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SOUTH NGURU MOUNTAINS:
a description of the biophysical landscape

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Key words: Biodiversity, endemic, South Nguru Mountains, Eastern Arc Mountains, Mvomero, Tanzania, Kanga Forest Reserve, Mkindo Forest Reserve.

Front cover photographs (clockwise from top left): *Callulina* sp. nov. is one of the new species of amphibian recorded during the surveys. Photo by Michele Menegon, 2005.
Charcoal harvested from woodland near Kanga. Photo by David Loserian 2005.
Leopard caught on a camera trap in Kanga.
View of the South Nguru landscape from Kanga F.R. Photo by Andrew Perkin.

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Executive Summary

This report presents a description of the biophysical characteristics of the South Nguru landscape including hydrology, geology, soils, climate, biodiversity and forest use. The report includes data collected by TFCG, combined with those of previous surveys and publications.

The South Nguru Mountains in Mvomero District, Morogoro Region are part of the globally important Eastern Arc Mountain forests. BirdLife International recognises the area as an **'Important Bird Area'** and Conservation International recognize the Eastern Arc to be part of the **'Eastern Afromontane Biodiversity Hotspot'**. The Eastern Arc is also one of WWF's '**Global 200 Ecoregions'**.

The area includes three Central Government Forest Reserves: Nguru South F.R., Kanga F.R. and Mkindo F.R with lowland, submontane and montane forest surrounded by extensive areas of woodland, subsistence agriculture, sugar and teak plantations and settlement. The total area of the mountain block is estimated to be 1,703.26 km^2 of which 340.4 km^2 is forest.

The mountains rise from 320 m a.s.l. to 2400 m a.s.l in Nguru South Forest Reserve. They are located between 5^o50'S and 6^o10'S and 37^o25'E and 37^o47'E.

The **geology** of the mountains can be summarized as pre-Cambrian basement rock, block faulted and uplifted during the Cretaceous period. The bedrock is predominantly gneiss and granulite and to a lesser extent schists and granites.

Based on data from **weather** stations at low and mid-altitude, mean annual temperatures vary between 12^o – 24^o C with rainfall records of between 1000 mm – 2100 mm, with considerably more rainfall estimated at higher altitude. There is a drier period between June and August while rainfall peaks in March and April.

The mountains are part of the Wami River **catchment basin** which provides water for Chalinze, the Mtibwa Sugar plantation and many villages.

Between October 2004 and May 2006, the Tanzania Forest Conservation Group in collaboration with the Museo Tridentino di Scienze Naturali (Italy), the Zoological Museum of the University of Copenhagen and Missouri Botanical Gardens conducted **bird, mammal, reptile and amphibian surveys** in Kanga F.R., Nguru South F.R., Mkindo F.R. and in adjacent woodland. As a result of these surveys, combined with a review of the literature, the biodiversity values of the area are summarized in Table 1.

Table 1. Summary of the species richness and endemism in the South Nguru Landscape.

Taxon	Total number of species	Number of South Nguru endemics	Number of Eastern Arc Endemics	Number of Eastern Arc Near Endemics
Plants	322	5	50	11
Animals				
Mammals	34	0	2	6
Birds	214	0	3	12
Reptiles	43	1	9	5
Amphibians	38	8	9	4
TOTAL	**651**	**14**	**73**	**38**

Relative to other Eastern Arc Mountain blocks, only the Udzungaws, Ulugurus and East Usambaras have more endemic species (strict endemics, Eastern Arc Endemics and Eastern Arc near-endemics) than the South Ngurus. The South Ngurus are particularly important for their amphibian fauna and have **more strict endemic species than some entire biodiversity hotspots**.

Within the South Nguru landscape, there are **1 critically endangered**, **8 endangered**, **10 vulnerable** 2 near-threatened, and 1 data deficient animal species and **20 vulnerable plant** species based on IUCN threat classifications.

The following types of **disturbance** were recorded within Nguru South, Mkindo and / or Kanga Forest Reserves: agricultural encroachment including cardamom, banana and yam cultivation in the forest understorey and forest clearance for bean and cocoa cultivation; timber harvesting; livestock grazing; pole cutting; firewood collection; hunting for duiker, bush pig, primates, hyrax and other mammals; wild bird and insect collection for trade; gold mining; fire and charcoal production. There are also settlements within the Nguru South Forest Reserve at Ubiri. The teams considered that the level of disturbance caused by cardamom cultivation, hunting and timber harvesting had reached critical levels and that urgent action is needed.

In conclusion, the South Nguru landscape is a diverse landscape. The area has globally important biodiversity values and is of national importance for its water catchment properties. Threats to the forest are critically high and urgent action is required to address these threats.

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Protected Area Authorities

We are grateful to the Director of Forestry, the Morogoro Regional Catchment Forest Officer and the Mvomero District Forest Officer for their permission and support in conducting these surveys.

