
FRONTIER-TANZANIA ENVIRONMENTAL RESEARCH

REPORT 109

Nawenge Forest Reserve

A Biodiversity Survey



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Nawenge Forest Reserve

A Biodiversity Survey

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

**Frontier-Tanzania
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Forest and Beekeeping Division (FBD)

The Division is part of the Government of Tanzania within the Ministry of Natural Resources and Tourism and is responsible for the management and implementation of the forest policy within Tanzania.

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 Frontier-Tanzania, of which one component is the Frontier-Tanzania Forest Research Programme (FT FRP). Biological field surveys were conducted in the coastal forests from 1989 to 1994, in the East Usambara mountains in collaboration with EUCAMP, Tanga from 1995 to 2002, the Udzungwa mountains in collaboration with MEMA, Iringa 1999 to 2001, in the Mahenge mountains in 2003 and in Mpanga / Kipengere Game Reserve, in collaboration with WWF-TPO, Dar es Salaam, in 2003.

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EXECUTIVE SUMMARY

Nawenge Forest Reserve (FR) is located within the Mahenge Mountains, the southern part of the Eastern Arc Mountains, on a latitude 8° 42-43' 00" and longitude 36° 43' 00". It is situated in Ulanga District, 8km north of Ifakara and was established in 1931 for its water catchment value supplying Mahenge town and Uponera and Isongo villages. It is a small FR of 757ha, consisting of mainly submontane forest, plantation forest, grassland and cultivated land. It has an elevational range of 1150m asl – 1350m asl and an average rainfall of 2000mm per year from March to June, although in recent years rain has been unpredictable and low.

The area is well documented in terms of its water catchment properties, but little is known of the exact biodiversity values. For five weeks from January – February 2003, Frontier-Tanzania Forest Research Programme (FT FRP) conducted a baseline biodiversity survey of Nawenge FR, which coincided with the start of the wet season. Both zoological and vegetation work was conducted throughout the FR, including trapping, casual observations and collections, large mammal and disturbance transects and vegetation plots. This report serves to detail the findings of the FT FRP biodiversity survey of the Nawenge FR. It provides an inventory of flora and fauna, highlighting records of particular interest. An assessment of the level of human resource use within the area was also made, giving the extent and potential threat of each form of 'disturbance' recorded. Table 1 summarises species richness and species of particular conservation and/or biological interest.

Table 1 Summary of biodiversity taxa surveyed

Taxa	Number of species	Species of biol./cons. interest *
Trees / shrubs	68	14
Herbs / grasses	15	1
Climbers	7	0
Ferns	2	0
Mammals	21	3
Birds	56	5
Reptiles	7	1
Amphibians	15	2
Butterflies	44	3
Total	235	29

* This includes species listed as range restricted, of conservation concern, forest-dependent or for which the record in the reserve represents a distribution or altitudinal range extension, but does NOT include the number of forest dwelling species

Nawenge Forest Reserve has significant conservation value on local, national and international levels. It is part of the Eastern Arc mountain range and has several floral and faunal endemics limited to this biodiversity hotspot area. It serves as an important water catchment area to local communities. Scientifically the area remains unknown and needs further investigation as pressure increases for illegal resource use, difficult to control with low finances, low manpower and no joint forest management strategy means further habitat destruction.

With regard to fauna surveyed, the reserve is home to 143 species of which 14 species hold particular interest for their conservation and biological value, such as the vulnerable Lesser pouched rat (*Beamys hindei*), the vulnerable Bearded pygmy chameleon (*Rhampholeon brevicaudatus*) and the coastal endemic toad *Spelaeophyrne methneri*.

It also has a rich diversity of flora with 93 species, of which 15 hold particular interest, such as the Eastern Arc endemics *Allanblackia stuhlmanni*, *Harungana madagascariensis* and *Odyendia zimmermannii*, with *Monanthataxis dictyoneura* being a shrub endemic to Mahenge. The habitats and species of Nawenge Forest Reserve are under threat from agriculture and soil erosion.

It is hoped the information will be useful in management planning by the Forest and Beekeeping Division and NGOs. The survey results will also form a baseline for future monitoring work.

Animal specimens have been deposited at the Department of Zoology and Marine Biology, University of Dar es Salaam and sent on loan to: The British Museum of Natural History, London; California Academy of Sciences, California; Southern highlands Project, Mbeya; Chicago Field Museum, Chicago; Zoological Museum, Copenhagen. Appendix 1 provides contact details.

Botanical specimens are held in the Herbarium at Dar es Salaam University, with specimens being sent to Missouri Botanical Gardens, USA.

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1. INTRODUCTION

1.1 Frontier-Tanzania Forest Research Programme

Frontier-Tanzania has been conducting baseline biodiversity surveys within biologically rich Eastern Arc and Coastal forests since 1989. Technical reports have been published from work in the Coastal forests, Eastern Arc Mountains: East Usambaras, Udzungwa mountains, and Mpanga / Kipengere Game Reserve; refer to Frontier Publications List www.frontier.ac.uk. Selected reports will be available for download on the website shortly.

During early work (1989-1994) in the Coastal and East Usambara forests, Frontier-Tanzania Forest Research Programme (FT FRP) developed an effective methodology that allowed systematic baseline biodiversity surveys to be conducted in a cost-effective way. In conjunction with this, the impact of human resource use within Catchment Forest Reserves is assessed and feedback provided to the Catchment Forest Project of the Forest and Beekeeping Division, as well as training in the techniques for future monitoring purposes. Environmental education within local communities is also conducted as an integral part of conservation work. These activities follow an Environmental Education Resource Pack dedicated to raising environmental awareness in the Eastern Arc, Oliver *et al* (2002). The long-term aim of this work is to provide baseline information about targeted areas, those understudied and unknown, within the Eastern Arc Mountains, thus helping to further scientific knowledge, identifying conservation values and needs, as well as to allow effective planning and implementation of sustainable management.

1.2 The Mahenge Mountains

The Mahenge Mountains form the southern part of the Eastern Arc Mountains (EAM), which sweep from southern Kenya to southern Tanzania (see Figure 1). The Eastern Arc Mountains are ancient crystalline block-faulted mountains and, due to millions of years of isolation, have diversified into a biologically rich area for both flora and fauna species. Many of these species are endemic to the EAM, contained in around 5,000 sq. km of highly fragmented and isolated forests. Approximately 30% of vascular plants (approx. 650 species) in the EAM are endemic. The EAM are recognised as a Biodiversity Hotspot by Conservation International and globally significant in terms of important ecoregions by WWF (USA) (Myers, 2000).

The Mahenge Mountain range is located in Ulanga District, Morogoro Region. It is connected to the Kilombero Valley, the largest freshwater wetland at low altitude in East Africa and a recently designated RAMSAR site, and to the Selous Game Reserve. The Mahenge mountains are an important water catchment and natural resource area for surrounding local communities, yet the expanding human population signals increasing threats to and encroachment of the remaining forested areas.

Ulanga District administers eight forest reserves – Nawenge, Mahenge Scarp, Mselezi, Myoe, Muhulu, Sali, Ligamba and Nambiga (see Appendix 2 for details). The FRs approximate co-ordinates cover: Longitude S 9° 10' - 9° 47' and Latitude E 36° 30' - 36° 45'. Six of the forest reserves (Nawenge, Nawenge, Mselezi, Myoe, Muhulu and Sali) are on the main part of the Mahenge mountains, with Ligamba forest reserve (FR) covering a hilltop south of the main Mahenge range, and Nambiga FR, an area of groundwater forest located west, connecting the Kilombero valley with the mountain range.

None of these forest reserves have had any form of systematic baseline biodiversity survey conducted within them, except for Nambiga forest reserve, which was surveyed by Frontier-Tanzania Savanna Research Programme (FT SRP) in 1999. Lovett & Pocs (1993) conducted a botanical appraisal of catchment forest reserves, therefore limited information is available about floral species in the region and the Mahenge Mountains remain scientifically unknown.

1.3 Objectives of the Survey

The objectives for work in each Forest Reserve area are:

- to conduct a biological survey to provide baseline information against which future monitoring activities may be based in order to detect 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;
- to provide training in basic survey techniques to Catchment Forest Officers, local field assistants, Tanzanian personnel from UDSM/SUA and expatriate volunteers;
- to provide a medium through which there is potential for project participants to gain the BTEC qualification Tropical Habitat Conservation (equivalent to a British A-level), funding dependent;
- to raise awareness through environmental education activities within primary schools and local communities via village and environmental committees;
- 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.

This report serves to detail the findings of the FT FRP biodiversity survey of the Nawenge Forest Reserve. It provides an inventory of flora and fauna compiled throughout the fieldwork, highlighting records of particular interest. An assessment of the level of human resource use within the area is also made, giving the extent and potential threat of each form of 'disturbance' recorded. This report is aimed at managers, conservationists and scientists alike and it is hoped that it will help in some way to ensure the future protection of this extremely valuable and interesting site.

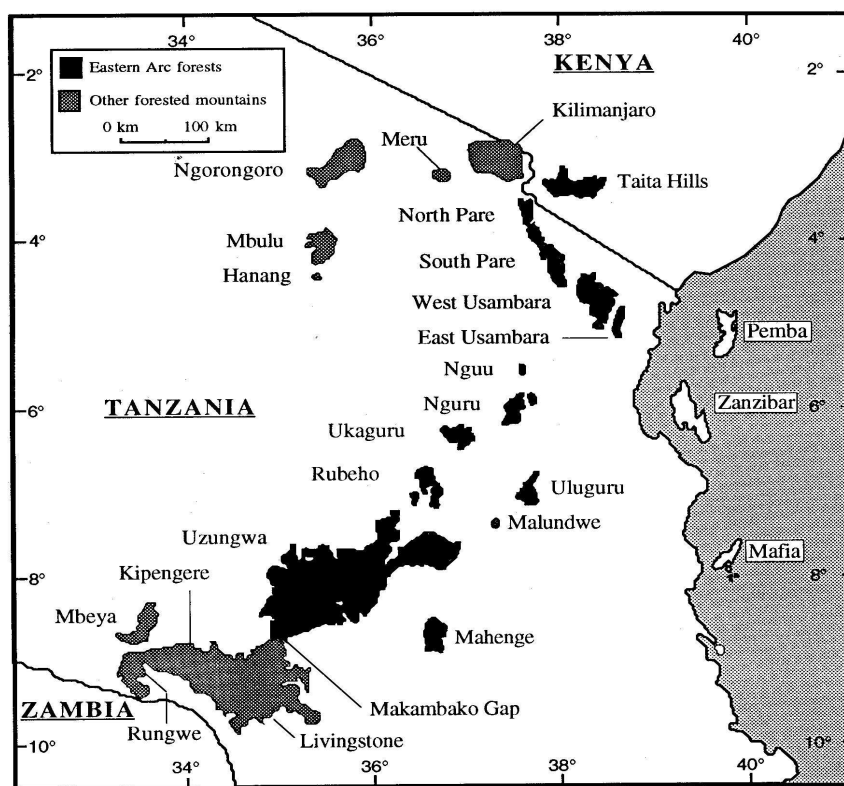


Figure 1 Map of the Eastern Arc Mountains and southern Kenya that support moist forest. Eastern Arc Forest shown in black. From Lovett (1993).

1.4 Report Structure

This report provides a floral and faunal inventory recorded during 5 weeks of biodiversity survey of Nawenge Forest Reserve. Each species is described in terms of its ecological requirements and its endemic status. The lists of species can be found in the appendices.

Ecological Type: (Iversen, 1991b)

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

Habitat: (where possible based on Hamilton, 1989)

- L – Lowland: Species occurring at altitudes less than 850m above sea level;
 - S - Submontane: Species occurring at altitudes of greater than 850m above sea level;
 - M - Montane: Species occurring at altitudes of greater than 1250m 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 850. above sea level).

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

- E – Endemic: Occurring only in the Mahenge Mountains;
- N – Near endemic: Species with limited ranges in the Eastern Arc Mountains and/or the East African lowland forests;
- W - Widespread distribution

This refers to the habitat 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. 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 (FTEA) for the species recorded from the systematic plots and from the List of East African Plants (LEAP), (Knox 2000), for the opportunistic plant records.

Endemic and near-endemic status for plants was taken from Iversen (1991b) and FTEA categories Tanzania T3, T6, T8 and Kenya K7. For animals, endemic and near-endemic status was gleaned from the NBD (1997).

The following references were also used (in order of priority):

Mammals:	Kingdon (1997), Kingdon (1989), Kingdon (1974)
Birds:	Stevenson & Fanshawe (2002)
Reptiles:	Spawls et al (2002), Howell (1993).
Amphibians:	Channing (2001), Passmore and Carruthers (1995)

Butterflies: Kielland (1990) and Larsen (1996).
Plants: Palgrave (1983), Polhill (1988), Heywood (1993)

The National Biodiversity Database (NBD) (UDSM, 1997) is used to categorise threat status of the animals listed. The lists were compiled with regard to status and threat within Tanzania and East Africa. Listed species of amphibians and reptiles are solely based on the Tanzanian National Biodiversity Database (UDSM 1997). The statuses of these species are undergoing national and international evaluation. IUCN, categorises species in terms of global threat and produces Red data books, available from 1996 and earlier. However, a new IUCN 2000 CD-Rom has been released. Many Tanzanian species are not included in the 2000 IUCN Red data CD-Rom. IUCN 2000 status is given for mammals in addition to NBD and is the main source of threat status for bird species.

