications for future levels of human disturbance which may reduce the protective vegetation cover and expose the soils to an increased risk of erosion and leaching.

It appears that soil type is not as important an influence on floristic composition as the proximity to a permanent water course and the effects of human disturbance. In general, dense riparian forest is found bordering the rivers and streams in the reserve. In other areas, the vegetation comprised both moist and dry lowland forest elements, though moist forest elements are more abundant. Disturbance has been most significant around the western boundary of the reserve which has experienced long-term encroachment, largely in the form of cattle grazing. The vegetation in this area is largely woodland and wooded grassland, with a few remnant forest elements. The cation exchange capacity of the soils in this area was low indicating soil impoverishment. Thus, any change in soil type, particularly relating to nutrient status, appears likely to influence the vegetation it supports and this should be considered when monitoring Longuza forest reserve.

5.0 BOTANY

5.1 Introduction

A survey of the major vegetation types within the forest reserve was undertaken to quantify the extent and distribution of forest types and their species composition. 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 studied. Data collected by this survey will be entered onto the EUCFP data base in Tanga.

5.2 Methods

The forest block is divided into grid squares which are measured and marked in the field. The methods used during this survey are detailed in the FT FRP methodologies report (SEE, 1996). A brief description is presented below. The location of vegetation plots and disturbance transects are illustrated in Figure 3.

5.2.1 Forest structure

Two methods were used to analyse forest structure: (1) quantitative vegetation analysis and (2) disturbance transects.

5.2.1.1 Quantitative vegetation analysis

A 450 m grid system was constructed throughout the forest on transect lines using boundary tape to mark the lines. A sample plot size of 50 m x 20 m was sampled in each grid square, giving an approximate sampling intensity of 0.5%. Within the sample plot, every tree with a dbh (diameter at breast height) of 10 cm and over was recorded, tagged and identified. Botanists from the Tanzanian Forestry Research Institute (TAFORI) and from the University of Dar es Salaam (UDSM) provided the field identification of plant species.

5.2.1.2 Disturbance transects

Disturbance transects provide an estimate of pole cutting and logging in a forest block. The disturbance transects were based on the 450 m x 450 m grid squares constructed for the vegetation plot analysis. Each transect running north-south was sampled from boundary to boundary. Every self-standing tree and sapling (i.e. not lianas or creepers) above 1 cm dbh was measured within an area 2.5 m either side of each transect line. Each plant was recorded under one of two categories: cut or naturally fallen and then subdivided to those less than 10 cm dbh or equal to or greater than 10 cm. These divisions represent differences in usage extraction. The smaller are considered poles and the larger are considered timber. The percentages of each category were then calculated to estimate their relative abundance.

Due to limitations of this method, one number representing the average cut and naturally fallen poles and timber per 100 m is given for the entire transect. The data are unable to be broken down into more meaningful units.

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Figure 3. Location of vegetation plots and disturbance transects.

5.3 Results

5.3.1 Quantitative vegetation analysis

Table 3 presents a checklist of the tree and shrub species recorded in the 20 m x 50 m vegetation plots. Species are described, where adequate information exists, in terms of their ecological type, their habitat and their endemic status.

Table 3. Checklist of trees and shrubs.

Species	Ecological type	Habitat ²	Endemic status
Anacardiaceae			
<i>Lannea schweinfurthii stuhlmannii</i>	f		W
<i>Lannea welwitschii</i>	F	L	N
<i>Sclerocarya birrea caffra</i> ¹	O		W
<i>Sorindeia madagascariensis</i>	f		W
Annonaceae			
<i>Annona senegalensis</i>	f		W
<i>Xylopiya parviflora</i>	f	L	W
Apocynaceae			
<i>Funtumia africana</i>	F	L & S	W
Araliaceae			
<i>Cussonia zimmermannii</i>	f	L (forest gaps)	N
Bignoniaceae			
<i>Fernandoa magnifica</i>	f	L	N
<i>Markhamia lutea</i>	f	L & S (forest gaps)	W
<i>Markhamia obtusifolia</i>	O		W
<i>Stereospermum kunthianum</i>	f		W
Bombacaceae			
<i>Bombax rhodognaphalon</i>	f		N
Boraginaceae			
<i>Ehretia amoena</i>	O		W
<i>Ehretia</i> sp.	?		?
Burseraceae			
<i>Commiphora eminii</i> ssp. <i>zimmermannii</i>	f	L	N
Celastraceae			
<i>Maytenus undata</i>	f	S	W
Combretaceae			
<i>Combretum schumannii</i>	f	L	N
<i>Terminalia sambesiaca</i>	f	L	W
Dracaenaceae			
<i>Dracaena steudneri</i> ¹	f	S (forest gaps)	W
Ebenaceae			
<i>Diospyros kabuyeana</i>	f		N
<i>Diospyros mespiliformis</i>	f	L	W
<i>Diospyros natalensis</i>	f	L	W
<i>Diospyros squarrosa</i> ¹	?	L	W
<i>Diospyros</i> sp.	?		?
Euphorbiaceae			
<i>Bridelia cathartica</i>	f	L & S	W
<i>Bridelia micrantha</i>	f	L & S	W
<i>Croton sylvaticus</i>	f	L	W

Table 3 (cont.)