Technical Reporting

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1 Introduction

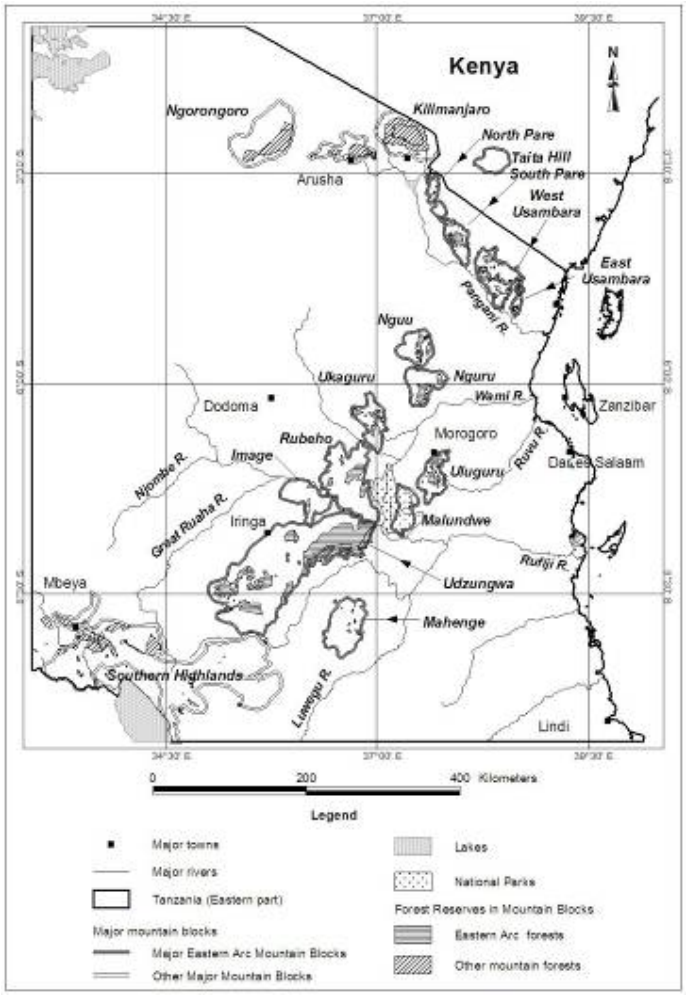
1.1 Background

This report describes the results of the PEMA biophysical study of the South Nguru landscape. The report aims to provide an overview of the physical and biological landscape of the South Nguru landscape. There is a particular focus on the biological values of the forest. The report aims to provide information for people working with the relevant protected areas authorities, civil society organizations, research institutions and development partners. A summary of the results in Swahili has been published.

The report includes sections on the physical landscape including climate, hydrology, soils and geology; the biological landscape including the plants and animals of the South Ngurus; and on human use of the forests.

The report summarises original research conducted with the support of the PEMA programme by researchers from TFCG, the Museo Tridentino di Scienze Naturali and the Zoological Museum of the University of Copenhagen as well as summarising results of a literature review.

Map 1. Map of the Eastern Arc Mountains.



1.2 About the Eastern Arc Mountains

The South Nguru Mountains are part of the Eastern Arc Mountains. The Eastern Arc is a range of mountains that stretches from the Taita Hills in southern Kenya to the Udzungwa Mountains in southern Tanzania. Nationally, these mountains are an important water catchment area supplying water to Dar es Salaam, Morogoro, Iringa, Chalinze, Tanga and many other smaller settlements. Internationally, the area is part of a biodiversity hotspot and is one of the earth's most important areas for the conservation of biodiversity. In large part this is because of the high concentration of endemic species.