2. STUDY SITE

2.1 Location

Nawenge Forest Reserve (FR) is located on the main Mahenge Mountain range, Southern Tanzania. It covers an area of 7.57 km² (757 ha) and lies in the district of Ulanga, Morogoro Region, covering land approximately 2 km west – south of Mahenge town located on latitude 8°42-43'00" and longitude 36°43'00" and lies 85km south of Ifakara, Kilombero District. It is bordered by the Kilombero floodplain to the west, Selous Game Reserve to the north east and forms a continuous mountain block with the Mbarika to the south, lying close to the Udzungwas and Southern highland Mountains blocks.

2.2 Site Description

Name: Nawenge Forest Reserve

Area: 757 ha

Status: Catchment Forest Reserve

Established in 1931 as delineated and described on Forest and Bee Keeping Division Map No. Jb. 1969
Gazettement notice GN 149 of 1931 and variation order GN288 of 18/08/61. Area extended in 1982.

Maps: Ordnance Survey topographic maps 1:50,000, Series Y 742 251/1: Mahenge Mountains area.
Forest and Beekeeping Division Map No. Jb. 513, Jb. 1969.

2.3 Topography

Nawenge FR consists of one main narrow ridge running north-south, reaching 1350m asl with the steep slopes and surrounding flatter area (approx. 1150m asl) incorporated into the FR. There are patches of Precambrian crystalline limestone rocks. The north western slopes of the main ridge are soil eroded from cultivation, whilst the eastern slopes are bracken covered. Much of the FR is either cultivated or tree plantations. It is an important water catchment area and has 9 intake tanks piping the water to villages. The northern part of the reserve has a road accessible by car, but the southern part must be accessed by foot.

2.4 Climate

The dry season is June to October with the main rains falling between November and April. Yearly rainfall is 2000mm.

Daytime temperatures range from: 22°C max (Nov) and 17°C min (July)

2.4 Land Use

The latest survey of the area was carried out by Lovett and Pocs (1993), who did a botanical appraisal of all the catchment forest reserves in 1993. Submontane and montane forest cover the intact parts of the reserve, mainly on the southern ridge. Thickets of succulents occur on open crystalline limestone rocks along the road below the continuous forest. Cultivation and tree plantations of *Eucalyptus* and *Grewilia* sp. cover the remainder of the reserve, with some bracken and scrubby woodland.

2.5 History and Status

Nawenge FR is located approximately 2 km from Mahenge town and was gazetted for its water catchment value in 1931. This area, then called Kwirow FR, was only 134 ha and encompassed the southern end of the ridge only. However, due to the importance of the Kwirow ridge as a water catchment area to the Mahenge town and the villages of Isongo and Uponera, the FR area was extended to incorporate the northern end of the ridge, increasing it to 757ha and renamed to Nawenge FR. The FR has 9 water intanks piping water to the above towns and villages.

The northern part of Nawenge FR was once a German owned coffee plantation, accounting for much of the deforestation seen. In 1976, a plantation of *Eucalyptus* and *Grewilia* species was established. Within and amongst this, there is *shamba* (farmland) (permitted legally) where the farmers are on a crop rotation scheme, whereby they plant maize and once the crop has been harvested, they are given trees to plant

before they leave to cultivate other land. It is believed this has not been as success as a similar scheme in northern Tanzania (Pers. comm. Mr Nkawamba).

The Forest Catchment officers have a tree nursery in the northern part of the FR, where they have hundreds of saplings to distribute, funded by NORAD. This year the forest officer has let villagers plant approximately 10ha of *Ficus* species in the plantation forest areas, as these trees are thought to be good for fire resistance and water catchment.

On the western boundary just inside the FR, there is a village called Epanko and it is along these steep western slopes that severe deforestation has occurred resulting in increasing soil erosion. Burning has occurred within the FR, mainly on the eastern slopes, those closest to Mahenge town (Pers. comm. Mr Nkawamba). The forest on the ridge top was not damaged. It is not known whether these are intentionally started within the reserve or have spread from *shambas* outside.

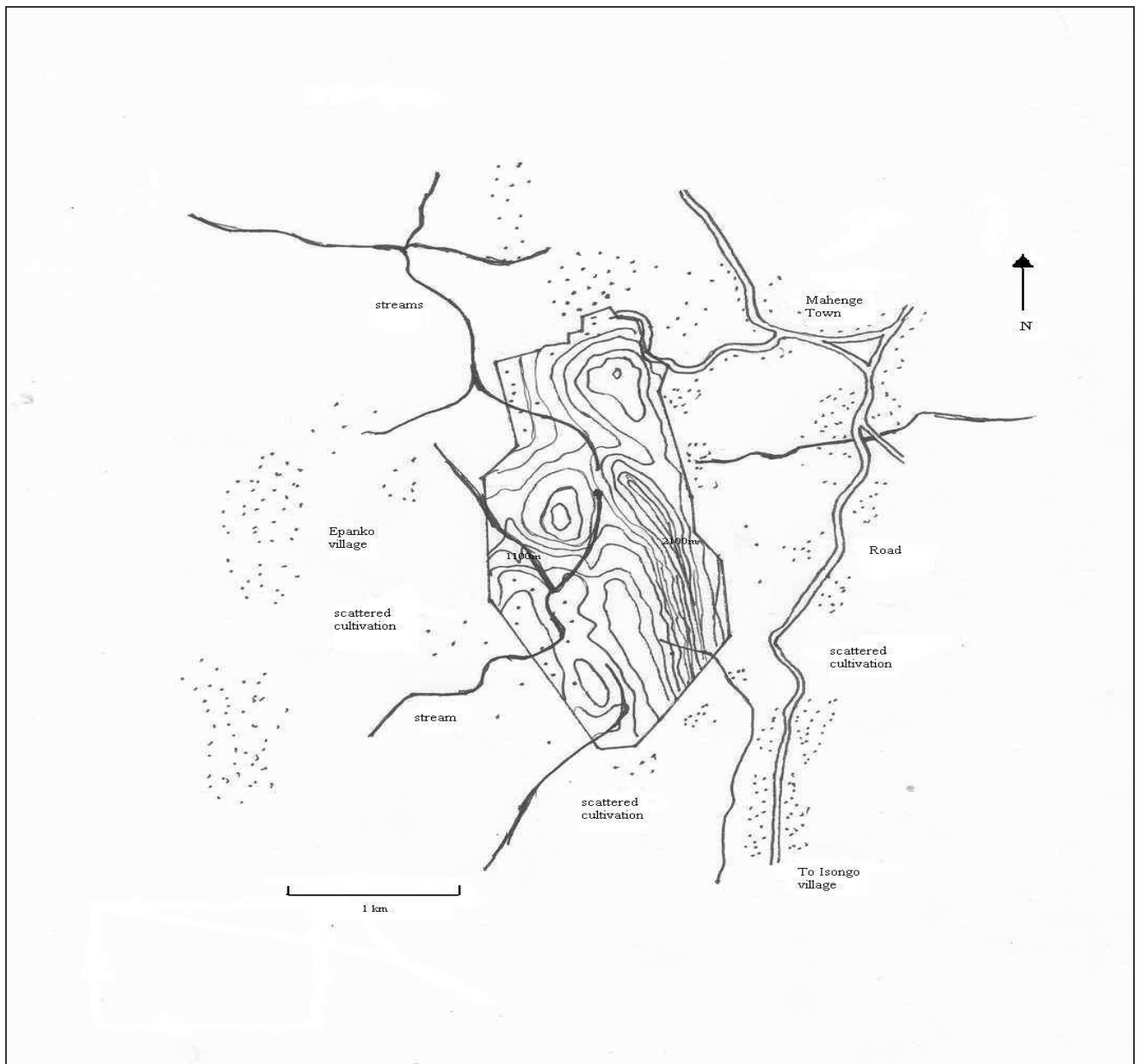
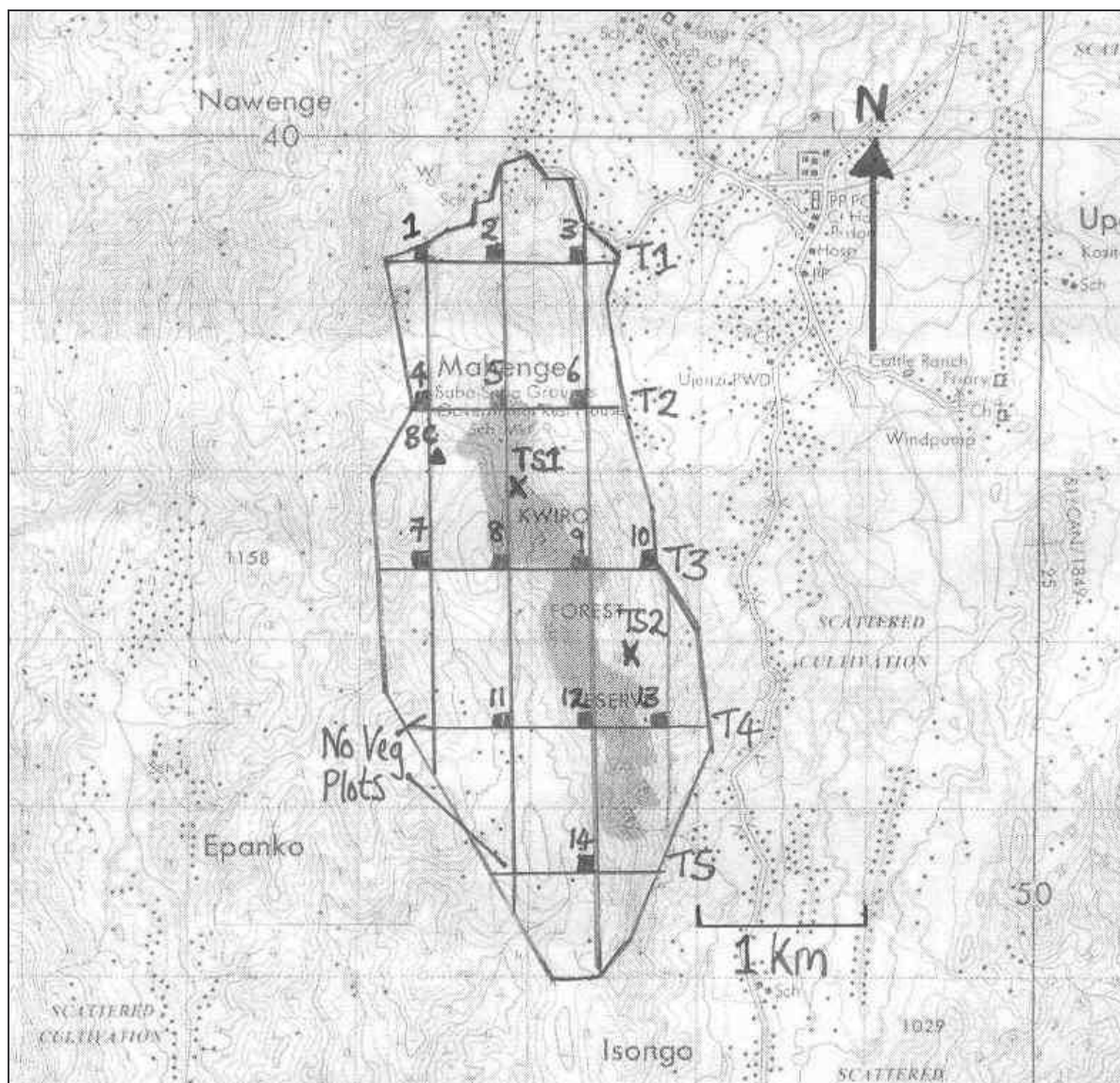


Figure 2 Topographical map of Nawenge FR.

3. METHODOLOGY

Fieldwork was conducted in five weeks during the wet season. Survey work concentrated on investigations of the reserve's flora, fauna and human resource use, with methods based on those employed by FT FRP in the East Usambara Biodiversity Survey (SEE Methodology, 1998). Two zoological sites, five transect lines and 14 vegetation plots were carried out within the FR (Figure 3).



KEY: TS = trapsite; BC = basecamp; T = transect line; ■ = vegetation plots

Figure 3 Map of work sites at Nawenge FR

3.1 Flora

A species inventory was compiled of the trees and shrubs found within the Nawenge 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.

The forest reserve was divided into a 900m x 450m grid of numbered squares marked in the field by tagged transect lines. This resulted in 5 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).

Three methods were used to analyse forest composition:

- (1) vegetation and regeneration plots;
- (2) opportunistic observations and
- (3) disturbance transects.

- *Vegetation plots (VPs)*

The botanical survey was based on a 900m x 450m grid marked in the field using tagged transect lines. One plot 50m x 20m was sampled in each grid square, giving an approximate sampling intensity of 0.25%. The 50m x 20m vegetation plots were located in the southeast corner of each of the 900m x 450m grid rectangles. Within each sample (vegetation) plot, every tree with a diameter at breast height (dbh) of 10cm and over was recorded (at 1.3m), marked with red paint, and identified. A botanist provided the field identification of plant species. Specimen collection was made of fertile individuals, and difficult to identify species.

- *Regeneration plots*

The regeneration layer was sampled within 6m x 6m nested subplots at the centre of each vegetation plot. All trees and shrubs with a dbh below 10cm were counted and identified within these plots. The ground cover (of herbaceous vegetation, bare soil, leaf litter and rocks), and the dominance of other vegetation (such as grasses, forbs, mosses, lichens and ferns) were documented as percentages. Systematically sampled vegetation data is presented in the form of checklists and analytical calculations summarised in tables, graphs and maps.