Species	Ecological type	Habitat ²	Endemic status
<i>Drypetes usambarica</i>	f	S	N
<i>Euphorbia candelabrum</i>	O		W
<i>Euphorbia nyikae</i>	O		N
<i>Flueggea virosa</i>	f		W
<i>Margaritaria discoidea</i>	f		W
<i>Ricinodendron heudelotii</i>	f	L	W
Lecythidaceae			
<i>Barringtonia racemosa</i>	f	L	W
Leguminosae subfamily:			
Caesalpinaceae			
<i>Azelia quanzensis</i>	f	L	W
<i>Dialium holtzii</i>	f	L	N
<i>Julbernardia magnistipulata</i>	f	L	N
<i>Piliostigma thonningii</i>	O		W
<i>Scorodophloeus fischeri</i>	f	L	N
<i>Senna singueana</i>	O		W
Leguminosae subfamily: Mimosaceae			
<i>Acacia robusta</i>	f		W
<i>Acacia</i> sp.	?		?
<i>Albizia adianthifolia</i>	f		W
<i>Albizia glaberrima</i>	f	L	W
<i>Albizia gummifera</i>	f	L	W
<i>Albizia schimperana</i>	F		N
<i>Dichrostachys cinerea</i>	O		W
<i>Entada pursaetha</i> ¹	f		W
<i>Newtonia paucijuga</i>	F	L	N
<i>Parkia filicoidea</i>	F	L & S	W
Leguminosae subfamily: Papilionaceae			
<i>Angylocalyx braunii</i>	F	L	N
<i>Craibia brevicaudata</i>	f	L	N
<i>Dalbergia lactea</i>	f		W
<i>Lonchocarpus bussei</i>	O		W
<i>Lonchocarpus cappasa</i> ¹	O		W
<i>Millettia oblata</i>	F		N
<i>Millettia stuhlmannii</i> ¹	O		W
<i>Millettia usaramensis</i>	f		W
<i>Ormocarpum muricatum</i> ¹	O		W
<i>Pterocarpus tinctorius</i>	F	S & L	N
Loganiaceae			
<i>Anthocleista grandiflora</i>	f		W
<i>Strychnos madagascariensis</i>	f		W
<i>Strychnos mitis</i>	F		W
<i>Strychnos stuhlmanii</i> ¹	O		W
Meliaceae			
<i>Khaya anthotheca</i> ¹	F		W
<i>Trichilia emetica</i>	f		W
Moraceae			
<i>Antiaris toxicaria</i>	f	L & S	W
<i>Dorstenia kameruniana</i>	f	L	W
<i>Ficus exasperata</i>	f	L & S	W
<i>Ficus usambarensis</i>	O		N
<i>Ficus</i> sp.	?		?
<i>Milicia excelsa</i>	f	L & S	W

Table 3 (cont.)

Species	Ecological type	Habitat ²	Endemic status
<i>Streblus usambarensis</i>	F		W
Olacaceae			
<i>Olax dissitiflora</i> ¹	f		W
<i>Ximenia</i> sp.	?		?
Pandanaeae			
<i>Pandanus stuhlmannii</i>	O		W
Rubiaceae			
<i>Breonadia salicina</i>	F		W
<i>CreMASpora triflora</i>	f		W
<i>Crossopteryx febrifuga</i>	O		W
<i>Leptactina platyphylla</i>	f		W
<i>Oxyanthus speciosus</i>	F	S (forest gaps)	W
<i>Rothmannia manganjae</i>	F	L & S	W
<i>Vangueria infausta</i>	f		W
Sapindaceae			
<i>Allophylus calophyllus</i> ¹	?		?
<i>Allophylus rubifolius</i>	O		W
<i>Allophylus stachyanthus</i>	F	L	N
<i>Blighia unijugata</i>	F	L & S	W
<i>Lecaniodiscus fraxinifolius</i>	F	L	W
<i>Zanha golungensis</i>	F	L & S	W
Sapotaceae			
<i>Bequaertiodendron natalense</i>	f	L & S	W
<i>Manilkara sulcata</i>	f	L	W
<i>Pachystela msolo</i>	F	L & S	W
Simaroubaceae			
<i>Harrisonia abyssinica</i>	f		W
Sterculiaceae			
<i>Cola microcarpa</i>	F		N
<i>Dombeya cincinnata</i> ¹	?		?
<i>Dombeya shupangae</i>	O		N
<i>Nesogordonia holtzii</i> ¹	?		N
<i>Sterculia appendiculata</i>	F	L	W
Tiliaceae			
<i>Grewia bicolor</i>	f		W
<i>Grewia calymmatosepala</i>	F		N
<i>Grewia goetzeana</i>	f	L	N
<i>Grewia microcarpa</i>	f		W
Ulmaceae			
<i>Celtis gomphophylla</i>	F	L	W
<i>Celtis wightii</i>	f	S	W
Violaceae			
<i>Rinorea ferruginea</i>	F		W

¹ Species which do not appear in Iversen (1991). Summary information is based on Ruffo *et al.* (1989), Lovett (1993) or the *Flora of Tropical East Africa*.

² Information is based on Ruffo *et al.* (1989).

KEY TO ABBREVIATIONS FOR TABLE 3

Ecological type (based on Iversen, 1991):

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Habitat: (based on Hamilton, 1989)

- L - Lowland: Species occurring at altitudes of <850 m;
- S - Submontane: Species occurring at altitudes of >850 m.

In the case where species occur in both lowland and submontane habitats, the most common habitat will be listed first and only this habitat will be counted in the summary statistics. If a species is common in forest gaps, rather than in the forest proper, this will also be noted.

Endemic status: (based on Iversen, 1991):

- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges in the Eastern Arc mountains and/or the East African lowlands between Somalia and Mozambique.
- W - Widespread distribution.

EU - Range limited to the East Usambaras; WU - Range limited to the West Usambaras
 ? Insufficient data

Species accumulation rates:

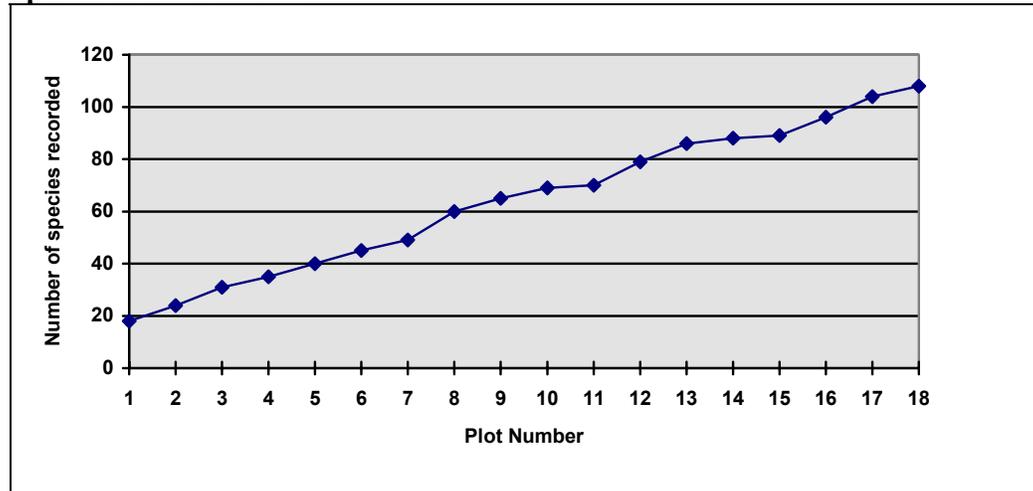


Figure 4. Species accumulation rates for tree and shrub species by vegetation plot.