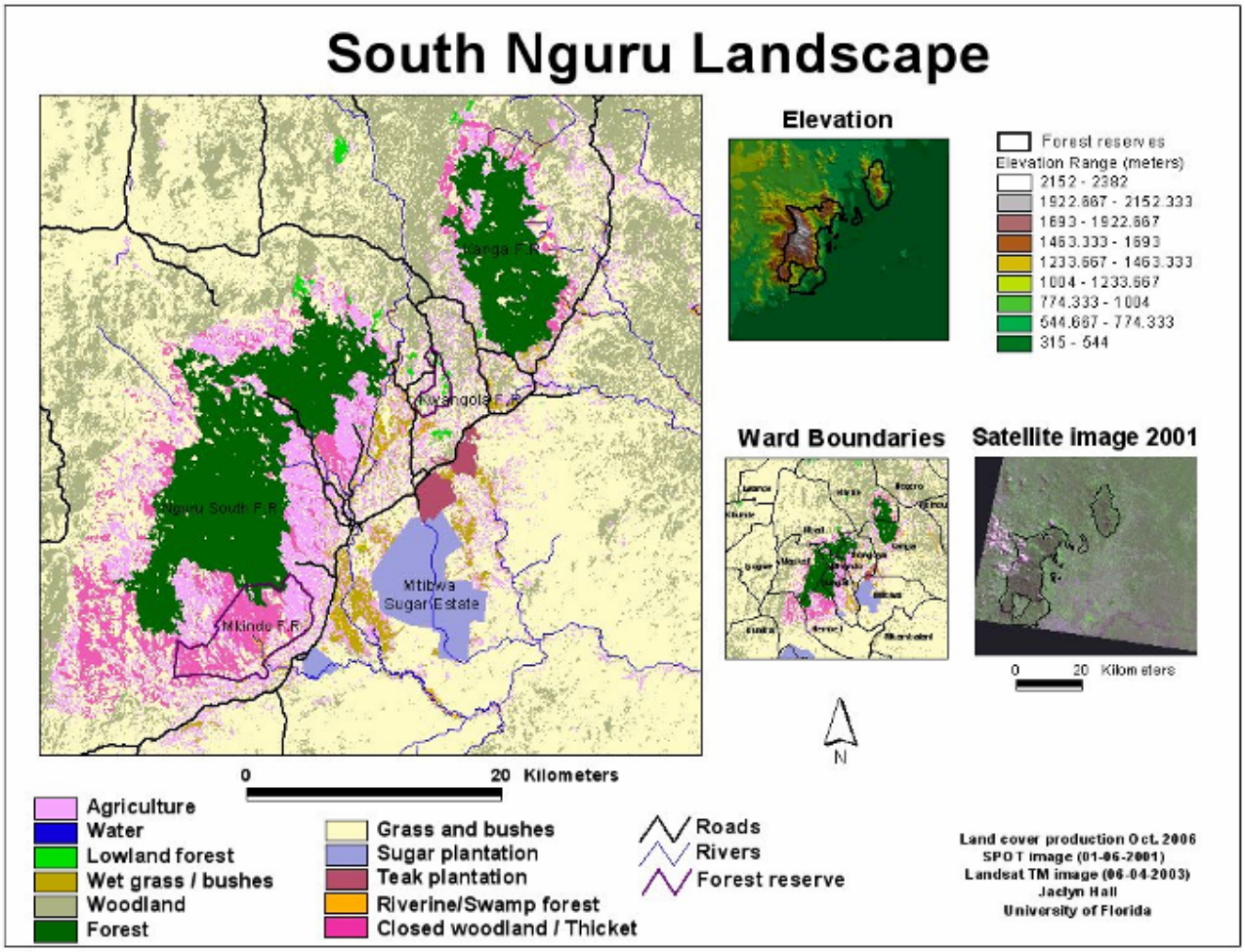
1.3 About the South Nguru Mountains

The South Nguru Mountain landscape is located between 5° 50' S to 6° 10'S and 37° 25'E 37° 47'E. The area is located in Morogoro Region, Mvomero District and includes Hembeti, Maskati, Mtibwa, Diongoya, Kanga, Mhonda, Kibati and Mvomero wards. There are three main forest reserves within the landscape which are summarized in Table 2. There are also two lowland reserves Dunduma and Lusunguru.

Table 2. Overview of the forest reserves of the South Nguru Mountains.

Forest Reserve	Area (ha)	District	Region	JB	Ownership	Min altitude (m)	Max altitude (m)
Kanga	6,664	Mvomero	Morogoro	1059	TT	380	2,018
Nguru South	18,792	Mvomero	Morogoro	84	TT	760	2,300
Mkindo	9,086	Mvomero	Morogoro	2034	TT	380	1,000
Lusunguru (also known as Lusungula)	1,047 (protective) 122 (productive	Mvomero	Morogoro	1658	TT		
Dunduma (proposed)	52.6	Mvomero	Morogoro	594	TT		

The mountains rise from 320 m a.s.l. to 2,400 m a.s.l in Nguru South Forest Reserve. The area is a mosaic of forest, woodland, heath, thicket, subsistence agriculture and plantation. The total area of the mountain block is estimated to be 1,703.26 km^2 of which 340.4 km^2 is forest (Burgess *et al*. 2007).



Map 2. Map of the South Nguru Landscape. Prepared by Jaclyn Hall.

1.4 *About the PEMA Programme*

The PEMA Programme is a partnership which in Tanzania includes the Tanzania Forest Conservation Group and CARE- Tanzania. Other partners include BirdLife Denmark, CARE-Denmark, CARE-Uganda, the Danish Institute for International Studies, NatureUganda, The World Wide Fund for Nature – Denmark, and the World Wide Fund for Nature – Eastern African Regional Programme Office.

PEMA's mission is to pilot and promote an approach to the management of natural resources in high biodiversity areas that reconciles the conservation and development interests of multiple stakeholders at local, national and international levels.

1.5 Defining key terms used in the report

A number of terms are used in various sections of this report and for the sake of consistency are defined here.

Eastern Arc Mountains: the range of ancient, block-faulted mountains under the climatic influence of the Indian Ocean that stretch from the Taita Hills in Southern Kenya down to the Udzungwa Mountains in Tanzania. The Eastern Arc Mountains include the following mountain blocks (from North to South): Taita, North Pare, South Pare,

West Usambara, East Usambara, Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Malundwe, Mahenge and Udzungwa Mountains.

Eastern Arc Endemic species (EA): these are species whose ranges are restricted to the Eastern Arc Mountains.

Eastern Arc near-endemic species (EA N): these are species whose ranges are restricted to the Eastern Arc Mountains as well as the Coastal forests from Kenya to Mozambique, Kilimanjaro, Meru and / or the Kenya Highlands and / or Southern Rift (including Rungwe, Matengo, Namuli, Nje and Malawisi).

Degree of forest dependence

FF: Strictly confined to forest;
F: Mainly forest, but also found outside;
f: Forest visitor;
O: Non-forest species

2 Geology and Soils

2.1 Introduction

The geology and soils of the South Nguru Mountains are typical of many other Eastern Arc Mountains.

2.2 *Methods*

The information included here is based on a review of the relevant literature. No original research was conducted on the geology and soils of the area.