- *Opportunistic collections and observations*

Opportunistic collections and observations of ground, shrub and tree floras were made throughout the survey. Two sites were visited for collection representing the varying vegetation types. 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 Herbarium, University of Dar es Salaam and Missouri Botanical Gardens, USA. Opportunistic data is presented as a checklist, with location information for specimens that were collected.

A botanist was employed to identify all individuals recorded in VPs and RPs and on the opportunistic basis. When necessary and if possible, up to six specimens of leaves and preferably flowers and fruits were taken to aid identification of an individual. All specimens were pressed and dried in the field and later identified in the University of Dar es Salaam herbarium, with specimens also being sent to Missouri Botanical Gardens.

3.2 Fauna

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

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

- *Sherman traps*

Small rodents and insectivores were sampled using 100 Sherman traps (standard size) baited with toasted coconut and peanut butter. Traps were placed approximately 10m apart in a grid of 10m x 10m. These were positioned either at the end of the last bucket line or running through the bucket lines, as terrain and size of suitable habitat were occasionally limiting factors. Where appropriate sherman traps were placed in branches to increase the chances of capturing arboreal species.

Traps were baited each evening (16.00hr or later) for the duration of the trappingsite and checked early the following morning (08.00hr or earlier). Traps were closed during each day of the trappingsite. Data were recorded on standardised sheets regarding the identification, sex, breeding status and biometrics of each animal captured, as well as habitat notes. Specimens were retained when species level could not be ascertained and in cases where sexed specimens were required; these specimens were subsequently sent to international taxonomic experts (refer to Appendix 1). In the case of small rodents, individuals to be released were each given a distinct mark-code made by trimming small patches of fur in a given pattern. 'Recaptured' individuals were then able to be identified.

- *Bucket Pitfall Traps*

Small mammals, amphibians and reptiles were sampled using bucket pitfall traps. Three 50m linear transects were created at a zoological trappingsite location whereby eleven 10 litre plastic buckets were sunk into the ground with their rims flush to ground level. Buckets contained small holes to allow rainwater to drain from them and each bucket was positioned 5m apart. A sheet of vertical plastic (approximately 0.5m high, and no less than 0.2m) was run along the bucket line crossing the centre of each bucket to form a 'drift fence'. A 10-15cm lip of plastic sheeting was left flat on the ground onto which soil and leaf litter was placed to prevent any gap in the drift fence at ground level. Animals moving into the area from either side would be channelled along the plastic towards the bucket traps. Each line was placed no more than 50m apart, but was located to encompass a range of micro-habitats. Brief habitat notes were taken for each bucket position. Traps were checked early each morning for the duration of the trappingsite period and data recorded on standardised data sheets regarding the identification of each animal captured.

- *Bat mist netting*

Bats were sampled using varying combinations and configurations of mist-nets within the trapping sites. Up to three mist-nets of varying sizes (3m x 3.5m, 6m x 3.5m, 9m x 3.5m) were utilised at any one time. Nets were placed across assumed 'flight corridors' such as rivers and paths. Nets were opened at dusk (approximately 18.30hr) and checked every 10 to 15 minutes for the duration of the netting session. Data were recorded on standardised data sheets regarding the identification, sex, breeding status, weight and biometrics of each bat captured. Detailed habitat notes were taken for each mist-netting location and the number of net-metre hours calculated for each session.

- *Butterfly sweepnetting*

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

- **Butterfly Blendon canopy traps**

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

- **Mollusc and millipede quadrats**

Molluscs and millipedes were sampled in eight 0.25m x 0.25m quadrats per bucket pitfall line, thus totalling 24 quadrats per trapsite. Quadrats were established systematically along the lines (see figure 4). Ten centimetres of soil was removed and placed on a plastic sheet and sifted until completed. All molluscs and millipedes encountered were collected and preserved.

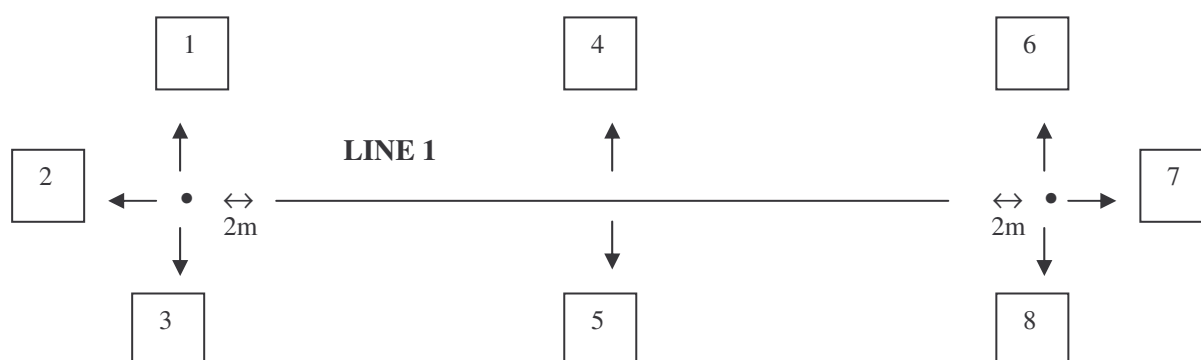


Figure 4 Diagram of systematic positioning of mollusc and millipede quadrats per bucket line

- **Timed bird counts**

Timed-bird species counts were used to assess the relative abundance of birds, based on the assumption that the birds seen first are the most common species. Suitable habitats were chosen within the forest reserve and a 'circuit' walk of an hour was established. A maximum of three people conducted the bird count at any one time to minimise disturbance in the area. Walks were optimally conducted at dawn and dusk, with some data collection at midday, accumulating to 16 hours of survey data. A species list was collected with a count made each time the species was first positively identified by sight or sound. A cumulative score was given for each species by counting the scores across all the walks, with a higher mean score indicating greater observation frequency. The 60 minute fixed time period was broken into 10 minute bands with birds recorded in the first 10 minutes allocated a score of 6, and so on, with a score of zero for those birds not observed in that count. Data was recorded on standardised sheets.

- **Animal sign transects**

Spoor and other signs of animal presence were assessed along every established transect line through the forest reserve (Figure 3). A 2m strip either side of each transect line was assessed for animal dung, tracks and paths, as well as other signs such as burrows, diggings, feathers etc. All animal signs were recorded along with brief geographical and habitat details. To determine identification of indirect evidences, the knowledge of experienced field assistants was utilised, in conjunction with a Reference Dung Collection and Walker (1996).

- **Opportunistic collection and observations**

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

night searches for tree frogs, chameleons, geckoes and bushbabies were conducted as well as attempting to record vocalisations of nocturnal fauna, such as bushbabies, hyrax and birds.

3.3 Human resource use

- *Disturbance transects*

Disturbance transects were used to record the intensity of pole and timber cutting and incidence of other disturbance types in the forest reserve. The disturbance transects were based on the 900m x 450m grid prepared for the vegetation plots (Figure 3). Each transect running east-west was sampled from border to border where accessible. Disturbance was recorded per 50m section along each transect. Every self-standing tree and sapling (not lianas or creepers) 5cm or above dbh was measured within 5m either side of each transect line. Each plant was recorded under one of four categories: live, old cut, new cut or naturally dead. Within these categories a distinction was made between poles and timbers. Poles were classified as having a dbh (diameter at breast height) between 5 and 15cm and a minimum of 2m relatively straight trunk. Timbers were classified as having a dbh of 15cm or above with a minimum 3m relatively straight trunk. These divisions are based on differences in use. New cut stems were determined by cream coloured slash and classified as freshly cut within recent months (approximately within the past 3 months). Old cut stems were determined by black coloured slash and classified as old cut (approximately more than 3 months old). Timber and pole cutting data are presented as an average per hectare and summarised in graphs and maps.

- *Opportunistic observations*

Observations of human resource use were made in each vegetation plot and throughout the reserve. Again, it was hoped that this would compliment the standard quantifiable methods employed and give a fuller picture of the state of the reserve with regards to human impact.

4. RESULTS

Survey work was conducted during the wet season between 11th January and 21st March 2003. Please refer to Appendix 2 for a detailed account of survey effort for each of the following research areas; flora, fauna and human resource use. Appendices five to seven present vegetative data with appendices eight to 12 presenting faunal data. Appendix 13 represents the disturbance data.

4.1 Flora

- *Vegetation types*

The vegetation of Nawenge FR is made up of patches of several different vegetation types:

- Plantation forest – this is found mainly on the northern part of the reserve. The area is planted with exotic tree species of *Grewillea robusta*, *Cedrella odorata*, *Syzygium cumminii*, *Cupressus lusitanica*, *Eucalyptus saligna*, *Eucalyptus maidennii* and *Juniperus procera*. Some *Ficus* species have been planted also. Vegetation plot 3 and zoosite 1.
- Cultivation – This area is mainly on the slopes of the western part of the reserve with a few scattered trees. Maize farms and houses predominate. Fruit trees have also been planted: Mango (*Mangifera indica*) oranges (*Citrus sinensis*), avocado (*Persea Americana*), banana (*Musa* sp) and papaya (*Carica papaya*). Vegetation plot 7,11 and 12.
- Grassland – This area is found near to the border and at the peak of the forest. Tall grasses of *Olyra latifolia*, *Digitaria abyssinica* predominate. Ferns and a few shrubs of *Crotalaria* species can be seen. Fire is a serious problem every year. Vegetation plot 10.
- Submontane and montane forest – This good quality forest is found on the ridge of Nawenge in the southern part. The area is only about 1km². The dominating tree species are: *Allanblackia stuhlmannii*, *Trilepsium madagascariensis*, *Sapium ellipticum*, *Mesogyne insignis*, *Myrianthus holstii*, *Trichilia emetica*, *Antiaris toxicaria*, *Drypetes* sp., *Chrisophylum* sp., and *Maytenus undulata*. Tree ferns, epiphytic ferns and herbs of different kinds are easily seen. Vegetation plots 9 and 13.

Extensive cultivation, encroachment and fire have been the major factors influencing vegetation physiognomy within Nawenge FR.

- *Vegetation plots*

In total 14 vegetation plots were systematically placed throughout the reserve, sampling the four above vegetation types. The dominant vegetation type was cultivation (28% of plots) and plantation forest (21% of plots), with fern dominated, scrub/thicket/bush and submontane forest all found to be in 14% of the plots. Grassland was found in 7% of plots only.

Twenty six plant families and one unknown family sample were recorded within the vegetation plots, with a total of 44 species within 40 genera. Most of the species found in vegetation plots were either forest dependent or forest dwelling species. Twelve forest dependent species were collected: *Xylopiya* sp., *Allanblackia stuhlmannii*, *Harungana madagascariensis*, *Ficus vallis-choudae*, *Mesogyne insignis*, *Trilepsium madagascariensis*, *Syzygium guineense*, *Strombosia schleffleri*, *Rothmania mangajae*, *Odyndia zimmermannii* and *Celtis Africana*. Of these forest dependents, four are Eastern Arc/ lowland forest endemics: *Allanblackia stuhlmannii*, *Harungana madagascariensis*, *Mesogyne insignis* and *Odyndia zimmermannii*. Of the forest dwelling but non dependent species, three are also endemics; *Cylicomorpha parviflora*, *Drypetes usambarica* and *Bersama abyssinica*.

Species of interest include:

Dalbergia melanoxydon used for black wood carving and an expensive timber in the world market

Monathotaxis dictyonearua a climbing shrub endemic to Mahenge mountains and last collected in 1932

Impatiens kirkii an epiphytic herb growing on trees in dense moist forest

Allanblackia stuhlmannii an endemic tree to the Eastern Arc Mountains. The fruit is good to extract for cooking oil. The Forest Division may try to commercialise this.

Coffea sp collected in Nawenge but not described taxonomically according to the Flora of Tropical East Africa (FTEA).

Holarrhena pubescens used for medicinal purposes, for treatment of influenza, venereal diseases and stomach disorders.

- *Regeneration plots*

Fourteen regeneration plots were established within the FR. The regeneration of trees and shrubs is very poor with only four plots having regenerating trees. Each was a different habitat type with *Harungana madagascariensis* found in the plantation forest, *Sorindeia madagascariensis*, *Syzygium sp.*, *Allanblackia stuhlmannii*, *Balsama abyssinica*, *Strombosia scheffleri* and *Afrocelsalicia ceraliferai* in submontane forest and *Psidium guava* in cultivation.

- *Opportunistic collections*

Casual observations and collections recorded 49 species within 35 families and 47 genera. Of these, 48 had not been recorded within the vegetation plots and consist of various lifeforms; 13 trees, 10 shrubs, 14 herbs, five climbers and five grass species (see Appendix 7b). *Lobelia longisepala* and *Psychotria megalopus* are endemic to the Eastern Arc Mountains (Lovett & Pocs 1993). The rare fern of *Lonchitis occidentalis* was found in the submontane forest. The forest harbours a number of epiphytes such as ferns and Impatiens, which grow on trees in wet and closed canopy forest.

4.2 Fauna

The results of the faunal section summarise two zoological trapsites and five transect lines, with additional information from casual collections.

Table 2 A summary of fauna recorded in Nawenge Forest Reserve (Appendix 8, 9, 10, 11 and 12)

Taxa	Number of families	Number of species
Mammals	12	21
Birds	24	56
Reptiles	4	7
Amphibians	6	15
Butterflies	5	45
Total	51	144

- *Mammals*

At least 21 species of native mammal representing 12 families were recorded in the reserve (Appendix 8). Although the identification of most species is certain, those of species that were captured remains tentative whilst awaiting taxonomic verifications (i.e. all small mammals, including bats) and some of the dung found could only be identified to genus. All taxonomy and nomenclature follows that of Kingdon (1997).