The summary information for the following species found in Longuza was described by Ruffo *et al.* (1989). This information is presented in Table 4 to further describe their ranges in the East Usambaras.

Table 4. Trees found outside their previously recorded range in the East Usambaras.

Species	Location as previously recorded
<i>Cussonia zimmermannii</i>	noted as only on Mhinduro and Mtai
<i>Diospyros natalensis</i>	noted as only on Mhinduro and Mtai
<i>Maytenus undata</i>	restricted to the northern end of the East Usambara range
<i>Cola microcarpa</i>	Mtai forest reserve

Ecological type (refer to Figures 5,6,7,8):

Table 5. Summary of ecological type for tree and shrub species (based on Table 3).

Ecological type	Number of species	% of total species
(F) Forest dependent	24	22.6
(f) Forest dwelling but not forest-dependent	55	51.9
(O) Non-forest	18	17.0
Unknown	9	8.5
Total:	106	100.0

Habitat (refer to Figures 9 and 10):

Table 6. Summary of habitat for tree and shrub species (based on Table 3).

Habitat	Number of species	% of total species
(L) Lowland Species	42	87.5
(S) Submontane Species	6	12.5
Total:	48	100.0

Table 7. Submontane species occurring in lowland areas and the altitudes where they were recorded.

Species name	Altitude recorded
<i>Maytenus undata</i>	165
<i>Celtis wightii</i>	175, 185, 200
<i>Oxyanthus speciosus</i>	190
<i>Drypetes usambarica</i>	180, 210
<i>Dracaena steudneri</i>	210

Endemic status (refer to Figures 11 and 12):

Table 8. Summary of endemic status for tree and shrub species (based on Table 3).

Endemic status	Number of species	% of total species
(E) Endemic	0	0
(N) Near Endemic	25	23.6
(W) Widespread	74	69.8
Unknown	7	6.6
Total:	106	100.0

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Figure 5. Distribution of forest dependent tree and shrub individuals.

No Figure / Map Currently Available in Digital Format

Figure 6. Distribution of forest dependent tree and shrub species.

No Figure / Map Currently Available in Digital Format

Figure 7. Distribution of non-forest tree and shrub individuals.

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Figure 8. Distribution of non-forest tree and shrub species.

No Figure / Map Currently Available in Digital Format

Figure 9. Distribution of submontane tree and shrub individuals.

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Figure 10. Distribution of submontane tree and shrub species.

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Figure 11. Distribution of near-endemic tree and shrub individuals.

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Figure 12. Distribution of near-endemic tree and shrub species.

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Figure 13. Vegetation of Longuza forest reserve.

5.3.2 Disturbance transects

Five disturbance transects were recorded for pole and timber extraction during the survey. The results are summarised in Table 9 for poles and Table 10 for timber. The terms pole and timber are used in this section only as this method examines the forest in terms of its extractive value. Poles are defined as <10 cm dbh and timber as ≥ 10 cm dbh.

Table 9. Disturbance transect results for pole counts.*

Transect number	Transect length (m)	Total poles sampled	Cut poles	Average per 100 metres	Naturally fallen poles	Average per 100 metres
1	1450	992	128	17.6	864	119.2
2	1550	409	64	8.2	345	44.6
3	1750	388	92	10.6	296	33.8
4	1760	154	76	8.6	78	8.8
5	675	118	27	0.8	91	27.0

* Due to differences in methods, the results under 'Average per 100 metres' are doubled to allow direct comparisons with other forest reserves in this series of surveys.

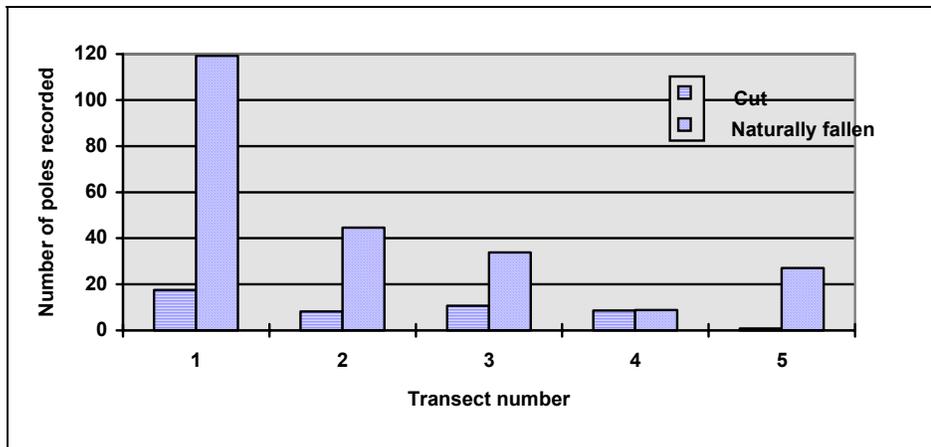


Figure 14. Cut and naturally fallen poles recorded per 100 metres of transect.

Table 10. Disturbance transect results for timber counts.*

Transect number	Transect length (m)	Total timber sampled	Cut timber	Average per 100 metres	Naturally fallen timber	Average per 100 metres
1	1450	77	24	3.4	53	7.4
2	1550	64	4	0.6	60	7.8
3	1750	202	68	7.8	134	15.4
4	1760	103	20	2.2	83	9.4
5	675	26	4	1.2	22	6.6

* Due to differences in methods, the results under 'Average per 100 metres' are doubled to allow direct comparisons with other forest reserves in this series of surveys.

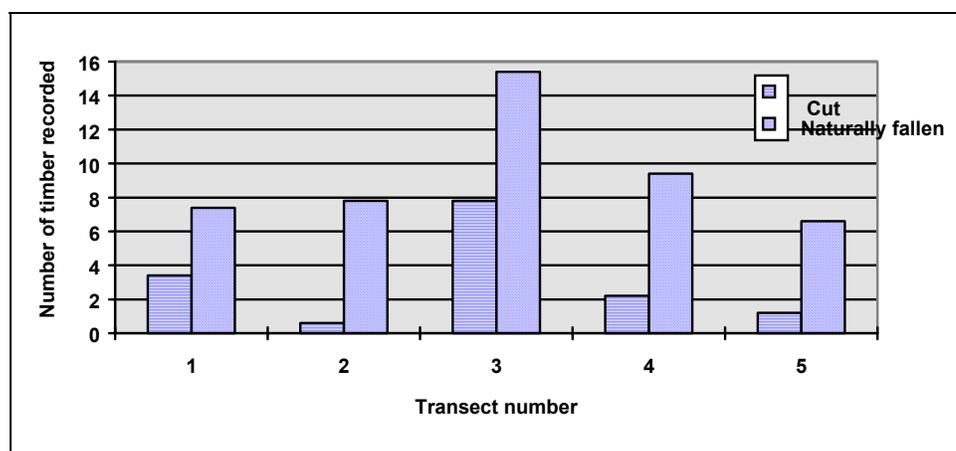


Figure 15. Cut and naturally timber recorded per 100 metres of transect.