2.3 Results

2.3.1 Overview of the geology of the area

The South Nguru mountains have their origin in Precambrian rock from the break up of Gondwanaland and subsequent uplifting and faulting during the Cretaceous period (Axelrod & Raven, 1978). The bedrock of the mountains and the surrounding area belong to the upper group of the Usagaran System within the Mozambique belt, which is the structural unit in which a wide variety of sedimentary and volcanic rocks have been subjected to a similar metamorphic history (Axelrod & Raven, 1978). The main constituent of the bedrocks is gneiss and granulite and to a lesser extent schists and granites (Awadalla, 1970).

2.3.2 Overview of the soils

On the mountains the main soil types are typically loamly entisols and ultisols with good drainage. In the drier foothills and plains more sandy entisols and vertisols are typical whereas in water-logged plains, inceptisol loams are more predominant.

Above 1,400 m a.s.l. the soils are acidic lithosols, ferralitic latosols, and in valleys deeper fluvisols, over Precambrian crystalline gneisses, graniolite and magmatites. In Mkindo forest soils are sandy brown loams over gneissic basement rock with some areas of seasonal inundation and rock outcrops on hills. In Kanga forest, soils are acidic lithosols, ferralitic latosols, with deeper fluvisols at the base, over Precambrian crystalline gneisses, graniolite and migmatite

Although no systematic data on erosion rates was found, Monela (1995) noted that during heavy rainfall in 1968, 1971 and 1988 / 89, large landslides occurred on the slopes above Turiani village, claiming several lives and destroying hectares of fertile land and property. He suggests that the landslides were connected with the rapid clearance of forest in the slopes above Turiani. Additional work to assess changing rates of soil erosion and the risks of land slides is required.

2.4 Discussion

Additional research is required into the soils of the area particularly in terms of the impact of forest clearance on soil structure and erosion rates.

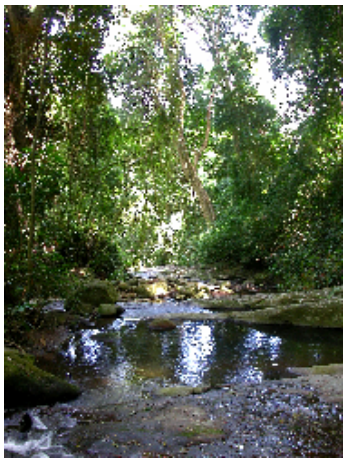
3 Hydrology

3.1 Introduction

The South Nguru Landscape is the main water catchment area for the Wami River. This river provides water to Chalinze Town, the Mtibwa sugar plantation and many villages in Morogoro and Coast Region. The Wami River flows into the Indian Ocean 86 km north-west of Dar es Salaam and 150 km from Nguru South Forest Reserve.

3.2 Methods

The information included here is based on a review of the relevant literature. No original research was conducted on the hydrology of the area.



3.3 Results

Nguru South Forest Reserve is the source of the Divue, Dikurura, Lubuta and Diwale streams. Kanga is the source of Chazamoyo and Mkange streams and Mkindo and Nguru South are the soure of the Mkindo and Chazi streams. All of these streams are part of the catchment area for the Wami River.

The Mvaji stream is a source of piped water for domestic use in Turiani and Mhonda villages. Apart from water for domestic and agricultural use, the streams are also a source of fish for local consumption and sale.

There are 14 river gauging stations in the Wami River basin of which two are in the South Nguru landscape. Most of the Wami river gauging stations were established in the 1950s and 1960s and provided data until the late 1980s. After the 1980s, data was no longer collected systematically. The two gauges within the South Nguru landscape are at the Dakawa Bridge on the Wami River (6^{o} 26' 55.6" S and 37 ^{o} 32' 01" E) which was operational between November 1953 and 1983 and at Ngomeni on the Diwale River (6 ^{o} 8' 38.6" S and 37 ^{o} 35' 45.8") which was operational between January 1964 and December 1989. FBD (2005) reported that in 2005, the staff gauges in the range 1 – 6 m were in relatively in good order at Dakawa Bridge except the 0 – 1 m staff which is slightly tilted. The gauge reading was 0.94 m during the time of the visit. The riverbed has a sandy alluvial bed. The riverbanks rise gently and are covered by aquatic grasses. The land area around the station is a floodplain. The Ngomeni guage is non-operational according to FBD (2005).

Research undertaken through the Conservation and Management of the Eastern Arc Mountain forests found no significant change in annual river flows in the Wami. However, an analysis of changes in seasonal river flows found significant declines in river flows during all seasons (FBD, 2005a). Additional research is required to understand this apparent inconsistency.

There is no long-term data available on the water quality of the Wami River although periodic studies have been conducted. Recent records indicate that: 'Nitrate concentration, turbidity and pH were high while bacteriological water quality indicators were poor. The general observation is that the rivers are polluted following the disposal of solid waste and wastewater discharges into the rivers by industries. Some results from rivers near the Mtibwa Sugar estate revealed water pollution due to clogging of Waste Stabilization Ponds (WSP) resulting in overflows discharging into the rivers' (FBD, 2005).

3.4 Discussion

While it is known that the South Nguru Mountains are an important catchment area for the Wami River, the available river flow data is intermittent and water quality data is largely lacking. An improved understanding of the hydrology of the area is important in demonstrating the value of the South Nguru forests for national development. This is particularly relevant if discussions on payments for environmental services are to be established.