Of the larger mammals recorded from transects only nine species were found, mostly in open areas. These include browsers such as Bushbuck (*Tragelaphus scriptus*), Duiker and Dik dik (*Cephalophus sp.* and *Madoqua kirkii*), as well as Bushpig (*Potamochoerus africanus*), Cane rat (*Thryonomys sp.*), Water Mongoose (*Ichneumia albicauda*), another unidentified Mongoose, African civet (*Civettictis civetta*) and the Common genet (*Genetta genetta*). Two primate species were recorded, both common, the Vervet monkey (*Cercopithecus aethiopicus pygerythrus*) and Yellow baboon (*Papio cynocephalus*). Vocalisations were heard of the Mozambique or Grant's galago (*Galagoides granti*), a forest dependent species that inhabits the East African coast between the Zambezi and Rufiji rivers. As a part of the Eastern Arc Mountains and close to the Selous Game Reserve, it is highly likely that once there would have been large mammal activity, such as leopard, elephant, buffalo, present within the area. However due to the close proximity to people and the general habitat destruction, no signs were recorded of these

species. In the southern part of the Mahenge mountains, for example Sali FR, a more pristine habitat and isolation from human activity has enabled elephants to continue to live within these parts.

No signs of domestic animals were recorded; the steep terrain and small grassland patches making it unsuitable for grazing, in addition to the high levels of cultivation occurring throughout the reserve.

Of the smaller mammals, zoological trapping resulted in captures of 12 species within seven families, including bats. For the rodents, 21 specimens were taken from 137 captures (excluding recaptures) from 1589 sherman trapping nights. Three species were found to be forest dependent, Lesser pouched rat (*Beamys hindei*), Climbing shrew (*Sylvisorex* sp) and Brush-furred mouse (*Lophuromys flavopunctatus*), of which the former is also an endemic to the Eastern Arc Mountains and classified as Vulnerable by IUCN. One small mammal was classed as a forest dweller, but not dependent upon it, Soft-furred rat (*Praomys delectorum*). Other species are found to live in a variety of habitats; Bush rat (*Aethomys* sp.), Narrow footed woodland mouse (*Grammomys dolichurus*), Common mouse (*Mus minutoides*), African dormouse (*Grahiurus* sp.), Horseshoe bat (*Rhinolophus clivosus*), the Evening bat (*Scotoecus* sp.), white-toothed shrews (*Crociodura* sp.) and a squirrel. Rodent captures were highest in the submontane forest averaging 25 captures per night. The species dominating the trapsites were *Lophuromys flavopunctatus* and *Grammomys dolichurus* at trapsite one with *Beamys hindei* and *Praomys delectorum* at trapsite two. *Beamys* is known to share habitats in which dominant species are *Praomys* and *Aethomys*, the latter being the third most common rodent in trapsite two. Three dormice were also found in the submontane forest.

Thirty two shrews were caught within the trapsites, most of which were identified to be of the genus *Crociodura*, White-toothed shrew. One individual was preliminary identified as a Climbing shrew (*Sylvisorex*), captured at trapsite two. However without expert identification using dentition and the skull morphology, identification to species level was not possible but it is likely that they represent a variety of species.

- *Birds*

At least 56 species of bird representing 24 families were recorded in the Nawenge FR (Appendix 9) during timed species counts. Observations took place over a 14 hour time period. Many of these were birds that inhabit disturbed areas, such as plantation forest and cultivated land. All identifications are considered certain. All taxonomy and nomenclature follows that of Stevenson and Fanshawe (2002).

Each bird was ranked after the scores were added cumulatively for all timed counts (see Table 3). The most common bird species are those that are able to live in a variety of habitats and are widespread throughout Tanzania. The ten least common were not necessarily those of a more closed canopy habitat, but were populous at a lower frequency, such as Long Crested Eagle, thus harder to see.

In terms of distribution ranges, the Black saw-wing has been recorded previously further north and west. Likewise the Red-rumped swallow (*hirundo daurica*) shows a similar range distribution as the Black saw-wing, thus both are recorded further south of their previous ranges. The Southern black flycatcher (*Melaenornis pammekaina*) is widespread in Tanzania, but distribution around the Mahenge mountain area is uncertain.

Bertram's weaver (*Ploceus bertrandi*) is restricted to Southern Tanzania, usually from 900-1800m, therefore it was encountered at the lower end of its altitudinal range. The Black-throated wattle-eye (*Ptyseira peltata*) is widespread but patchily distributed and not numerous, with the Marsh Tchagra (*Tchagra minuta*) thinly distributed in its range. Four species of birds were forest dependent, being the Peters Twin-spot (*Hypargos niveoguttatus*), White-tailed blue flycatcher (*Elminia albicauda*), Mountain yellow warbler (*Chloropeta similes*) and Dark-backed weaver (*Ploceus bicolor*). The Mountain yellow warbler was seen at a much lower altitude than expected as it is normally common from 1800 - 3400m.

Several migrant species were present in the area, being common visitors from Sept to March/April. These were: Common Buzzard (*Buteo buteo*), Black Cuckoo (*Cuculus clamosus*), European bee-eater (*Merops apiaster*) and Willow warbler (*Phylloscopus trochilus*).

Table 3 Ten most common and uncommon birds seen within Nawenge FR

Family	Species	Common Name	Ecol. Type	End. status	Rank
Pycnonotidae	<i>Pycnonotus barbatus</i>	Common Bulbul	O	W	1
Sylviidae	<i>Cisticola cantans</i>	Singing Cisticola	O	W	2
Fringillidae	<i>Serinus citrinelloides</i>	African Citril	O	W	3
Ploceidae	<i>Ploceus bertrandi</i>	Bertrams Weaver	O	N1	4
Laniidae	<i>Laniarius aethiopicus</i>	Tropical Boubou	O	W	5
Sylviidae	<i>Prinia subflava</i>	Tawny-flanked Prinia	O	W	5
Nectariniidae	<i>Hedydipna collaris</i>	Collared Sunbird	f	W	7
Sylviidae	<i>Camaroptera brachyura</i>	Grey-Backed Camaroptera	f	W	8
Ploceidae	<i>Euplectes capensis</i>	Yellow Bishop	O	W	9
Musophagidae	<i>Turaco livingstonii</i>	Livingstones Turaco	f	W	10
Fringillidae	<i>Serinus mozambicus</i>	Yellow-fronted Canary	O	W	44
Laniariidae	<i>Tchagra australis</i>	Brown-crowned Tchagra	O	W	48
Columbidae	<i>Treron calva</i>	African Green Pigeon	O	W	50
Muscicapidae	<i>Batis molitor</i>	Chin-spot Batis	O	W	51
Hirundinidae	<i>Hirundo daurica</i>	Red-rumped Swallow	O	?	51
Accipitridae	<i>Lophaetus occipitalis</i>	Long-crested Eagle	O	W	51
Muscicapidae	<i>Melaenornis pammelaina</i>	Southern Black Flycatcher	O	W	51
Hirundinidae	<i>Riparia paludicola</i>	Plain Martin	O	W	51
Laniariidae	<i>Tchagra minuta</i>	Marsh Tchagra	O	W	51
Muscicapidae	<i>Pltysteira peltata</i>	Black-throated Wattle-eye	f	W	58

F = Forest dependent species; f = forest dwelling species, not dependent; O = primarily inhabiting more open habitats, such as woodland, grassland

W = widespread distribution; N1 = restricted range, Southern Tanzania

- *Reptiles*

Seven species of reptile representing four families were recorded in Nawenge FR (Appendix 10). All identifications of species that were captured remain tentative whilst awaiting taxonomic verifications. All taxonomy and nomenclature follows that of Spawls *et al.* (2002).

One forest dependent, endemic to Eastern Arc / Coastal forests species was found, the Bearded pygmy chameleon (*Rhampholeon brevicaudatus*). This species has a conservation status as vulnerable (UDSM 1997). The Green mamba (*Dendroaspis angusticeps*) was seen as a casual observation and is a forest dwelling species. The other captures were species able to live in a variety of habitats, such as the Flap-necked chameleon (*Chameleo dilepsis*), Burrowing asp (*Atractaspis aterrima*), Twig snake, (*Thelothornis capensis*), Loveridge's limbless skink (*Melanoseps loveridgei*) and the Snake-eyed skink (*Panaspis wahlbergii*). Two specimens were taken that were only identified to genera, *Lygosoma* sp. and *Proscelotes* sp. and one individual taken could not be identified.

- *Amphibians*

Fifteen species of amphibian (of which four could not be identified at all) representing at least six families were recorded in the reserve (Appendix 11). Thirty specimens were taken from 83 individuals captured during 1320 bucket pitfall trapping nights. All identifications remain tentative whilst awaiting taxonomic verifications. All taxonomy and nomenclature follows that of Channing (2001).

Of particular interest was the presence of Kirk's Caecilian (*Scolecophorus kirkii*) caught in a bucket pitfall trap and casually after rain. This is a forest dependent species. Caecilians are leg-less worm-like amphibians of the order Gymnophonia. Although widespread in distribution, they are difficult to observe and capture. They are thought to feed on earthworms and other invertebrates – little else is known of their ecology. One other forest dependent species caught at trapsite was *Spelaeophyrne methneri*, a microhylid frog. It is confined to the Eastern Arc and Coastal forests of Tanzania and Kenya.

Of the Arthroleptidae family, the 'Squeakers', three species of frog were caught; the Common squeaker (*Athroleptidae stenodactylus*) a generalist species found in many habitats providing there is leaf litter, and the most numerous capture in the reserve; an unknown squeaker species (*Arthroleptis* sp.), and; the Dwarf squeaker (*Schoutedenella xenodactyloides*), a resident of both forest and grassland swamps. Its only known predator is the Vine snake, *Thelotornis capensis*, also recorded within the reserve.

Within the Microhylidae family, the Mossambique rain frog (*Breviceps mossambicus*), the Banded rubber frog (*Phrynomantis bifasciatus*) and the Rain frog (*Probreviceps* sp) were caught. They are essentially savanna forms of the genus, *miombo* woodland being a part of the savanna ecosystem complex.

One frog was caught from the Hyperolidae family, the Senegal kassina (*Kassina senegalensis*) and the spotted reed frog (*Hyperolius puncticulatus*). The Kassina is essentially a savanna form, whilst the reed frog is forest dwelling but not dependent. *Phrynobatrachus* sp. was captured from the Ranidae family.

Four different frogs were caught but were not identified. These await taxonomic identification.

- *Butterflies*

Forty five species of butterfly representing five families were recorded in Nawenge FR (Appendix 12) with a total of 161 captures made. At least two species from the family Hesperidae, five species of the family Lycaenidae, 32 species of Nymphalidae, two species of Papilionidae and five species of Pieridae were recorded. Identifications remain tentative whilst awaiting taxonomic verifications. All taxonomy and nomenclature follows that of Larsen (1991).

Both the Hesperidae and Lycaenidae families are under represented as they are small butterflies and often difficult to see and catch. Most species were widely distributed, occupying a variety of habitats, from forest, woodland and grassland to gardens and cultivation.

Four forest dependent butterflies were recorded, two from Lycaenidae, *Uranotauma falkensteini* and *Uranotauma heritsia*, with two from Nymphalidae, *Charaxes druceanus* and *Gnophodes betsimena*. No endemic species were found; most butterflies had a wide distribution in a broad range of habitats. Nine butterflies were forest dwelling, eight from Nymphalidae family and one from the Pieridae family.

Three specimens were unidentifiable to genus, one from the Hesperidae family and two from the Nymphalidae family.

- *Molluscs and millipedes*

We await formal identification of 11 mollusc and 38 millipede specimens collected at zoological trap sites and opportunistically throughout the survey.

4.3 Human resource use

Survey work aimed at investigating the level of human disturbance within the reserve from a total length of 6.45km of (five) transect lines and casual observations revealed one of the problems in the forest is clearance for cultivation and agriculture, which covers a lot of the western side of the FR, from steep slopes to the flatlands below. Soil erosion is a major threat. Human activities such as logging, charcoal production and fire were largely not encountered and are minimal threats. Old cut poles and timbers were found along transect two near the villages to the north of the reserve. There were very few signs of traps and fire damage. Paths found throughout the reserve are used as a short cut to reach villages on the west of the FR from Mahenge town. Firewood collection was encountered once in the submontane forest by an old lady from one of the local villages and by people along the FR border, possibly collecting from the plantation at the northern end of the FR. Generally human disturbance above and beyond the damage from agriculture was minimal.

Table 4 Summary results of a pole and timber cutting survey in Nawenge FR

	Total transect length (m)	Total area of transect (m ²)	Total no. sampled	Live (% of total)	Average live per area hectare (ha ²)	Dead (% of total)	Average dead per area hectare (ha ²)	Cut (% of total)	Average cut per area hectare (ha ²)
Poles	6,450	64,500	737	587 (79.6)	91.0	39 (5.3)	6.0	111 (15.1)	17.2
Timbers	6,450	64,500	589	476 (80.8)	74.8	28 (4.7)	4.3	85 (14.4)	13.2

A total of 737 poles and 589 timbers were surveyed along transect lines. Averages of 17.2 poles were cut per hectare with timber cutting observed at a lower frequency with an average of 13.2 per hectare. However with 15.1% and 14.4% cut poles and timbers, extraction is reasonably low. Most cutting was old with only 0.95% and 0.85% of poles and timbers, respectively, being new cut, confirming that this activity at present is low scale.