Table 11. Other human disturbance recorded in the forest on an *ad lib.* basis other than pole and timber cutting.

Transect number	Disturbance
1	2 pitsaws; fire (plot 3,4)
2	1 pitsaw (plot 10); fire (plot 1,2); hunting-gunshot (near plot 10);
3	1 pitsaw; villagers carrying black and white colobus monkey
4	3 traps (plot 16); cattle grazing; people carrying mushrooms and other plants
5	fire (plot 13)

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Figure 16. Areas of highest disturbance in relation to the distribution of tree and shrub individuals that are both forest dependent and near-endemic.

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Figure 17. Areas of highest disturbance in relation to the distribution of tree and shrub species that are both forest dependent and near-endemic.

5.4 Summary

Longuza forest reserve covers an area of approximately 1,000 ha with altitudes ranging from 95 to 345 m. The number of trees and shrubs surveyed was 693, representing 106 species from 28 families.

Of the 18 plots systematically surveyed, 4 (22.2%) were recorded as mature mixed forest, 9 (50.0%) as colonising, poorly stocked forest or formerly disturbed, 3 (16.7%) as open woodland, 2 (11.1%) as bushland/thicket.

Species Accumulation Rates

The species accumulation rate shows no decline in the rate that new species were recorded. The checklist of trees and shrubs 10 cm dbh and larger in Table 3 is thus far from complete.

Ecological Type

Forest dependent species, defined as limited to primary forest only, were recorded 118 times. This represents 22.6% of all specimens recorded. Forest dependent individuals are distributed throughout the reserve except near the south-east and in the north-west corner. The south-east corner is characterised by open forest/previously disturbed and the north-west by woodland. The highest density of the forest dependent trees occurs in the central area of the forest. The most common forest dependent tree is *Lecaniodiscus fraxinifolius*. Nine of the forest dependent species are also near-endemic to the Usambaras.

Eighteen non-forest species were recorded in 72.2% of the plots (13 plots). *Dombeya shupangae* is the most common non-forest species. This species is typical of forest edges, clearings, secondary forest and woodland areas (Iversen, 1991).

Habitat

As expected from a low altitude reserve, almost 90% of the tree species surveyed with known altitude characteristics were considered to be typical of lowland forest with the remaining species typical of submontane forest. The majority of submontane species were found mainly in the central area of the reserve with a small number being recorded next to the Sigi river.

Endemic Status

Of the plant species recorded, 73 (68.9%) have widespread distributions. Near-endemics contribute 25 species (23.6%) from 13 families to the floristic composition of the reserve. These near-endemics account for 181 (26.1%) of the surveyed trees and shrubs and are found throughout the reserve except near the south-east corner. Of the 18 plots surveyed, 6 (33.3%) were found to have >10 near-endemics. The most common near-endemic in the reserve is *Diospyros kabuyeana*, a wet evergreen forest tree which also occurs in forest edges, clearings and secondary forest (Iversen, 1991). Of these 25 near-endemic species of Longuza, nine species are also considered to be forest dependent. Two of these appear to be locally uncommon as they were recorded

in Longuza but not in the other reserves in this series of surveys (Cunneyworth & Stubblefield, 1996a,b,c; Cunneyworth, 1996a,b). These are: *Allophylus stachyanthus* and *Grewia calymmatosepala*. These species are typical wet evergreen forest trees (Iversen 1991).

No endemic species were recorded in the reserve.

Range Extensions

Nesogordonia holtzii is a coastal endemic (Hawthorne, 1993). This species may also represent a range extension however the FTEA has not yet been published for this family.

Disturbance

Disturbance by pole and timber extraction were recorded at lower rates than naturally fallen trees. Other disturbances, such as pitsaws, fire, and traps were observed on all the transects in the reserve. For the reserve as a whole, cut poles were found at levels between 0.4 and 8.8 per 100 m. Cut timber occurred at the rate of 0.3 to 3.9 per 100 m.

The highest concentration of pole extraction was recorded on the east side of the reserve next to the Sigi river. This area is characterised as open forest/previously disturbed. Two pitsaws were also seen in this area in addition to evidence of fire.

The highest concentration of timber extraction was recorded on the central transect. This transect cuts through the only area of the reserve where mature mixed forest remains.

The disturbance was found to range from light to heavy according to location. The reserve as a whole appears to be under pressure not only from timber and pole removal but also from hunting and livestock grazing. Encroachment is, at present, occurring from all boundaries. Large areas of woodland and scrubland exist, leaving only a remnant forested area in the centre of the reserve.

6.0 ZOOLOGY

6.1 Introduction

The faunal biodiversity of Longuza forest reserve was investigated using standard, repeatable, survey methods. Studies on small mammals, birds, bats, reptiles, amphibians and various invertebrate groups were carried out. In line with the specific aims of the survey, an inventory of all fauna encountered was compiled. This data was analysed to assess the biodiversity value of the area.

6.2 Methods

All methods used during the expedition survey are outlined in detail in the FT FRP methodologies report (SEE, 1996). A brief description is presented below. The location of trap sites are presented in Figure 17.

6.2.1 Mammals

Four different methods are used to sample the mammal community within Longuza forest reserve: (1) snap trap lines, (2) bucket pitfalls, (3) bat netting and (4) opportunistic observations.

6.2.1.1 Snap-trap lines

In order to sample the community of rodents, small and large break-back traps (snap-traps) were used. Typically the traps were set out in transect lines of approximately 50, with traps positioned at least 2 m apart. However, this was not always possible due to the nature of the habitat. The traps were set each evening and checked early the following morning. A bait of fried coconut and peanut butter was used. Previous forest surveys indicate that this bait is very successful in terms of catch numbers and species diversity (Stanley, *pers. comm.*). Each mammal caught was weighed and measured. Trapping and biometric data was recorded on standardised data sheets. Unless otherwise indicated, specimens were identified by Prof. Kim Howell or by Dr. Dieter Kock (see Appendix 2).