4 Climate

4.1 Introduction

The climate of the South Nguru Mountains is typical of the Eastern Arc Mountains in being strongly influenced by the Indian Ocean.

4.2 Methods

The information included here is based on rainfall data from Mtibwa and Mhonda stations and a review of the relevant literature. Temperatures are based on Lovett and Pócs (1992). No original research was conducted on the climate of the area as part of this survey.

4.3 Results

There are at least five rainfall stations within the South Nguru Landscape:

NAME	LAT	LONG	ALT (m)	Startyr
KWEKIVU SCHOOL	-5.77	37.38	853	1951-02-01
SONGE PRIMARY SCHOOL	-5.58	37.28	1150	1976-01-01
MASKATI	-6.08	37.47	1829	1936-10-01
MHONDA MISSION	-6.13	37.58	488	1904-03-01
MVOMERO CCM	-6.32	37.43	487	1938-08-01
LUKENGE MTIBWA SUGAR LTD	-6.00	37.60	395	1974-06-07
MAKUYU VILLAGE	-6.02	37.20		1981-12-28
KANGA PRIMARY SCHOOL	-6.02	37.75		1981-12-28

Based on data published in FBD (2005a).

The area is dominated by oceanic rainfall with oceanic temperatures. Data from these stations indicate that on the eastern slopes the estimated rainfall is between 2,100 mm/year at lower altitude to 3,000-4,000 mm/year at 2,000 m altitude. On the drier western slopes the rainfall is estimated to be between 1,000-2,000 mm/year. There is rainfall throughout the year but the driest period is between June, July and August with highest rainfall in March and April. Mean annual temperatures vary with altitude from 24^0 C to 12^0 C. At altitude temperatures can fall to close to 0^0 C in July and August.

4.4 Discussion

Rainfall patterns in the South Ngurus are typical of other Eastern Arc Mountains with increasing rainfall with altitude and drier conditions on the western slopes. The absence of a weather station at altitude means that only estimates of the rainfall and temperature is available. This may result in an underestimate of the rainfall. Additional research is required to understand the relationship between forest loss in the South Ngurus and the local climate.

5 Vegetation

5.1 Introduction

The South Nguru landscape consists of a mosaic of montane, submontane and lowland moist forest, dry montane forest, heath, open woodland, closed woodland and thicket interspersed with subsistence agriculture, teak plantation, sugar plantations and other commercial agriculture. Botanically, the area is less well known than the Uluguru, Udzungwa and Usambara Mountains in the Eastern Arc although collections have been made there by several collectors (Lovett, 1998).

5.2 Methods

5.2.1 Literature review

A review of recent literature was made with a particular focus on records of species endemic or near-endemic to the Eastern Arc Mountains.

5.2.2 Collection of botanical specimens

Specimens were taken of all species fruiting or flowering at the time of the surveys. Collections were made of trees, shrubs, herbs, lianas and vines. For each specimen notes were made on the locality (Forest Reserve, local place name, Longitude / Latitude), habitat (altitude, vegetation type, topography) and local name. The form and colour of the plant were also described.

Botanical specimens were collected with secateurs and were then placed in newspaper, labelled, pressed and dried.

Where possible three duplicates were collected for each specimen. These have been sent to:
Herbarium, Botany Department, University of Dar es Salaam
Missouri Botanical Gardens
National Herbarium, Arusha, Tanzania

Specimens were identified at the National Herbarium with reference to the Flora of Tropical East Africa and voucher specimens.

The collections are part of Moses Mwangoka's (MM) series.

5.2.3 Habitat descriptions

Descriptions of the main habitat types have been adapted from Lovett and Pócs (1992).

5.3 Sampling intensity

The work was conducted intermittently over eight months between July 2004 and March 2005 by Moses Mwangoka. A total of 793 collections were made over this period. Collections were made in the following areas:

Kanga Forest Reserve
South Nguru Forest Reserve including areas around Kwamnerwa, Kwamwasa, Kwazinyambo Ridge, Lugotwi, Makunguru, Makweli, Mkuru, Mangidi, Maskati, Mgambo and Lugona River.
Dunduma Forest Reserve
Mbulumi River and near Madukani sub-village which is in general land close to Dunduma Forest Reserve.
Mkindo Forest Reserve
Public land close to Mtibwa sugar plantation.

In total nine days were spent collecting in Kanga Forest Reserve, nine days in Nguru South, nine days in Mkindo Forest Reserve and four days close to Dunduma Forest Reserve.

5.4 Results

5.4.1 South Nguru Forest Reserve

This section is taken from Lovett and Pócs (1992).

The very dissected orography, with steep slopes, deep valleys, high summits, rocky cliffs, and wide range of climatic and soil conditions have resulted in a wide range of vegetation types. Lowland rain forest occurs in valleys

on the eastern slopes between 300 m and 900 m above sea level (asl). Submontane forest covers a large area between 900 and 1,400 m asl in the eastern valleys with fragments on the western slopes at 1,400-1,500 m. Montane forest occurs between 1,400 and 1,800 m with moss covered upper montane forest at higher altitudes, and drier montane forests on the western side above Maskati mission at 1,600-2,000 m. Heath occurs on the upper ridges above 2,000 m, with some isolated stands as low as 1,200 m where soil conditions do not permit forest growth. Woodlands and dry forests occupy large areas in the drier slopes of the Nguru mountains between 400-1,500 m though very little occurs within the reserve. Dry semi-evergreen forests are typical of the northern and southern end of Nguru Mountains, again outside the reserve.