As well as recording levels of pole and timber cutting, the survey also revealed that 13.2 % of transects (17 out of 129 50m sections) had been damaged to some degree by fire, with most naturally dead poles and timbers dying from this cause (an average of 6.0 and 4.3 per hectare respectively). 22.5% of transects passed through cultivated (29 out of 129 50m transects) land with 4.6% being settlements in the same vicinity (6 out of 129 50m transects). These were located in the western side of the FR.

5. DISCUSSION AND RECOMMENDATIONS

5.1 Flora

An interesting and varied flora was recorded within Nawenge Forest Reserve (Table 5).

Table 5 A summary of floral diversity recorded throughout the Nawenge Forest Reserve (including opportunistic collection).

Taxa	Number of families	Number of species
Trees and shrubs	35	68
Herbs and grasses	12	15
Climbers	5	7
Ferns	2	2
Total	54	92

* This excludes the two unknown trees that were recorded in the reserve.

Of the four habitat types, cultivation was most abundant in the west of the reserve with plantation forests dominating the northern end. Grassland was found further on the east side with the southern ridge having the only small patch of submontane forest left in the reserve. However it is this small isolated pocket of submontane forest that is most important in terms of interesting species and threat, with several floral endemics being found there. Valuable tree species, useful for timber and carving were *Dalbergia melanoxylon* and *Pterocarpus angolensis*. Trees with medicinal value were *Holarrhena pubescens* and *Vangueria infausta*. Various exotic species were present throughout the reserve; plantations were dominated by *Grewillea robusta* and *Eucalyptus* species. Other exotic species were: *Cupressus lusitanica* and *Cedrela odorata*.

Twelve forest dependent tree species were found mostly within the submontane areas of the reserve: *Xylopi* sp., *Allanblackia stuhlmannii*, *Harungana madagascariensis*, *Ficus vallis-choudae*, *Mesogyne insignis*, *Trilepsium madagascariensis*, *Syzygium guineense*, *Strombosia schleffleri*, *Rothmania mangajae*, *Odyendia zimmermannii* and *Celtis Africana*. Of these forest dependents, four are Eastern Arc/lowland forest endemics: *Allanblackia stuhlmannii*, *Harungana madagascariensis*, *Mesogyne insignis* and *Odyendia zimmermannii*. Of the forest dwelling but non dependent species, three are also endemics; *Cylicomorpha parviflora*, *Drypetes usambarica* and *Bersama abyssinica*.

This is the most extensive study conducted within Nawenge, but more studies need to be carried out to ascertain other species, to list further the herbs, grasses and ferns within the habitats. However, it is clear that this is an important area for a variety of flora, some being unsustainably utilised by the local communities and for some Eastern Arc endemics. Emphasis needs to be put on clamping the deforestation and concentrating on regeneration of native species.

5.2 Fauna

A diverse and interesting fauna was recorded within Nawenge Forest Reserve during the current study (Table 6).

Table 6 A summary of faunal diversity and species of biological or conservation interest recorded throughout the Nawenge Forest Reserve.

Total	Number of species*	Species of biol./cons. interest **
Mammals	21	3
Birds	56	5
Reptiles	7	1
Amphibians	15	2
Butterflies	44	3
Total	143	14

* This includes all opportunistic observations together with those from systematic survey work

** This includes species listed as range restricted, of conservation concern (IUCN, CITES), forest-dependent or for which the record in the reserve represents a distribution or altitudinal range extension, but does NOT include the number of forest dwelling species

Most of the forest dependent faunal species were also near endemic and of a high conservation status (e.g. Lesser pouched rat and Bearded pygmy chameleon). As with many forest patches throughout Tanzania, this reflects the habitat destruction by increasing pressure on rural communities, thereby threatening the fauna most dependent on these small isolated pockets of remaining quality forest. Of the eight forest reserves within Ulanga District, Nawenge is one of those close to human villages, increasing the chances of cultivation and non-timber product extraction at an unsustainable rate. The problem is also exacerbated by the small size of the reserve. The lack of large mammals also reflects the recent changes to the reserve due to man's actions. Close proximity to the Selous Game Reserve would predict signs of large mammal use within the reserve, however nothing larger than a Bushbuck or Bushpig was recorded within this study.

The near endemic species found within the reserve are those belonging to the rich and diverse fauna of the Eastern Arc Mountains and Coastal forests, already renowned for high endemism and recognised as a global biodiversity hotspot. Further research needs to be carried out to uncover more endemic species and unique habitats of the fauna within this southern part of the Eastern Arc Mountains. Other studies have been conducted within the Mahenge mountains (Loader, Poynton and Mariaux 2004), primarily targeting herptofauna in Sali FR, which by contrast to Nawenge is remote and is still home to elephant and other larger mammals, as well as important small fauna. Biogeographical analyses between amphibian assemblages of the highland (>850m) Mahenge Mountains and lowland Kilombero Valley show a significant difference in patterns of spatial turnover in species with greater turnover at higher altitude. These results are likely to represent other small fauna too, highlighting the conservation importance of this little known part of the Eastern Arc Mountains. It is imperative that further investigation is conducted sooner rather than later.

5.3 Human resource use

A variety of forms of human resource use were recorded throughout the Nawenge Forest Reserve. The predominant threat to this area is ensuing cultivation, particularly on the western slopes of the reserve. There are also some very low levels of hunting using snare traps and extraction of plants for medicinal use. Cutting for pole and timbers was seen to be minimal and non-threatening, as was fire.

Positive ways in which the Forest department are trying to combat the over cultivation of the area are the introduction of replanting native species. A tree nursery was located in the northern part of the FR and after one year of cultivation the farmers are obliged to leave that plot and replant. However Mr Octavian Nkawamba (Pers. comm) believed the scheme was not as effective as that of a similar case in Arusha.

This needs to be addressed, along with distinguishing boundary borders and combating potential soil erosion.

Ultimately the destruction of the habitat lies in inadequate management strategy and implementation due to lack of financial resources. There is no Joint Forest Management (JFM) plan or activity within Nawenge; there is no ownership or sense of responsibility for local communities. Coupled with expanding human populations and increased pressure on natural resources, it is only a matter of time before irreparable damage is done, if not already. Without JFM, attempts at halting illegal resource use extraction may be futile, especially when authorities cannot regulate the charcoal trade in Mahenge town and elsewhere, and licensed and unlicensed products are indistinguishable. The manual labour is available, due to higher unemployment rates, the market is there and there is no patrolling of the FRs. Catchment and the local communities need to co-ordinate their strengths and motivations to formulate some cohesion and set the JFM in place.

There also remain questions as to the extent to which the aims of biodiversity conservation and maintaining water catchment values are mutually compatible, the latter being the reason for FR status designated to Nawenge. Given that funds are limited, one concern has to be that management initiatives designed to enhance catchment value will take precedence over those that are purely conservation-orientated (such as controlling poaching). However, the prevention of forest loss and fragmentation is a powerful tool for both; nevertheless the key theme of afforestation strategy should shift from plantation (e.g. Nawenge FR) to managing the regeneration of native species.

Priorities cited by Catchment (boundary demarcation, environmental education in local communities, achieving JFM status for reserves such as Nawenge) are a testimony to insufficient and unpredictable patterns of funding. This needs rectifying. Catchment strategies need also to be sophisticated enough to manage reserve-specific threats whilst providing a co-ordinated approach that prevents poachers, loggers etc taking advantage of holes in conservation's defences.

6. CONCLUSION

The findings of this biodiversity survey of the Nawenge Forest Reserve are extremely interesting and reveal the area to be of great importance for a variety of Eastern Arc Mountain endemics, which are forest dependent and threatened by increasing habitat destruction due to an expanding human population. The largest threat is agriculture, which has denuded the western slopes of the main ridge and the lowlands. Other non-timber forest products are being extracted at lower levels, but are a potential threat as non-protected areas are destroyed and pressure mounts to exploit those that are protected by law. However, although officially a protected area, lack of financial resources means that the area is not well managed, such as unclear boundary demarcation, a lack of fire breaks and no patrols. Also, the reserve was originally gazetted for its importance as a water catchment area not for its conservation status and high biodiversity value. This must not be forgotten when funding is sourced and management plans are formulated. Both interests need to be accounted for and the problem of deforestation joins both viewpoints tightly. Joint Forest management is imperative to try to curb the illegal activities occurring in small FRs, such as Nawenge. Funding is crucial so that local stakeholders can be involved in conserving their natural resources, so that there is something worth researching and conserving in the future.

7. REFERENCES

- CITES listing, 2001: Copied from TRAFFIC office, Dar es Salaam, Tanzania, March 2001.
- Channing, A., 2001. *Amphibians of Central and Southern Africa*. Cornell University Press, USA.
- Coates Palgrave, K., 1983. *Trees of Southern Africa*. Struik Publishers (Pty) Ltd, Cape Town.
- Hamilton, A.C. (1989). The place and the problem, a survey of forest types on the East Usambaras using variable-area tree plot method. In A.C. Hamilton & R. Bensted-Smith (eds). *Forest conservation in the East Usambara Mountains, Tanzania* IUCN, Gland. Pp 213-226
- Heywood, V. H., 1993. *Flowering plants of the world*. BT Batsford Ltd, London.
- Hilton-Taylor, C. (compiler) 2002. *2002 IUCN Red List of Threatened Species*. IUCN, Gland, Switzerland and Cambridge.
- Iverson, S.T. (1991a). *The Usambara mountains. NE Tanzania: History, vegetation and conservation*: Uppsala University, Uppsala.
- Kielland, J., 1990. *Butterflies of Tanzania*. Hill House Publishers (Melbourne & London).
- Kingdon, J., 1974. *East African Mammals. An atlas of evolution in Africa. Vol. 2B: Hares and rodents*. University Chicago Press, Chicago.
- Kingdon, J., 1989. *East African mammals. An atlas of evolution in Africa. Vol. 2A: Insectivores and bats*. University of Chicago Press, Chicago.
- Kingdon, J., 1997. *The Kingdon field guide to East African Mammals*. Academic Press, London, 464 pages.
- Knox, E.B., 2000. *List of East African Plants (LEAP). Database compiled largely from the Flora of Tropical East Africa (Rotterdam: Balkema) and Beentje (1994)*.
- Larsen, T. B. 1996. *The Butterflies of Kenya and their natural history*. Oxford University Press, Oxford.
- Loader, S.P, Poynton, J. C and Mariaux, J. *Herpetofauna of Mahenge Mountain, Tanzania: A window on African biogeography*. African Zoology 39 (1).
- Lovett, J.C. & Pócs, T., 1993. *Assessment of the Condition of the Catchment Forest Reserves: a botanical appraisal*. The Catchment Forest Project, Dar es Salaam, Tanzania.
- Mabberley, D.J., 1997. *The Plant-book: a portable dictionary of the vascular plants*. Cambridge University Press, Cambridge, UK.
- Myers, N et al, 2000. *Biodiversity hotspots for conservation priority*. Nature 403: 853-858.
- Passmore, N. I. And V. C. Carruthers. 1995. *South African frogs: a complete guide*. Southern book publishers, Johannesburg.
- Palgrave, K.C. (1983). *Trees of southern Africa*. Second edition. Struik Publishers, Cape Town.
- Passmore, N.I. and V.C. Carruthers (1995). *South African frogs: a complete guide*. Southern book publishers, Johannesburg.

Polhill, D. ,1988. *Flora of Tropical East Africa. Index of collecting localities*. Royal Botanical Gardens, Kew.

SEE, 1998. Methodology report (SEE, 1996. Frontier-Tanzania Forest Research Programme: methodology report 'Old and New'. L. Stubblefield & P. Cunneyworth eds. *Technical paper of the Society for Environmental Exploration*, London).

Spawls S., Howell K., Drewes R & Ashe J., 2002. *A Field Guide to the Reptiles of East Africa*. Academic Press, Hong Kong.

Stevenson T. & Fanshawe J., 2002. *Field guide to the birds of East Africa*. T. & A. D. Poyser, London.

UDSM, 1997. *National Biodiversity Database 1997*. Unpublished. Department of Zoology and Marine Biology, University of Dar es Salaam, Dar es Salaam.

Van Wyk, B. & Van Wyk, P., 1997. *Field guide to trees of Southern Africa*. Struik Publishers (Pty) Ltd, Cape Town.

Walker, C. 1996. *Signs of the Wild*. Struik Publishers (Pty) Ltd, Cape Town.

APPENDIX 1: TAXONOMIC VERIFICATIONS.