6.2.1.2 Bucket pitfall trapping

The bucket pitfall traps consist of ten 20 litre plastic buckets sunk flush to ground level in a linear transect. These were positioned approximate 2.5 m apart. A continuous piece of plastic sheeting ran perpendicular to the ground across the centre of each bucket forming a “runner”. A lip of plastic sheeting, a drift fence, was kept on the ground on to which soil and leaf litter was placed. An animal was, therefore, channelled along the plastic to one of the buckets. The bucket pitfalls, acting as live traps, were designed for sampling a community of shrews within the forest. Each mammal captured was weighed and measured. Trapping and biometric information was recorded on standardised data sheets. Unless otherwise indicated, taxonomic identification was made by Prof. K. Howell, Dr. Dieter Kock or Dr. William Stanley (see Appendix 2).

6.2.1.3 Bat netting

Bat mist netting was used to collect and study a representative sample of the forest bat community, and also provide data on species' ranges. Mist nets were placed near potential roosts sites and across obvious flight "corridors", such as paths and rivers. Nets were set up at dusk, observed continuously throughout the night and closed shortly before dawn. Each bat caught was weighed and measured at the netting site. Trapping and biometric information was recorded on standardised data sheets. Unless otherwise indicated, taxonomic identification was made by Prof. K. Howell or Dr. Dieter Kock (see Appendix 2).

6.2.1.4 Mammal observations

Other vertebrate species were recorded on an opportunistic basis throughout the survey.

6.2.2 Reptiles

The aim of this study was to collect and identify a representative sample of the forest reptile community. The community of ground-dwelling reptiles was sampled using the bucket pitfall method (see 6.2.1.2 above). Opportunistic captures were also conducted by hand, and a snake stick where necessary. Unless otherwise indicated, taxonomic identifications were made by Prof. Kim Howell or Prof. Don Broadley (see Appendix 2).

6.2.3 Amphibians

The aim of this study was to collect and identify a representative sample of the forest amphibian community. The community of ground-dwelling amphibians was sampled using the bucket pitfall method (see 6.2.1.2 above). Opportunistic captures were also conducted, especially in reference to tree frog collections since they are often beyond capture with the bucket pitfalls. After rain, typical amphibian habitats were targeted for sampling. Unless otherwise indicated, taxonomic identifications were made by Prof. Kim Howell or by Prof. John Poynton (see Appendix 2).

6.2.4 Invertebrates

6.2.4.1 Invertebrate pitfall trapping

This method was used to sample the invertebrate ground (forest floor) dwelling community. Four 1.5 litre pots were sunk flush with the level of the ground. Plastic sheeting was erected between the pots using wood stakes to keep the plastic sheeting perpendicular to the ground surface. A lip of plastic sheeting was kept on the ground on to which soil and leaf litter was placed. The pots were placed in a star arrangement with one central pot and the other three set so that the plastic sheeting was positioned at an angle of 120° from the next line of plastic sheeting. Each length of plastic sheeting was 2.5 m. Approximately 1/4 litre of 10% formalin is put in each pot. A few drops of washing-up liquid was added to reduce surface water tension. The trap was then left for 5 days before collection. Specimens were identified and sorted to order level in the field. These specimens were sent for curation at the Zoological Museum, University of Copenhagen. Specific groups are then be sent on to individual taxonomists.

6.3 Trapping sites and sampling intensity

Six trapping sites were conducted in various habitats. Table 12 describes the sites and Table 13 and 14 summarise the sampling intensity for each site and for each trapping method.

Table 12. Summary descriptions of trapping sites.

Plot Number	Vegetation type	Altitude (m)	Topography	Slope (degrees)
1	colonising lowland forest	190	gentle upper slope	30
2	previously disturbed lowland forest	95	riverine	0
8	mature mixed lowland forest	105	gentle lower slope	0
9	colonising lowland forest	185	mid-slope	10
16	lowland forest with dense understory	150	steep lower slope	20
17	mature mixed lowland forest	160	mid-slope	5

Table 13. Sampling intensity by trap night (number of traps x number of nights).

Trapping method	Plot 1	Plot 2	Plot 8	Plot 9	Plot 16	Plot 17
Small snap traps	0	0	0	520	0	0
Large snap traps	546	546	750	0	750	750
Live traps	0	72	146	0	0	0
Bucket pitfall traps*	164	0	0	0	0	182
Invertebrate pitfall traps**	16	0	0	16	0	0

* Each bucket of the bucket pitfall as one trap night.

** Each trap array of 4 pots is considered one trap night

Table 14. Summary of bat-netting sites.

Site description	Sampling intensity (hours)	Altitude	Topography
Over Sigi River	36	95	bottom of hill (riverine)
Cave in Plot 5	12	200	ridge top

No Figure / Map Currently Available in Digital Format

Figure 18. Location of trapping sites.

6.4 Results

6.4.1 Mammals (non-bat)

Seven specimens were retained for taxonomic purposes however, these have not been identified thus far.

Five species from five families were observed but not retained for taxonomic purposes. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997) and Kingdon (1989).

Table 15. Summary of mammal observations.

Species	Certainty	Ecological type	Endemic status	IUCN status	Observation locations
Muridae					
<i>Rattus rattus</i>	definite	O	W		plot 2,16
Cricetidae					
<i>Beamys hindei</i>	definite	f	N	DD	plot 2,8,9
Viverridae					
<i>Nandinia binotata</i>	definite	f	W		plot 5
<i>Genetta</i> sp.	definite	?	?		plot 5
Primates					
<i>Cercopithecus mitis</i>	definite	f	W		plot 1, 5, 8,18, 10

KEY TO ABBREVIATIONS FOR TABLE 15 (Definitions based on those described in the botanical section of this report).

Ecological type:

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic status:

- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:

- DD - Data Deficient

OR - Refers to observations outside but in proximity to the reserve to be considered associated to it.

? - No data available

Certainty: Indicates the probability of the correctness of the identity of the species observed;

Definite: Can be regarded as occurring in the reserve.

Probable: Identification is likely but requires further information before being considered on the reserve's species list.

No Figure / Map Currently Available in Digital Format

Figure 19. Distribution of near-endemic mammal species.

6.4.2 Bats

Five individuals were retained for taxonomic purposes. These specimens represent five species from three families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997), Howell (1993) and Kingdon (1989).

Table 16. Summary of bats.