Lowland forest: Canopy with: *Bombax rhodognaphalon*, *Cephalosphaera usambarensis, Erythrophloeum suaveolens*, *Tetrapleura tetraptera* and *Uapaca paludosa*. Lower canopy with: *Memecylon erythranthum*, *Dicranolepis usambarica* and *Mesogyne insignis*. Ground layer with: *Hypolytrum testuim*, *Marantochloa leucantha*, *Calvoa orientalis*, *Geophila obvallata* subsp*. ioides*, *Psychotria pocsii*, *P. tanganyicensis* and the West African *Palisota schweinfurthii*. Riverine forests at this altitude are dominated by *Breonadia salicina*, *Bridelia micrantha*, *Ficus* spp. and *Harungana madagascariensis*.

Submontane forest: The dominant emergents are: *Allanblackia stuhlmannii*, *Beilschmiedia kweo*, *Cephalosphaera usambarensis*, *Chrysophyllum gorungosanum*, *Cylicomorpha parviflora* (usually indicating former pitsawing), *Drypetes reticulata*, *Entandophragma excelsum*, *Isoberlinia scheffleri*, *Mesogyne insignis*, *Myrianthus holstii*, *Newtonia buchananii, Parinari excelsa*, *Polyscias fulva* and *Strombosia scheffleri*. In the lower canopy: *Alsodeiopsis schumannii*, *Garcinia kingaensis*, *Lasiodiscus usambarensis*, *Uvariodendron usambarense* and *Zenkerella egregia*. In the ground layer: *Brachystephanus africanus*, *Leptaspis cochleata*, *Palisota schweinfurthii*, *Renealmia engleri*, *Stenandripsis afromontana* and *Whitfieldia stuhlmannii* occur. On shady cliffs the Nguru endemic African violets *Saintpaulia pusilla* and *S. nitida* occur.

Montane forest: Canopy 20m - 25m dominated by: *Allanblackia uluguruensis*, *Aningeria adolfi-friedericii*, *Bequaertiodendron natalense*, *Chrysophyllum gorungosanum*, *Ficalhoa laurifolia, Garcinia volkensii*, *Ocotea usambarensis* and *Podocarpus milanjianus*. In the lower storeys tree ferns, *Cyathea manniana* and *C. humilis* occur with: *Agauria salicifolia, Peddiea subcordata, Polyscias stuhlmannii*, *Rapanea melanophloeos* and *Xymalos monospora*. In the ground layer *Blotiella stipitata*, *Blechnum attenuatum*, *B. punctulatum*, *Dorstenia schliebenii, Impatiens keilii*, *I. massumbaensis, Plectranthus luteus* and *Streptocarpus bambuseti* occur.

Upper montane forest. The canopy is lower than in the montane forest with: *Balthasaria schliebenii, Garcinia volkensii*, *Ocotea usambarensis*, *Podocarpus milanjianus* and *Schefflera myriantha.* The tree trunks are covered in mosses and epiphytes. Common species include: *Stolzia viridis*, *Mystacidium nguruense*, Lycopodiums and filmy ferns. In the ground flora among the many ferns *Cincinnobotrys oreophilum* and *Cincinnobotrys ranarum* are common. Elfin forest covers the summits and ridges above 2,000 m in the highest rainfall area of the eastern side. Canopy 2-4 (-6) m tall with: *Balthasaria schliebenii, Garcinia volkensii* and *Syzygium cordatum*. The trees are covered by mosses and ferns. The ground is also covered by bryophytes, with cushions of *Mastigophora diclados*, *Sphagnum* spp., *Dicranoloma billarderi* and *Syrrhopodon stuhlmannii*. A characteristic shrub is *Dissotis dichaetantheroides*. On small canopy branches a common orchid is the Nguru and Uluguru endemic, *Tridactyle brevifolium*. The montane bamboo (*Sinarundinaria alpina*) forms extensive stands 4-10 m tall between 2,000 – 2,400 m on the western slopes of Mafulumula summit and on some of the higher western ridges. It replaces elfin forests in drier areas. Undergrowth is sparse and includes: *Streptocarpus bambuseti*, *Peddiea subcordata*, *Rauvolfia mannii*, *Teclea simplicifolia* and *T. trichocarpa*. A characteristic fern is the large *Asplenium linckii*.

Dry montane forest: Canopy 18-20 m with: *Allophylus pervillei*, *Bridelia brideliifolia*, *Drypetes reticulata*, *Flacourtia indica, Leptonychia usambarensis*, *Mussaenda microdonta*, *Parinari excelsa*, *Podocarpus milanjianus*, *Sapium ellipticum*, *Turraea holstii*, *T. floribunda* and *Teclea amaniensis*. Shrubs include: *Coffea mufindiensis*, *Pavetta holstii*, *P. mshigeniana*, *P. sparsipila*, *Psychotria goetzei* and *Solanum kitivuense*. In the ground layer: *Aneilema leiocaule*, *Barleria amaniensis, Impatiens kentrodonta*, *I. nana* and *Streptocarpus caulescens* occur.