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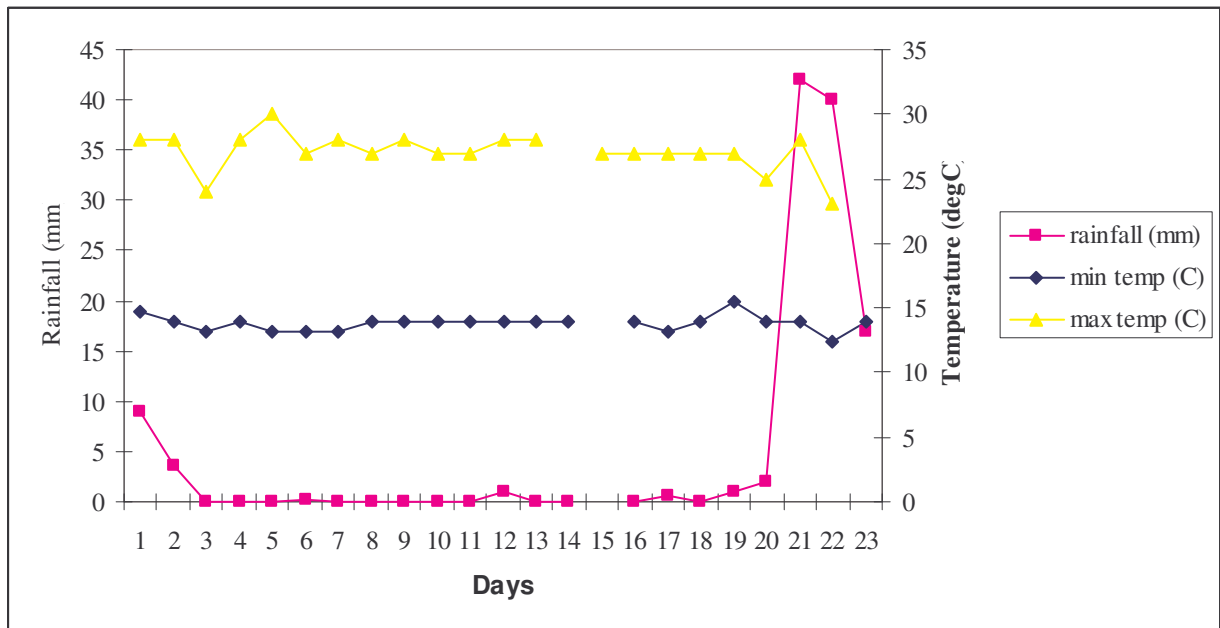
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APPENDIX 2: SUMMARY OF SAMPLING EFFORT OF EACH SURVEY TECHNIQUE EMPLOYED.

Survey technique (and sampling unit)	Target taxa	Total sampling effort
Flora		
Vegetation plot	Trees, shrubs, herbs	14 VPs
Opportunistic obs./collection	Trees, shrubs, herbs	-
Fauna		
Sherman traps (trap-nights)	Small mammals	1589 trap-nights
Bucket pitfall traps (trap-nights)	Reptiles, amphibians, rodents	176 trap-nights
Animal signs transects	Larger mammals	5 transects, 6.45km
Bat netting (mist-net hours)	Bats	301 mist-net hours
Bird surveys (survey hours)	Birds	14 survey hours
Sweep-netting (man-hours)	Butterflies	32 man-hours
Canopy traps (trap-days)	Butterflies	16 trap-days
Opportunistic obs./collection	All animal taxa	-
Human resource use		
Transects	Human resource use	5 transects, 6.45km
Opportunistic observation	Human resource use	-

APPENDIX 3: SUMMARY OF WEATHER CONDITIONS

Summary of weather conditions during survey work between January and February 2003



APPENDIX 4: GPS CO-ORDINATES FOR NAWENGE FR**4a Summary of basecamp and zoological worksites**

Site	Latitude	Longitude	Altitude (m asl)	Major habitat type
Basecamp	08° 41' 41.5"	036° 41' 46.3"	1100	
Zoological trapsite 1	08° 41' 54.0"	036° 42' 03.3"	1200	Plantation forest & grassland
Zoological trapsite 2	08° 41' 54.6"	036° 42' 02.5"	1400	Subsubmontane forest

4b Summary of transects line end points

End point of transect	Latitude (S)	Longitude (E)	Grid reference (E)	Grid reference (N)
Transect Line 1 - East	08° 41' 11.7"	036° 41' 43.0"	02 46395	90 39115
Transect Line 1 - West	08° 41' 10.3"	036° 42' 17.8"	02 47458	90 39164
Transect Line 2 - East	08° 41' 40.0"	036° 42' 20.4"	02 47543	90 38252
Transect Line 2 - West	08° 41' 39.3"	036° 41' 39.6"	02 46295	90 38265
Transect Line 3 - East	08° 42' 09.2"	036° 42' 31.6"	02 47890	90 37357
Transect Line 3 - West	08° 42' 11.7"	036° 41' 40.0"	02 46315	90 37271
Transect Line 4 - East	08° 42' 39.0"	036° 42' 38.9"	02 48120	90 36443
Transect Line 4 - West	08° 42' 43.0"	036° 41' 46.0"	02 46502	90 36310
Transect Line 5 - East	08° 43' 07.4"	036° 42' 25.2"	02 47706	90 35568
Transect Line 5 - West	08° 43' 09.0"	036° 42' 02.5"	02 47013	90 35513

4c Summary of beacon points* and landmarks indicating the FR boundary

Type of point	Beacon number	Grid reference (E)	Grid Reference (N)
Beacon	B1	02 47442	90 39396
Beacon	B2	02 47437	90 39363
Beacon	B3	02 47469	90 39262
Beacon	B4	02 47426	90 39042
Beacon	B5	02 47486	90 38285
Beacon	B6	02 47495	90 38174
Beacon	B7	02 47671	90 37751
Beacon	B8	02 47822	90 37505
Beacon	B9	02 47965	90 37104
Beacon	B10	02 48124	90 36323
Beacon	B11	02 47487	90 35189
Beacon	B12	02 47394	90 35016
Beacon	B13	02 47088	90 34965
Beacon	B14	02 46211	90 36654
Beacon	B15	02 46090	90 37469
Beacon	B16	02 46077	90 37931
Beacon	B17	02 46264	90 38313
Beacon	B18	02 46222	90 39280
Beacon	B19	02 46268	90 39340
Beacon	B20	02 46430	90 39369
Beacon	B21	02 46467	90 39359
Beacon	B22	02 46497	90 39366
Beacon	B23	02 46536	90 39402
Beacon	B24	02 46648	90 39463

Type of point	Beacon number	Grid reference (E)	Grid Reference (N)
Beacon	B25	02 46655	90 39517
Beacon	B26	02 46689	90 39558
Beacon	B27	02 46753	90 39613
Beacon	B28	02 46808	90 39597
Beacon	B29	02 46922	90 39801
Beacon	B30	02 46966	90 39833
Beacon	B31	02 47016	90 39850
Beacon	B32	02 47075	90 39854
Beacon	B33	02 47122	90 39846
Beacon	B34	02 47157	90 39846
Beacon	B35	02 47183	90 39884
Beacon	B36	02 47279	90 39797
Beacon	B37	02 47291	90 39760
Beacon	B38	02 47294	90 39675
Beacon	B39	02 47256	90 39583
Beacon	B40	02 47288	90 39505
Beacon	B41	02 47326	90 39477

4d Summary of botanical opportunistic collection sites

Site	Latitude (S)	Longitude (E)	Site description	Altitude (m)
1	08° 41' 11.6"	036° 41' 59.6"	Lowland, plantation forest	1240m
2	08° 42' 26.0"	036° 42' 26.2"	Subsubmontane forest	1400m

APPENDIX 5: GENERAL VEGETATION PLOT DESCRIPTIONS

Plot no.	Topography	Altitude (m asl)	Slope (degrees)	Vegetation condition	Canopy height (m)	Disturbance category	Feature of interest	No. species	No. indivs	Dominant sp.
1	GLS	1151	17	Plantation forest	>30	None	Rocky outcrops	3	7	<i>Grevillea robusta</i> (exotic)
2	GUS	1232	12	Ferns dominated	<10	Fire, cutting	None	3	3	
3	GMS	1176	15	Plantation forest	10-20	None	None	3	17	<i>Cupressus lusitanica</i> (exotic)
4	VF	1120	2	Cultivation	10-20	Cultivation	Rocky outcrops, stream	2	16	<i>Cedrela odorata</i> (exotic)
5	GLS	1160	8	Scrub/thicket/bush	<10	None	Tracks, rocky outcrops	4	4	
6	R	1240	15	Plantation forest	20-30	Cutting	None	3	20	<i>Eucalyptus</i> sp (exotic)
7	GMS	1170	14	Fern dominated / scrub	<10	Cutting, cultivation	None	0	0	
8	SLS	1210	26	Scrub/thicket/bush	<10	None	Tracks, rocky outcrops	1	1	
9	SUS	1310	30	Subsubmontane forest	>30	None	None	18	40	
10	SMS	1116	31	Grassland	<10	Cultivation	None	4	4	
11	VF	1120	8	Cultivation	10-20	Cultivation	None	2	4	
12	GMS	1250	4	Grassland / cultivation	<10	Cultivation	None	2	3	<i>Ficus sycomorus</i>
13	SUS	1130	35	Subsubmontane forest	20-30	None	Rocky outcrops	9	19	<i>Afrocersalicia ceracifera</i> / <i>Allanblackia stuhlmannii</i>
14	VF	1097	7	Scrub / cultivation	10-20	Cultivation	None	1	7	<i>Mangifera indica</i> (mango)

KEY Topography: G - gentle; S - steep; LS - lower slope; MS - mid slope; US - upper slope; VF - valley floor; R - ridge

APPENDIX 6: REGENERATION PLOT DESCRIPTIONS

Regen. plot	Habitat	Ground cover (%)				Dominance (%)				Soil Texture	Soil colour	No. of inds	No of species
		Herbs	Bare Soil	Litter	Rocks	Grasses	Forbs	Sages	Ferns				
1	Plantation forest	55	15	10	20	80	20	0	0	Loamy-clay	Black	0	0
2	Fern dominated	90	8	0	2	50	10	0	40	Loamy-clay	Brown	0	0
3	Plantation forest	30	30	40	0	40	50	0	10	Loamy-clay	Light grey	2	1
4	Cultivation	40	30	30	0	60	40	0	0	Loam	Black	0	0
5	Scrub/thicket/bush	100	0	0	0	90	10	0	0	Loam	Black	0	0
6	Plantation forest	45	5	50	0	60	40	0	0	Loamy-clay	Black	0	0
7	Fern dominated	90	5	0	5	80	20	0	0	Sandy-loam	Dark grey	0	0
8	Scrub/thicket/bush	90	5	0	5	80	20	0	0	Sandy-loam	Dark grey	0	0
9	Subsubmontane forest	30	20	20	30	40	50	0	10	Sandy-clay	Light grey	2	2
10	Grassland	80	10	0	10	40	10	0	50	Sandy-loam	Dark brown	0	0
11	No RP												
12	Cultivation	50	30	20	0	10	70	0	20	Loam	Dark grey	0	0
13	Grassland / cultivation	60	20	20	0	70	10	0	20	Loam	Black	0	0
14	Subsubmontane forest	30	40	30	0	10	55	10	25	Sandy-loam	Dark grey	8	4
15	No RP												
16	Cultivation / thicket	50	0	50	0	80	20	0	0	Sandy-loam	Dark brown	3	1
MEAN		42	10.9	13.5	3.6	39.5	21.25	0.5	8.75			0.75	0.4

APPENDIX 7: VEGETATIVE DATA

7a Plant species recorded in the vegetation plots in Nawenge FR, following Mabberley (1997) and Palgrave (1996)

Family	Species	Kipogoro name	Lifeform	Ecol. Type	Habitat	Endemic status	Notes
ANACARDIACEAE	<i>Mangifera indica</i>		Tree	f	L&S	W	Mango tree. Can be used for timber, fruits eaten
ANACARDIACEAE	<i>Sorindeia madagascariensis</i> Thouars ex DC. 1825		Smal tree	f	L&S	W1	
ANNONACEAE	<i>Xylopia</i> sp.		Tree	F	L&S	W	Can be used for timber and medicinal
APIACEAE	<i>Steganotenia araliaceae</i>		Tree				
ARALIACEAE	<i>Cussonia arborea</i> Hochst. Ex A. Rich. 1847		Tree	f	L&S&M	W	
BOMBACACEAE	UNKNOWN (VP11)	Mkarangapori	Tree	?	?	?	
CARICACEAE	<i>Cylicomorpha parviflora</i> Urban		Tree	f	L&S&M	N	Often has bees nest in hollow trunk
CHRYSOBALANACEAE	<i>Parinari excelsa</i> Sabine		Tree	f	S	W	Fruit dispersed by bats and elephants
CLUSIACEAE	<i>Allanblackia stuhlmannii</i> (Engl.) Engl.		Tree	F	L&S&M	N	
CLUSIACEAE	<i>Garcinia buchananii</i> Bak.		Tree	f	L&S&M	W	
CLUSIACEAE	<i>Harungana madagascariensis</i> Poir		Tree	F	S	N	
COMPOSITAE	<i>Vernonia</i> sp.		Tree	?	?	?	
CUPRESSACEAE	<i>Cupressus lusitanica</i>		Tree	f	?	W	Exotic species
DRUCAENACEAE	<i>Dracaena mannii</i>		Tree	?	?	?	
DRUCAENACEAE	<i>Dracaena</i> sp.		Tree	?	?	?	
EBENACEAE	<i>Diospyros</i> sp.	Nakatitu	Tree	?	?	?	
EUPHORBIACEAE	<i>Bridelia micrantha</i> (Hochst.) Baill 1862	Mwizia	Tree	f	L&S&M	W	
EUPHORBIACEAE	<i>Drypetes usambarica</i> (Pax) Hutch		Tree	f	L&S&M	N	
EUPHORBIACEAE	<i>Myrianthus holstii</i> Engl.		Tree	f	S	W	
EUPHORBIACEAE	<i>Sapium ellipticum</i> Jacq.		Tree	f	L	W	
FLACOURTIACEAE	<i>Oncoba spinosa</i>		Smal tree	O	L&S&M	W	
LOGANIACEAE	<i>Strychnos</i> sp.		Shrub	?	?	?	
MELIACEAE	<i>Cedrella odorata</i> L.		Tree	?	?	W	Exotic species
MELIACEAE	<i>Trichilia emetica</i> Vahl	Papa	Tree	f	L&S	W	