Species	Ecological type	Endemic status	IUCN status	Capture location and number collected		
				Plot 5	Over Sigi River	Total
MICROCHIROPTERA						
Rhinolophidae						
<i>Rhinolophus deckenii</i>	f	W	LC		1	1
<i>Rhinolophus eloquens</i>	?	W			1	1
Vespertilionidae						
<i>Pipistrellus nanus</i>	f	W			1	1
<i>Eptesicus flavescens</i>	?	W		1		1
Molossidae						
<i>Tadarida (Mops) brachyptera</i>	?	W		1		1

KEY TO ABBREVIATIONS FOR TABLE 16 (Definitions based on those described in the botanical section of this report).

Ecological type:

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic status:

- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:

- LC - Least concern

? - No data available

6.4.3 Reptiles

Six individuals were retained for taxonomic purposes. These specimens represent six species from three families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997), Broadley and Howell (unpubl.), Howell (1993); and Branch (1994).

Table 17. Summary of reptiles.

Species	Ecological type	Endemic status	IUCN status	Capture location by plot and number captured				
				1	8	9	17	Total
Colubridae								
<i>Prosymna stuhlmannii</i>	?	W		1				1
<i>Aparallactus guentheri</i>	F	W		1				1
<i>Crotaphopeltis tornieri</i>	F	W	V		1			1
<i>Thelotornis capensis</i> spp. <i>mossambicanus</i>	f	W			1	1		2
Scincidae								
<i>Mabuya maculilabris</i>	f	W			1			1
Gekkonidae								
<i>Hemidactylus mabouia</i>	f	W					1	1

Two species from two families were observed but not retained for taxonomic purposes. Ecological type and endemic status were compiled from the National Biodiversity Database (UDSM, 1997), Broadley and Howell (unpubl.); Howell (1993); and Branch (1994).

Table 18. Summary of reptile observations.

Species	Certainty	Ecological type	Endemic status	Observation locations
Boidae				
<i>Python sebae</i>	definite	f	W	brought by villagers
Viperidae				
<i>Bitis gabonica</i>	probable	F	W	plot 1
Varanidae				
<i>Varanus niloticus</i>	definite	f	W (CITES II)	OR

KEY TO ABBREVIATIONS FOR TABLE 17 & 18 (Definitions based on those described in the botanical section of this report).

Ecological type

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic status

- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:

- V - Vulnerable

OR - Refers to observations outside but in proximity to the reserve to be considered associated to it. ? : No data available

Certainty: Indicates the probability of the correctness of the identity of the species observed;

Definite: Can be regarded as occurring in the reserve.

Probable: Identification is likely but requires confirmation.

No Figure / Map Currently Available in Digital Format

Figure 20. Distribution of forest dependent reptile species.

6.4.4 Amphibians

One amphibian was retained for taxonomic purposes. This specimen has yet to be identified past genus level.

Table 19. Summary of amphibians.

Species	Ecological type	Endemic status	Capture location
Hyperoliidae <i>Afrixalus</i> sp.	?	?	Plot 1

6.4.5 Invertebrates

6.4.5.1 Invertebrate pitfall trapping

Preliminary identifications to order level are provided in Table 20.

Table 20. Summary of ground-dwelling invertebrates.

Order	Common name	Plot 1	Plot 9
Araneae	spiders	52	91
Blattaria	cockroaches	28	16
Chilopoda	centipedes	0	1
Coleoptera	beetles	26	91
Collembola	springtails	20	60
Diplopoda	millepedes	2	10
Diptera	flies	1	4
Heteroptera	true bugs	2	2
Homoptera	true bugs	1	1
Hymenoptera	wasps, bees, ants etc.	28	60
Isopoda	termites	5	4
Neuroptera	mantispids	0	1
Opiliones	harvestmen	0	0
Orthoptera	crickets & grasshoppers	38	46
Pseudoscorpiones	pseudoscorpions	1	0
Thysanoptera	bristletails	0	11

6.5 Summary

Species Richness

The capture rate was very low in all taxa which can be attributed to the lack of rain during the survey. Because of this, species richness and diversity is difficult to discuss.

Table 21. Summary of faunal families and species (identified to date).

Taxon	Number of families	Number of species
mammals	7	10
reptiles	6	9
amphibians	1	1

Table 22. Summary of capture locations of faunal species.

Taxon	Plot 1	Plot 2	Plot 5	Plot 8	Plot 9	Plot 16	Plot 17	Over Sigi river	Outside reserve	Unknown capture location
mammals*	0	2	4	1	1	2	0	3	0	0
reptiles	3	0	0	3	1	0	1	0	1	1
amphibians	1	0	0	0	0	0	0	0	0	0

*primates excluded due to their large ranges.

Ecological type

Three forest dependent species were recorded: *Aparallactus guentheri*, *Crotaphopeltis tornieri* and *Bitis gabonica*; all three of which are snakes. One invasive species, *Rattus rattus*, was recorded. This species was recorded in plots 2 and 16, both consisting of a mosaic of wooded grassland and forest.

Table 23. Summary of ecological type of faunal species.

Ecological type	No. of species	% of total species recorded
(F) Forest dependent	3	15.0
(f) Forest dwelling but not forest dependent	10	50.0
(O) Non-forest species	1	5.0
Unknown	6	30.0
Total	20	100.0

Endemic Status

No endemic and only one near-endemic species to the Usambara mountains, *Beamys hindei*, was recorded.

Table 24. Summary of endemic status of faunal species.

Endemic status	No. of species	% of total species recorded
(E) Endemic to the Usambara Mountains	0	0
(N) Near-Endemic: ranges in restricted locations	1	5.0
(W) Widespread	17	85.0
Unknown	2	10.0
Total	20	100.0

Range Extensions**Mammals**

The bat, *Eptesicus flavescens*, is a first record for Tanzania. It was previously recorded only in Angola and Burundi (Kock, *pers. comm.*).

CITES

The Nile monitor lizard, *Varanus niloticus*, as are all Varanidae, is a CITES Appendix II species. These reptiles have encountered high hunting pressure for their meat and skin and are now protected (Branch, 1994).

IUCN status (National Biodiversity Database, 1997)

The snake, *Crotaphopeltis tornieri*, is listed as 'Vulnerable'.

7.0 SOCIO-ECONOMICS

By M. Fundi

7.1 Introduction

The major threats to the lowland forests, both inside and outside gazetted reserves, are the expansion of agricultural cultivation, uncontrolled collection of fuel wood and building poles and illegal pitsawing.