Heath: *Erica arborea* and *Philippia usambarica* form small stands on exposed, rocky ridges with shallow soil. In the loose, open stand of Ericaceous shrubs very interesting plants occur such as: *Lobelia* sp. nov., *Struthiola thomsonii*, *Eulophia odontoglossa*, *Rangaeris muscicola*, *Notonia amaniensis*, *Polystachya adansoniae* and *Sticherus inflexus*.

Woodlands: Dominants: *Brachystegia boehmii*, *B. microphylla*, *B. spiciformis*, *Pterocarpus angolensis*.

5.4.2 Kanga Forest Reserve

This section is taken from Lovett and Pócs (1992)

The reserve is covered by a wide range of forest types on the wetter eastern side from lowland through submontane, montane to upper montane forest. There is a short heath on the summit, and large rock outcrops on

the steeper slopes. Woodland occurs in the drier areas in the foothills and on the western side from 380 to 600 m. Buffalo are reported from the western side.

Woodland: Trees to 10 m tall with: *Annona senegalensis*, *Brachystegia boehmii*, *B. microphylla*, *B. spiciformis*, *Diplorhyncus condylocarpon*, *Julbernardia globiflora*, *Kigelia africana*, *Pteleopsis myrtifolia*, *Pterocarpus angolensis*, *Sterculia appendiculata* and *Stereospermum kunthianum*. Along watercourses riverine and groundwater forests occur with *Sterculia appendiculata*, *Ficus exasperata*, *Monanthotaxis trichocarpa*, *Bequaertiodendron natalense*, *Ricinodendron heudelotii* and *Ziziphus pubescens*. The ground layer is dominated by *Aframomum angustifolium* and *Olyra latifolia*.

Lowland forest. From 500 to 800 m, canopy 25 m with emergents to 35 m. Trees include: *Afrosersalisia cerasifera*, *Antiaris toxicaria*, *Bequaertiodendron natalense*, *Cola greenwayii*, *C. stelecantha*, *Erythrophloeum suaveolens*, *Milicia excelsa*, *Parinari excelsa*, *Parkia filicoidea*, *Sapium ellipticum*, *Scorodophloeus fischeri*, *Terminalia sambesiaca*, *Euphorbia candlabrum* and *E. quadrialata* (both tree size up to 20 m), *Tabernaemontana pachysiphon* and *Erythrina sacleuxii*. In the lower canopy *Dracaena deremensis*, *Garcinia buchananii*, *Pandanus engleri* and *Harungana madagascariensis* occur with *Schlechterina mitostemmatoides*, *Nephrolepis biserrata*, *Phymatodes scolopendria* and *Hilleria* sp. in the ground layer.

Submontane forests: From 750 to 1,300 m. Canopy 30-35 m. With: *Allanblackia stuhlmannii*, *Leptonychia usambarensis*, *Myrianthus holstii*, *Macaranga capensis*, *Newtonia buchananii*, *Parinari excelsa* and *Strombosia scheffleri*. On rocky ridges and boulders between 1,000 to 1,300 m on the eastern and southern ridges, an evergreen rock forest occurs with a cycad, *Drypetes reticulata*, *Ficus sur*, *Xymalos monospora* and on the shady cliffs, African violets, *Saintpaulia brevipilosa* (endemic to the Nguru mountains) with *S. nitida*.

Montane forests: From 1300 to 2000 m. With: *Agauria salicifolia*, *Aphloia theiformis*, *Cryptocarya liebertiana*, *Ilex mitis*, *Maesa lanceolata*, *Myrica salicifolia*, *Nuxia congesta*, *Ocotea usambarensis*, *Parinari excelsa*, *Schefflera goetzenii*, *Podocarpus milanjianus*, *Polyscias stuhlamnnii* and *Rapanea melanophloeos*. On the summit the forest trees are covered in moss and the canopy is 5-10 m tall with: *Allanblackia ulugurensis*, *Cussonia lukwangulensis*, *Garcinia volkensii* and *Syzygium cordatum*. On the huge cliffs forming the south face of the main summit the rocks are covered either by a heathlike bush of the 3 m tall *Xerophyta spekei* with the creeping orchid *Neobenthamia gracilis*; or large clumps of *Aloè schliebenii* with *Pentas longituba* and *Urogentias ulugurica*. Peat moss (*Sphagnum* spp.) also occurs on the rocks, indicating a moist environment.

5.4.3 Dunduma Forest Reserve

This section is adapted from Lovett and Pócs (1992):

Lowland forest: Broken, open canopy to 20-30 m tall with tangled shrub layer to 10 m. The dominant tree is *Antiaris toxicaria*, with *Parkia filicoidea* and *Grewia* sp. Levels of disturbance are high in this forest.

Woodland: Scattered trees to 3 m tall in 2 m tall grass.

5.4.4 Mkindo Forest Reserve

This section is taken from Lovett and Pócs (1992):

The vegetation is lowland and riverine forest with grassland clearings on level ground and along rivers, with woodland on the hills in drier areas. Mango trees indicate past cultivation.

Lowland and riverine forest: Broken to intact canopy 20-30 m tall with emergents (*Sterculia appendiculata*) to 40 m. Trees include: *Afrosersalisia cerasifera*, *Albizia* sp., *Antiaris toxicaria*, *Anthocleista grandiflora*, *Breonadia salicina*, *Khaya anthotheca* (formerly *K. nyasica*), *Malacantha alnifolia*, *Milicia excelsa*, *Pachystela brevipes*, *Sterculia appendiculata* and *Trilepisium madagascariensis*.