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Family	Species	Kipogoro name	Lifeform	Ecol. Type	Habitat	Endemic status	Notes
MELIACEAE	<i>Trichilia</i> sp.		Tree	?	?	?	
MELIANTHACEAE	<i>Bersama abyssinica</i> Fresen		Tree	f	S	N	
MORACEAE	<i>Ficus</i> sp.		Tree	?	?	?	
MORACEAE	<i>Ficus sycomorus</i>	Mkuyu	Tree	f	L&S	W	Can be used for firewood, carvings, fruit, medicine
MORACEAE	<i>Ficus vallis-choudae</i> Delile		Tree	F	L&S	W	
MORACEAE	<i>Mesogyne insignis</i> Engl.		Tree	F	L&S	N	
MORACEAE	<i>Trilepsium madagascariensis</i> D.C.		Tree	F	S&M	W	
MYRTACEAE	<i>Eucalyptus</i> sp.		Tree	?	?	W	Exotic species
MYRTACEAE	<i>Syzygium guineense</i> (Willd.) DC.	Zambaran	Tree	F	?	W	
OLACACEAE	<i>Strombosia schleffleri</i> Engl.		Tree	F	L&S&M	W	
PROTEACEAE	<i>Grevillea robusta</i>		Tree	?	?	W	Exotic species
RUBIACEAE	<i>Rothmania mangajae</i> (Hiern) Keay		Tree	F	L&S&M	W	
RUBIACEAE	<i>Vangueria infausta</i> Burch	Mviru	Shrub	O	L&S	W	Used for medicine
SAPOTACEAE	<i>Afrocersalicia cerasifera</i>		Tree	f	L&S	W	
SAPOTACEAE	<i>Chrysophyllum gorungosanum</i> Engl.		Tree	F	S	W	
SAPOTACEAE	<i>Manilkara sulcata</i>		Tree	?	?	?	
SIMAROUBACEAE	<i>Odyndia zimmermannii</i>		Tree	F	S	N	
ULMACEAE	<i>Celtis africana</i> Burm. F		Tree	F	L&S&M	W	
UNKNOWN (VP9)			Tree	?	?	?	
VERBENACEAE	<i>Vitex doniana</i> Sweet.	Mfuru	Tree	f	L&S	W	

KEY TO ABBREVIATIONS FOR TABLE 7A

Ecological type: (based on Iversen, 1991b)

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

Habitat: (where possible based on Hamilton, 1989)

- L - Lowland: Species occurring at altitudes less than 850m above sea level;
- S - Subsubmontane: Species occurring at altitudes greater than 850m above sea level.
- M - Submontane 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 Mahenge Mountains
- N - Near endemic: Species with limited ranges in the Eastern Arc Mountains and/or the East African lowland forests;
- W - Widespread distribution.

7b Opportunistic botanical collection within Nawenge FR

FAMILY	GENUS	SPECIES	AUTHOR	LIFE FORM
ACANTHACEAE	<i>Jasticia</i>	<i>nyassana</i>	Lindau	Herb
ANNONACEAE	<i>Monanthes</i>	<i>dictyoneura</i>		Shrub
APOCYNACEAE	<i>Holarrhena</i>	<i>pubescens</i>	(Buch. -Ham.) Wall.	Tree
APOCYNACEAE	<i>Saba</i>	<i>comorensis</i>	(Boj)Pichon	Vine
ARACEAE	<i>Culcasia</i>	<i>scandens</i>	P.beauv	Climber
ASTERACEAE	<i>Aspilia</i>	<i>abyssinica</i>	Oliv &Hiern	Herb
BALSAMINACEAE	<i>Impatiens</i>	<i>keilii</i>		Herb
COMMELINACEAE	<i>Commelina</i>	<i>africana</i>	L	Herb
CONNARACEAE	<i>Byrsocarpus</i>	<i>orientalis</i>	(Baill) Baker	Shrub
CONVOLVULACEAE	<i>Ipomea</i>	<i>sp</i>		Herb
CUPRESSACEAE	<i>Junipresus</i>	<i>procera</i>	Hochst. Ex Endl.	Tree
DENNSTAEDTIACEAE	<i>Lonchitis</i>	<i>occidentalis</i>		Ferns
DRACAENACEAE	<i>Dracaena</i>	<i>afromontana</i>		Shrub
DRACAENACEAE	<i>Dracaena</i>	<i>laxissima</i>	Engl	Vine
EUPHORBIACEAE	<i>Macaranga</i>	<i>capensis</i>	(Baill) Sim	Tree
GESNERIACEAE	<i>Streptocarpus</i>	<i>sp</i>		Herb
GRAMINEAE	<i>Olyra</i>	<i>latifolia</i>		Grass
LABIATAE	<i>Leucas</i>	<i>holstii</i>	Guerke	Shrub
LILIACEAE	<i>Asparagus</i>	<i>falcatus</i>	L	Climber
LOBELIACEAE	<i>Lobelia</i>	<i>longispala</i>		Herb
LOGANIACEAE	<i>Strychnos</i>	<i>spinosa</i>	Lam.	Tree
LORANTHACEAE	<i>Loranthus</i>	<i>sp</i>		Parasite
MALANTHOCLOACEAE	<i>Malanthocloa</i>	<i>leucantha</i>	(K.Schum.) Milne-Redh	Shrub
MARRATTIACEAE	<i>Marattia</i>	<i>fraxinea</i>	Sm	Fern
MELASTOMACEAE	<i>Memecylon</i>	<i>sp</i>		Shrub
MENISPERMACEAE	<i>Stephania</i>	<i>abyssinica</i>	(Dill&Rich) Walp	Climber
MIMOSACEAE	<i>Albizia</i>	<i>versicolor</i>	Welw	Tree
MORACEAE	<i>Antiaris</i>	<i>toxicana</i>	Leschen.	Tree
MORACEAE	<i>Milicia</i>	<i>excelsa</i>	Benth.& Hook.f	Tree
MUSACEAE	<i>Ensete</i>	<i>edule</i>	(Gmel) Horan	Herb
PAPILIONACEAE	<i>Crotolaria</i>	<i>sp</i>		Shrub
PAPILIONACEAE	<i>Dalbergia</i>	<i>melanoxyton</i>	(Guill.&Perr)	Tree
PAPILIONACEAE	<i>Desmodim</i>	<i>adscendens</i>	(Sw) Dc	Herb
PAPILIONACEAE	<i>Erythrina</i>	<i>abyssinica</i>	Lam.	Tree
PAPILIONACEAE	<i>Mucuna</i>	<i>pruriens</i>	Dc	Climber
PAPILIONACEAE	<i>Pterocarpus</i>	<i>angolensis</i>	Dc	Tree
PIPERACEAE	<i>Piper</i>	<i>umberatum</i>	L	Herb
POACEAE	<i>Digitaria</i>	<i>abyssinia</i>		Grass
RUBIACEAE	<i>Tarrena</i>	<i>pavettoides</i>	(Harv) Sim	Tree
RUBIACEAE	<i>Coffea</i>	<i>sp</i>		Shrub
RUBIACEAE	<i>Psychotria</i>	<i>megalopus</i>		Tree
RUBIACEAE	<i>Rothmania</i>	<i>manganjae</i>	K.Schum) Bullock ex Oberm	Tree
SAPOTACEAE	<i>Chrysophyllum</i>	<i>sp</i>		Shrub
SAPOTACEAE	<i>Englerophytum</i>	<i>natalensis</i>	(Sond) J.H.Hensley	Tree
VITACEAE	<i>Cissus</i>	<i>sp</i>		Climber
ZAMIACEAE	<i>Zamioculcas</i>	<i>loddigesii</i>	Schott	Shrub
ZINGIBERACEAE	<i>Afromomum</i>	<i>angustifolium</i>	(Sonnerat) K.Schum	Herb

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ZINGIBERACEAE	<i>Costus</i>	<i>sarmentosus</i>	Bojer	Herb
ZINGIBERACEAE	<i>Costus</i>	<i>subbiflorus</i>	K.Schum	Herb

APPENDIX 8: MAMMAL DATA

8a Small mammal species recorded in Nawenge FR following Kingdom (1997). Voucher specimens are currently under going formal taxonomic verification (Appendix 1).

Family	Common name	Ecol. Type	End. status	Threat status			No. of individuals captured (recaptures)			KMh no.s	
				IUCN 2002	USDM 1997	CITES 2001	Trap sites	Casual	Total		
Cricetomyinae											
<i>Beamys hindei</i>	Lesser pouched rat	F	N	Vu				14	0	14	23914
Muridae											
<i>Aethomys</i> sp.	Bush rat	O	W				9 (1)	0	9		25766, 25769, 26024,
<i>Grammomys dolichurus</i>	Narrow-footed woodland mouse	O	W				16 (8)	0	16		23631, 25762
<i>Lophuromys flavopunctatus</i>	Brush-furred mouse	F	W				33 (5)	0	33		23658, 23906-08, 23957-58
<i>Mus minutoides</i>	Common mouse	O	W				4	0	4		26044
<i>Mus</i> sp.							1	0	1		25768
<i>Praomys delectorum</i>	Soft-furred rat	f	W				57 (39)	0	57		23916-17, 26027
Myoxidae											
<i>Graphiurus</i> sp.	Dormouse	O	W				3	0	3		23657, 23915, 25765
Rhinolophidae											
<i>Rhinolophus clivus</i>	Horshoe bat	O	W				1	0	1		23962
Sciuridae											
?	Squirrel	?	?				1	0	1		
Soricidae											
<i>Crocidura</i> sp.	White-toothed shrew	?	?				32 (2)	0	32		23902-4, 23909-11, 23913, 23918-19, 23959, 25760-61, 25763-64, 26022-23, 26025-26, 26033-34
<i>Sylvisorex</i> sp.	Climbing shrew	F	?				1	0	1		23912
Vespertilionidae											
<i>Scotoecus hirundo</i>	Evening bat	O	W				1	0	1		23963

8b Large mammal species recorded in Nawenge FR following Kingdom (1997). Voucher specimens are currently under going formal taxonomic verification (Appendix 1).

Species	Common name	Local name	Evidence	Habitat recorded from	Ecol. Type	End. status	Threat status		
							IUCN 2002	USDM 1997	CITES 2001
Bovidae									
<i>Madoqua kirkii</i>	Dik Dik	Digi digi	Tracks	BU, CU	f	W			
<i>Tragelaphus scriptus</i>	Bushbuck	Pongo	Track	BU	f	W			
Cercopithecidae									
<i>Cercopithecus aethiopicus pygerythrus</i>	Vervet Monkey	Tumbili	Track	BU	O	W			II
<i>Papio cynocephalus</i>	Yellow baboon	Nyani	Track	BU	O	W			
Herpestidae									
<i>Ichneumia albicauda</i>	Water mongoose	Nguchiro	Track	GR	O	W			
?	Mongoose	Nguchiro	Dung	GR	O	W			
Thryomyidae									
<i>Thryonomys</i> sp.	Cane rat	Kungusi	Dung, hole	PF, GR	O	W			
Viverridae									
<i>Civettictis civetta</i>	African Civet	Funo	Dung	GR	O	W			
<i>Genetta genetta</i>	Common Genet	Kano	Dung	CU	O	W			

KEY TO ABBREVIATIONS FOR APPENDIX 8

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 Mahenge 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

CITES listings:

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

Vegetation type:

- CU = Cultivation
- GR = Grassland
- PF = Plantation forest
- BU = scrub / thicket / bush

APPENDIX 9: BIRD DATA

Birds species recorded in Nawenge FR, following Stevenson & Fanshawe (2002)

Species	Common Name	Ecol. Type	End. status	IUCN	CITES	Rank	Notes
Accipitridae							
<i>Buteo buteo</i>	Common Buzzard	O	W		II	38	Migrant species sep-apr
<i>Lophaetus occipitalis</i>	Long-crested Eagle	O	W		II	51	
Alcedinidae							
<i>Halcyon albiventris</i>	Brown-Hooded Kingfisher	O	W			26	
<i>Ispidina picta</i>	Pygmy Kingfisher	f	W			28	
Apodidae							
<i>Apus affinis</i>	Little Swift	O	W			44	
Bucerotidae							
<i>Bycanistes brevis</i>	Silvery-cheeked Hornbill	f	W			13	
<i>Tockus alboterminatus</i>	Crowned Hornbill	f	W			28	Wo and forest edges
Capitonidae							
<i>Stactolaema olivacea</i>	Green Barbet	f	W			23	fo, wo
Coliidae							
<i>Colius striatus</i>	Speckled Mousebird	O	W			34	
Columbidae							
<i>Streptopelia semitorquata</i>	Red-Eyed Dove	f	W			16	
<i>Turtur afer</i>	Blue-Spotted Wood-Dove	f	W			23	
<i>Treron calva</i>	African Green Pigeon	O	W			50	But can be forest edge
Cuculidae							
<i>Centropus superciliosus</i>	White-browed Coucal	O	W			20	
<i>Cuculus clamosus</i>	Black Cuckoo	O	W			38	intra-African migrant to Fe, wo, wo gr and thicket
Emberizidae							
<i>Emberiza cabanisi</i>	Cabanis's Bunting	O	W			31	Incl. Forest edge, uncommon
Estrildidae							
<i>Estrilda astrild</i>	Common Waxbill	O	W			13	
<i>Hypargos niveoguttatus</i>	Peters Twinspot	F	W			12	Forest undergrowth, thicket
<i>Lagonosticta rubricata</i>	African Firefinch	O	W			21	
<i>Estrilda quartinia</i>	Yellow-bellied Waxbill	O	W			21	Incl. Forest edge. 900-3000m