7.2 Methods

Over a period of ten days forty-four interviews were conducted from a broad cross-section of the local people. These interviews varied in format from informal group discussions to the more directed one to one interviews. The aim was to gather information on the nature and extent of local forest use in the past, present and future.

7.3 Results

7.3.1 The people and the place

(1) Kiwanda: The working population of Kiwanda was 725 at the time of the 1988 census, however it is now estimated at 3000. The average number of children of interviewees was four. Though the Wasambaa is the dominant and indigenous tribe, other tribes such as Wamakonde, Webena Wapare, Wahehe, Wadigo, Wazigua, Wabondei and others are also present. The sub-villages of Kiwanda are Kiwanda Mission, Kiwanda Enyeji, Misajini, Mngeza A and Mngeza B, Kwevumo, Kwemananasi and Mangubu.

(2) Kweboha: Kweboha is administered as a subvillage of Kambai. The population of Kweboha is estimated at 630. The average number of children of interviewees was five. This subvillage lies on a former Sisal Estate, now belonging to Muheza District Development Corporation (SHUWIMU). The mixture of tribes is much more obvious in Kweboha where Kiswahili tends to be the main language of communication between neighbours rather than Kisambaa, though each family speaks its mother tongue in the home.

(3) Kwatango: Kwatango is the oldest of the three villages with as many as five generations of history. The 1988 census recorded the working population as 655 and it is now estimated to be approximately 1000. Research was concentrated in Tamota, a subvillage with an estimated population of 284. Land in Kwatango has been inherited rather than bought, therefore few immigrants have the opportunity to farm the surrounding land. Kwatango consists of Tamota, Mkoroshini, Gombero, Mlembule and Vumba subvillages. Longuza forest reserve is approximately one hours walk.

7.3.2 Economic activities

The local population is, for the most part, engaged in subsistence farming. The main crops are maize and cassava. Most farmers practice inter-cropping and shifting

cultivation. About a quarter of the total plot is left fallow and is rotated every two to three years. The nearest transport to Muheza (market) is Bombani, which is 18 km from Kiwanda, about three hours walking distance.

Secondary incomes include fish selling, kiosk operation, hotel and tea houses, sale of palm oil and boha (fermented sugarcane juice), and mat and basket making.

In Kweboha many who are now primarily involved in agriculture were originally employed on Sisal Estates. In both Kweboha and Kiwanda, several interviewees mentioned pitsawing as an income source.

7.3.3 Village land tenure

Land is acquired either by inheritance, or by sale or donation by village authority. In the case of inheritance, land is passed down through the male line. A woman will be allocated some land from her father or brother, however if she marries and moves away from the village, her land reverts back to the family. If she marries within the village, she can still farm the land with her husband. A man who marries into the village has no claim on his wife's land and would have to buy or be given another piece that he can call his own. A married woman automatically shares her husband's land until he dies or they divorce. As a result, most couples interviewed owned at least two farms between them.

7.3.4 Use of and dependence on the forest

7.3.4.1 Hunting

Interviewees were unwilling to discuss hunting at length. Some admitted to hunting cane rats with dogs and traps and were aware of people hunting monkeys for food, although none admitted personal involvement in this. During the expedition though, local boys were seen carrying a black and white colobus monkey that had been shot.

When questioned on measures taken to reduce crop disturbances by forest animals such as monkeys and wild pigs, none of the interviewees said that pests were scared off farms. When they were seen though and that at particular times of the year, farmers would sleep on their land in order to deter the animals.

7.3.4.2 Medicinal plants

The area is served by modern medicine through a government dispensary at Kiwanda Mission and at Tamota (Kwatango). The Kiwanda dispensary receives supplies once a month but these are insufficient and some medicines last less than three to four days. The situation is similar at Tamota which treats around 500 patients per month. The lack of conventional medicine contributes to dependence upon forest products for herbal remedies. The doctor in Tamota neither encourages or discourages traditional remedies and reported a high local use with patients generally turning to a local herbalist first and coming to him if this fails. Some of the medicinal products are available only within the forest reserves and as one interviewee commented, that supply is not a problem, this seems to indicate that they are being removed.

7.3.4.3 Farm forestry and tree planting

The perception of the future availability of such resources varies widely. Not surprisingly, those who believed there would be a building pole and fuelwood shortage within 5 to 10 years, were the most likely to have planted trees on their farms. Otherwise, people only leave standing trees whilst clearing their land to retain shade or because the effort required to remove them would be too great.

Apart from some innovators, such as former pitsawyers, there are more organised attempts to establish village nurseries, specifically the Kambai Forest Conservation Project, operating in Kambai and Kweboha. The Kweboha Women's Group began one year ago, planting vegetables, but is now involved in the planting of teak seedlings. It is hoped that in the future money can be raised to help pay school fees from the sale of timber, but the primary aim is to provide fuelwood and building poles. None of the interviewees had planted teak on their farm land more than three years ago, and therefore, as yet, there had been no dividends. In general, those involved seem unsure of the likely returns, and it is too early to assess the likely outcome of such efforts.

7.3.5 Peoples attitudes to conservation

There often appeared to be an automatic and unconsidered response to questions on the benefits and disadvantages of living near a forest reserve. This response was that the forest "brings rain and a good climate" (a phrase we heard repeatedly and predictably). This resulted in contradictory statements when interviewees expressed frustration at bans on fuelwood and building pole collection in the forest reserves and complained of protection for pests such as monkeys, yet did not explicitly identify the advantages and disadvantages of living next to a reserve.

For many people, when forest reserves are declared or gazetted, it is viewed that the government is taking the villagers land and depriving them of future resources. No-one saw the forest reserves as a policy designed to conserve forest products. Thus there was the attitude, "where will the children stay if the government takes their land?" One interviewee had the impression that the reserves were being saved for use as future farmland.

A lot of people complained that they did not know much about the aims of a reserve and that they had not been consulted during the demarcation process. They would have like to be more informed and given more education on other alternatives to forest products. One interviewee argued that a prohibition on entry to the reserve was unenforceable when certain resources are only available in the reserve. On the other hand, many felt that declaring reserves was the only way to provide incentives for village nurseries.

7.3.6 Eco-tourism potential

The impact on the local community as a result of the presence of the survey's camp in Kiwanda has mainly been on the financial side. The women employed to fetch water and wash the laundry are not the only ones benefiting. The local kiosks have sold more cigarettes, sodas and matches than ever before, as have the farmers who brought their bananas, spinach, pineapples, papaya, carrots, and eggs. When asked for their

opinion of the camp's presence, the reply was a positive one and they were most pleased by the fact that they could sell their products and increase the family income.

The economic impact through the presence of tourists in Kiwanda, Kweboha and Kwatanga would probably mean that the surplus crops would have a market. If not directly bought by the tourists' camps, the increased communication line between the market centres, Muheza and Tanga, would ensure sales of any surplus. A few people could be employed as staff in tourist camps, while local guides with a good knowledge of the paths and plants could prove useful. Unfortunately most of them do not speak English and do not have the skills required to serve a tourist camp (e.g. waiters, cooks). Tour operators may decide to employ English speaking and perhaps better skilled staff from elsewhere, and employ the locals as casual labourers or non-permanent staff.

In response to a tourist trade, better roads and infrastructure would be set up. This likely would lead to more intensive farming for increased revenue as surplus could reach markets. Fallow land would become rare, and farms would likely be extended, thus putting further pressure on the forest. More efficient farming techniques would have to be introduced to minimise soil erosion and pressure on the forest reserve.

7.4 Discussion

The local population draws on the forest reserves for a variety of products. In the case of medicinal plants, the scale of use does not pose a significant threat to the survival of the reserves. However, because forested land is cleared for agricultural use in direct relation to the size of population, the future is of concern. The interviewees on the whole reported good soil fertility and an abundance of land resulting in a surplus food production. It was stated that if a road were to be established creating market access, this would lead to increased prosperity. Currently, much land is left fallow allowing crop rotation however, if the crops were marketable, all available land may well be cultivated with little or no fallow land. In addition, pitsawing appears to still be an integral part of the culture and economic reliance on this activity persists. Hunting does exist but the extent of this activity was not ascertained due to the unwillingness of participants to co-operate in this discussion. Firewood collection and pole extraction is also of concern. There has been a limited amount of tree planting in the villages however it is too soon to assess the success of these projects.

In general, the pressure on the forest is high yet there appears to be little change in activities which will slow or reverse the present course of damage to the reserve.

8.0 Conclusion

This report presents the raw data of the survey with preliminary descriptions in terms of ecological type and endemic status. These two factors provide an indication of three main 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.

Longuza forest, gazetted as a forest reserve in 1954, covers an area of approximately 1000 ha in the central area of the East Usambara range. With altitudes between 95 m and 345 m, it consists of approximately 22.2% mature forest, 50.0% previously disturbed, colonising or poorly stocked forest, 16.7% woodland and 11.1% bushland/thicket.

Disturbance

Longuza forest reserve appears to be heavily encroached on all sides leaving a small remnant of forest in the central area of the reserve. Yet even this small remnant is under pressure as this area shows higher timber extraction than any other area within the forest reserve. All areas within the reserve show some level of disturbance in addition to pole and timber removal including cattle grazing and hunting. Large areas of woodland and bushland exist, almost certainly a product of long-term human disturbance.

Species Richness

The forest reserve was found to contain a minimum of 106 species of tree and shrub; 10 species of mammal, 9 species of reptile and 1 species of amphibian.

Flora

No tree or shrub species were recorded which are endemic to the Usambara mountains, 25 though, have restricted ranges limited to the Eastern Arc and/or East African lowland forests. Twenty four species are dependent only on primary forest, and of these species, nine are also endemic or near endemic to the Usambara mountains. Eighteen non-forest tree and shrub species are established within the reserve boundaries.

Fauna

No faunal species were recorded which are endemic to the Usambara mountains and only one species was recorded as a near-endemic, having a restricted range limited to the Eastern Arc and/or East African lowland forests. Three species are dependent only on primary forest. None of these are endemic or near endemic to the Usambara mountains. One non-forest species was recorded in the reserve.

Table 25. Summary of biodiversity of taxa surveyed.

Taxon:	Total no. of species	% forest dependent	No. of non-forest species	No. of endemics	No. of near-endemics	No. of forest dependent endemics and near-endemics
trees and shrubs	106	22.6	18	0	25	9
mammals	10	0	1	0	1	0
reptiles	9	33.3	0	0	0	0
amphibians	1	0	0	0	0	0
Total	126	--	19	0	26	9

Conservation

Accessibility generally determines the extent of exploitation of an area (Hall & Rodgers, 1986). Longuza forest reserve is of low altitude with easy walking terrain. This level of accessibility is likely responsible for the long term exploitation of the area especially towards the periphery of the reserve. Removal of forest resources affects the structure in numerous ways. Collection of firewood, although already dead, reduces the organic levels in the soil. Timber and pole removal targets specific species which leads to changes in the floral composition of the area. Levels of timber and pole removal are usually extensive and only the remote areas of a forest remain relatively unaffected (Hamilton & Mwasha, 1989). This appears to be occurring in Longuza where the only forest plots are toward the centre of the reserve.

In addition, the soils of the forest are highly erodable and quickly lose fertility once the land has been cleared. It appears that the impact of these actions have affected the soils of the reserve with marked differences between soils under mature mixed forest and areas of bushland, woodland and those under poor quality forest.

In general, the pressure on the forest is high yet there appears to be little change in the attitude and behaviour of the local people which will slow or reverse the present course of damage to the reserve.

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Appendix 1:**General plot information**

Plot Number	Topography	Altitude (metres)	Slope (degrees)	Vegetation Condition	Canopy Height (metres)
1	GU	210	20	EC	20-30
2	GU	235	15	EC	10-20
3	GL	170	20	EC	20-30
4	RT	175	40	EC	10-20
5	M	180	20	P	20-30
6	M	175	15	M	10-20
7	GU	165	10	EC	20-30
8	GL	190	10	B	> 30
9	GL	185	25	EC	10-20
10	FV	190	0	EC	20-30
11	M	180	15	EC	20-30
12	SU	345	30	B	10-20
13	SU	300	50	W	?
14	GL	180	5	M	20-30
15	GL	175	5	W	20-30
16	SL	190	45	M	>30
17	M	200	0	M	20-30
18	FV	225	0	W	<10

KEY TO ABBREVIATIONSTopography

GL - gentle lower slope
 SL - steep lower slope
 M - mid-slope
 GU - gentle upper slope
 SU - steep upper slope
 FV - flat valley floor
 RT - ridge top
 F - mature mixed forest

Vegetation Condition

M - mature mixed forest/more or less natural forest
 P - disturbed primary forest or secondary forest
 G - grassland
 B - bushland and/or thicket
 W - woodland
 EC - former encroachment/colonising

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