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Species	Common Name	Ecol. Type	End. status	IUCN	CITES	Rank	Notes
Fringillidae							
<i>Serinus citrinelloides</i>	African Citril	O	W			3	Incl. Forest edge
<i>Serinus mozambicus</i>	Yellow-fronted Canary	O	W			44	
Hirundinidae							
<i>Hirundo daurica</i>	Red-rumped Swallow	O	?			51	Distribution shows west and north Tz, out of range for Mahenge
<i>Hirundo fuigula</i>	Rock Martin	O	W			44	Most numerous in highlands
<i>Psalidoprocne holomelas</i>	Black Saw-wing	f	?			25	more highland. Out of range for south tz, west and north recordings
<i>Riparia paludicla</i>	Plain Martin	O	W			51	large flocks occur over water, esp highlands
Laniariidae							
<i>Dryoscopus cubla</i>	Black-backed Puffback	O	W			18	Incl. Forest edge
<i>Tchagra australis</i>	Brown-crowned Tchagra	O	W			48	
<i>Tchagra minuta</i>	Marsh Tchagra	O	W			51	thinly distributed within range, inhabits rank vegetation along streams, tall wet grassland edge of marshes
Laniidae							
<i>Laniarius aethiopicus</i>	Tropical Boubou	O	W			5	
Meropidae							
<i>Merops apiaster</i>	European Bee-Eater	O	W			13	Palaertic migrant, south sep-nov, north mar-may
Muscicapidae							
<i>Batis molitor</i>	Chin-spot Batis	O	W			51	
<i>Elminia albicauda</i>	White-tailed Blue Flycatcher	F	W			38	Restricted for Forest and forest edge at 1600-2500m but has occurred at 1200m, Mahenge out of range map, recorded further west
<i>Melaenornis pammelaina</i>	Southern Black Flycatcher	O	W			51	Widespread in Tz, but question mark for Mahenge area
<i>Musicapa caerulescens</i>	Ashy Flycatcher	f	W			36	Commonly in middle levels of forest edges and along well-wooded rivers
<i>Pltysteira peltata</i>	Black-throated Wattle-eye	f	W			58	Widespread but patchily distributed and not numerous in variety of Forest and woodland
<i>Terpsiphone viridis</i>	Paradise Flycatcher	f	W			16	Common in variety of habitats incl. Forest
Musophagidae							
<i>Turaco livingstonii</i>	Livingstones Turaco	f	W		II	10	mature wo and riveirne fo
Nectariniidae							
<i>Anthrepte longuemarei</i>	Western Violet-backed Sunbird	f	W			44	
<i>Cinnyris venusta</i>	Variable Sunbird	O	W			26	
<i>Hedydipna collaris</i>	Collared Sunbird	f	W			7	

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Species	Common Name	Ecol. Type	End. status	IUCN	CITES	Rank	Notes
Phoeniculidae							
<i>Phoeniculus purpureus</i>	Green Wood-hoopoe	f	W			28	
Picidae							
<i>Dendropicos fuscescens</i>	Cardinal Woodpecker	O	W			38	Forest edge and wo, bush
Ploceidae							
<i>Euplectes capensis</i>	Yellow Bishop	O	W			9	
<i>Ploceus bertrandi</i>	Bertrams Weaver	O	N1			4	Restricted to mountains of SE Tz in wooded country by streams from 900-1800m
<i>Ploceus bicolor</i>	Dark-backed Weaver	F	W			38	
<i>Ploceus ocularis</i>	Spectacled Weaver	O	W			11	Incl. Forest edge
Pycnonotidae							
<i>Phyllastrephus</i> sp?	Greenbull spp (Cabanis?)	?	?			34	
<i>Pycnonotus barbatus</i>	Common Bulbul	O	W			1	
Sylviidae							
<i>Apalis flavida</i>	Yellow-breasted Apalis	f	W			36	
<i>Camaroptera brachyura</i>	Grey-Backed Camaroptera	f	W			8	
<i>Chloropeta similis</i>	Mountain Yellow Warbler	F	W			19	common in forest and bambo at higher altitudes from 1800-3400m
<i>Cisticola cantans</i>	Singing Cisticola	O	W			2	forest edge and other dense vegetation
<i>Phylloscopus trochilus</i>	Willow Warbler	O	W			31	Common Palearctic visitor from sep-may
<i>Prinia subflava</i>	Tawny-flanked Prinia	O	W			5	
Turdidae							
<i>Cercotrichas quadrivirgata</i>	Eastern Bearded Scrub-robin	f	W			38	Shy, stick to dense vegetation
<i>Cossypha heuglini</i>	White-browed Robin Chat	O	W			31	Incl. Forest edge

KEY TO ABBREVIATIONS FOR APPENDIX 9

Ecological (Ecol.) type:

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Endemic (End.) status:

- E – Endemic: Species only found in the Mahenge Mountains.
- N – Near endemic: Species with limited ranges in Southern Tanzania
- W – Widely distributed species.

IUCN status:

- EN – Endangered
- VU – Vulnerable
- LR/NT – Lower risk / Near threatened

CITES listings:

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

Abbreviations used in Notes:

- Bu - bush
- FE - Forest edge
- FO - Forest
- GDN - garden
- GR - Grassland
- RF - Riveirne forest
- WO - woodland

APPENDIX 10: REPTILE DATA

Reptiles species recorded in Nawenge FR following Spawls, *et al.* (2002). Voucher specimens are currently undergoing taxonomic verification (Appendix 1)

Family	Common name	Ecol. Type	End. status	Threat status			No. of individuals captured			KMH no.s
				IUCN 2002	UDSM 1997	CITES 2001	Trap sites	Casual	Total	
Chameleonidae										
<i>Chamaeleo dilepsis</i> *	Flap necked chameleon	O	W				0	1	1	23884
<i>Rhampholeon brevicaudatus</i>	Bearded pygmy chameleon	F	N		VU		2	0	2	23886
Colubridae										
<i>Atractaspis aterrima</i>	Burrowing Asp	O	W				1	0	1	23887
<i>Thelotornis capensis</i> *	Twig snake	O	W				0	1	1	
Elapidae										
<i>Dendroaspis angusticeps</i> *	Green mamba	f	W				0	1	1	
Skinkidae										
<i>Lygosoma</i> sp.		?	?				1	0	1	23885
<i>Melanoseps loveridgei</i>	Loveridge's limbless skink	O	W				1	0	1	23888
<i>Panaspis wahlbergii</i>	Snaked-eyed skink	O	W				1	0	1	23889
<i>Proscelotes</i> sp		?	?				1	0	1	23883
Unknown		?	?				1	0	1	23890

* Casual sightings outside of zoosite

APPENDIX 11: AMPHIBIAN DATA

Amphibian species recorded in Nawenge FR following Channing (2001) and Passmore & Carruthers (1995). Voucher specimens are currently undergoing taxonomic verification (Appendix 1).

Family	Common name	Ecol. Type	End. status	Threat status			No. of individuals captured (recaptures)			KMH no.s
				IUCN 2002	USDM 1997	CITES 2001	Trap sites	Casual	Total	
	Unknown sp. A	?	?				9	0	9	23846, 23852, 23980
	Unknown sp. B	?	?				1	0	1	23842
	Unknown sp. C	?	?				1	0	1	23834
	Unknown sp. D	?	?				1	0	1	23983
Arthroleptidae										
	<i>Arthroleptis stenodactylus</i>	Common squeaker	f	W			21	2	23	23836, 23838, 23985
	<i>Arthroleptis</i> sp.	Squeaker	?	?			11	0	11	23835, 23841, 23843-45, 23847, 23849, 23851,
	<i>Schoutedenella xenodactyloides</i>	Dwarf Squeaker	f	W			13	0	13	23836, 23981
Hyperolidae										
	<i>Hyperolius puncticulatus</i>	Spotted reed frog	f	W			0	1	0	23839
	<i>Kassina senegalensis</i>	Senegal kassina	O	W			2	0	2	23832
Microhylidae										
	<i>Breviceps mossambicus</i>	Mossambique rain frog	O	W			13	1	14	23831
	<i>Probreviceps</i> sp.	Rain frog	?	?			2	0	2	23942, 23984
	<i>Phrynomantis bifasciatus</i>	Rubber frog	O	W			8	0	8	23833, 23850
	<i>Spelaeophyrne methneri</i>		F	N			2	0	2	23833, 23850
Ranidae										
	<i>Phrynobatrachus</i> sp.		f	W			1	0	1	23840
Scolecophoridae										
	<i>Scolecophorus kirkii</i>	Kirk's caecilian	F	W			1	1	2	23347

KEY TO ABBREVIATIONS FOR APPENDIX 10 and 11

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Endemic (End.) status:

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- W – Widely distributed species.

IUCN status:

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

CITES listings:

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

APPENDIX 12: BUTTERFLY DATA

Butterfly species caught in Nawenge FR following Larsen (1996), voucher specimens are currently undergoing taxonomic verification (Appendix 1).

Genus	Common name	Ecol. Type	End. Status	Individual numbers caught at trapsites			
				1	2	Casual	Total
Hesperiidae							
<i>Zenonia zeno</i>	Orange spotted skipper	O	W	0	1	0	1
<i>Unknown species</i>		?	?	3	0	0	3
Lycaenidae							
<i>Anthene otacilia</i>	Trimen's ciliate blue	O	W	0	1	0	1
<i>Cacyreus sp 42</i>	Bush blue	?	?	0	1	0	1
<i>Euchrysops malathana</i>	Smokey bean cupid	O	W	1	0	0	1
<i>Uranotauma falkensteini</i>		F	W	1	0	0	1
<i>Uranotauma heritsia</i>		F	W	2	0	0	2
Nymphalidae							
<i>Acraea cabira</i>	Yellow banded acraea	O	W	1	0	0	1
<i>Acraea johnstoni</i>		f	W	3	1	0	4
<i>Acraea lycoa</i>		f	W	9	0	0	9
<i>Acraea pharsallus</i>		O	W	0	1	0	1
<i>Acraea sotikensis</i>	Sotik acraea	f	W	1	0	0	1
<i>Bicyclus campinus</i>		O	W	13	0	0	13
<i>Bicyclus ena</i>	Grizzled bush brown	O	W	0	1	0	1
<i>Bicyclus safitza</i>	Common bush brown	O	W	32	6	0	38
<i>Byblia anvataria</i>	African joker	O	W	0	1	0	1
<i>Charaxes cithaeron</i>	Blue spotted charaxes	O	W	1	0	0	1
<i>Charaxes druceanus</i>	Silver barred charaxes	F	W	1	0	0	1
<i>Eurytela dryope</i>	Golden piper	f	W	1	0	0	1
<i>Eurytela hiarbas</i>	Pied pier	f	W	0	3	0	3
<i>Gnophodes betsimena</i>	Banded evening brown	F	W	2	0	0	2
<i>Hypolimnas misippus</i>	Variable eggfly	O	W	1	0	0	1
<i>Junonia tera</i>	Soldier commodore	O	W	23	0	0	23
<i>Neocoenyra gregorii</i>		O	W	1	4	0	5
<i>Neocoenyra cf masaica</i>		f	W	3	1	0	4
<i>Neocoenyra sp</i>		?	?	0	2	0	2
<i>Neptis kiriakoff</i>	Kariakoff's sailor	O	W	0	1	0	1
<i>Neptis sp 54</i>	Sailor	?	?	0	1	0	1
<i>Pseudacraea lucretia</i>	False chief	f	W	1	0	0	1
<i>Sallya boisduvali</i>	Brown tree nymph	O	W	6	1	0	7
<i>Sallya garega</i>		O	W	4	0	0	4
<i>Sallya morantii</i>	Obscure tree nymph	f	W	9	0	0	9
<i>Sallya sp A</i>	Tree Nymph	?	?	1	0	0	1
<i>Sallya Sp B</i>	Tree Nymph	?	?	1	0	0	1
<i>Sallya Sp C</i>	Tree Nymph	?	?	1	0	0	1
<i>Unknown specimen 47</i>		?	?	0	1	0	1
<i>Unknown specimen 53</i>		?	?	0	1	0	1
<i>Ypthima sp</i>	Three-ring	?	?	0	1	0	1
Papilionidae							
<i>Papilio ophidicephalus</i>	Emperor swordtail			0	1	0	1

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Genus	Common name	Ecol. Type	End. Status	Individual numbers caught at trapsites			
				1	2	Casual	Total
<i>Papilio sp</i>	Swordtail	?	?	0	1	0	1
Pieridae							
<i>Belenois sp</i>	Caper white	?	?	0	1	0	1
<i>Eurema desjardinsi</i>	Angled grass yellow	O	W	1	1	0	2
<i>Eurema floricola</i>	Malagasy grass yellow	O	W	0	2	0	2
<i>Eurema hapale</i>	Marsh grass yellow	f	W	1	0	0	1
<i>Eurema hecabe</i>	Common grass yellow	O	W	0	2	0	2
Total				124	37	0	161

APPENDIX 13: SUMMARY OF HUMAN RESOURCE USE DATA

Transect number	Length of transect (m)	Average numbers per transect line							
		No. live saplings	No. naturally dead sapling	No. old cut saplings	No. new cut saplings	No. live timbers	No. naturally dead timbers	No. old cut timbers	No. new cut timbers
1	1100	99	14	47	1	104	6	30	0
2	1200	96	3	16	6	123	4	16	5
3	1700	232	8	17	0	159	9	20	0
4	1700	105	3	21	0	76	7	12	0
5	750	55	11	3	0	14	2	2	0
Total	6450	587	39	104	7	476	28	80	5