Woodland: Trees to 10 m, including: *Anonna senegalensis*, *Brachystegia boehmii*, *B. spiciformis*, *Combretum molle*, *Cussonia arborea* and *Pterocarpus angolensis*.

5.4.5 Magotwe Forest Reserve

Lovett and Pócs (1992) describe this as a mix of lowland forest and dry lowland forest however it appears that almost all of the forest has now been cleared for agriculture.

In the valleys groundwater gives rise to the development of lowland forest, whereas on the hills the forest is dry lowland forest.

Lowland forest: Broken canopy 20-30 m with emergent *Sterculia appendiculata* to 40 m. Trees include: *Drypetes natalensis*, *Bequaertiodendron natalense*, *Celtis* sp., *Malacantha alnifolia*, *Pachystela brevipes*, *Parkia filicoidea*, *Ricinodendron heudelotii*, *Trilepisium madagascariensis*, *Uvariodendron* sp. and *Ziziphus pubescens*. *Milicia excelsa* and *Khaya anthotheca* (formerly *K. nyasica*) are reported to occur.

Dry lowland forest: Canopy 15-20 m. Trees include: *Antiaris toxicaria*, *Combretum schumannii*, *Scorodophleus fischeri* and *Tamarindus indica*.

5.4.6 Species inventory

Identifications have been provided to at least genus for 300 species from 81 families. This list also includes 25 endemic and near species recorded in Burgess *et al*. 2007. The complete list is provided in Appendix 3. Additional species await verification.

5.5 Discussion

Within the South Nguru landscape, there are at least nine distinct vegetation types. Botanical species richness is high, as is typical of many Eastern Arc Mountain forests.

In terms of endemism, there are at least five plant species endemic to the South Nguru Mountains. In addition 50 species that are endemic to the Eastern Arc Mountains and 10 that are near endemic have been recorded from the South Ngurus.

The number of restricted range species varied between reserves. Nguru South had the most restricted range species. However given differences in sampling intensity between reserves, comparisons between reserves in terms of the number of restricted range should be treated with caution

There are at least 20 plant species found in the South Nguru Mountains that are considered Vulnerable according to the IUCN red list.

The presence of such high levels of restricted ranage and threatened plant species highlights the importance of this area for conservation.

Many forest plants are used by the surrounding communities for food, fuel wood, medicines and as shade. The forests also provide habitat for the many unique animals found in the area.

6 Fauna

6.1 Birds

By Nike Doggart, Jacob Kiure and Claire Bracebridge

6.1.1 Introduction

The South Nguru Mountains are an important bird area based on the presence of one 'Vulnerable' species: Banded green sunbird and two near threatened species: Southern banded snake eagle and Moreau's sunbird as well as seven restricted range species and the African Highland 'biome-restricted assemblage' (Baker and Baker, 2002). The area is also part of the Tanzania – Malawi Mountains Endemic Bird area.

Bird records from the area are included in: Fischer and Reichenow (1880), Fuggles-Couchman (1939, 1984), Moreau (1940) and Romdal (2001).

The aims of the survey were:

- To survey the bird fauna of Nguru South Forest Reserve, Kanga Forest Reserve, Mkindo Forest Reserve lowland teak plantation and woodland.
- To provide a baseline data set for monitoring the bird fauna of the South Nguru Mountains.

6.1.2 Methods

Two methods were used to record the birds of the South Ngurus: mist netting and observations. In addition a thorough review of the literature was undertaken.

Mist netting

Aim: To record the presence of understorey bird species and to obtain standard biometric data, blood samples and other anatomical details of the birds for later analysis of evolutionary relationships of Eastern Arc montane forest species.

Nets were set at a range of altitudes and were moved every few days in order to maximise catch rates. Twelve nets were used in each locality. Nets were opened just before birds became active and kept open until about half an hour before darkness. Nets were checked at least every hour with most frequent checking occurring in the early morning. Nets were closed during the night to avoid entangling bats.

Observations

Aim: To record the presence of bird species particularly those that are unlikely to enter mist nets such as raptors.

In each forest, survey walks were conducted to record forest birds and raptors using binoculars. Special efforts were made to record species in mixed flocks in an attempt to record some of the restricted range and threatened species.

6.1.3 Survey effort

Bird survey work was conducted by Jacob Kiure at 13 sites for more than 45,634 net metre hours of mist netting and 200 hours of observations (Table 3) between October 2003 and March 2005. In addition Claire Bracebridge made records of birds during a 19 day stay in Mkindo Forest Reserve during May 2006.

Table 3. Bird survey sampling intensity and sites

Site	Coordinates	Altitude (m a.s.l)	Habitat description	Duration of Survey	Amount of time mist netting (net metre hours)	Observation Hrs
Mtibwa Forest Reserve	E 37^0 39' 04" S 6^0 07' 36"	420	Teak plantation with no understorey.	3 days 25 – 27/02/2005	0	24
Msolokelo (general land between South Nguru and Kanga Forest Reserves)	E 37^0 41'12" S 6^0 01' 12"	420-460	Brachystegia woodland .	6 days 1 – 6/03/2005	0	72

Site	Coordinates	Altitude (m a.s.l)	Habitat description	Duration of Survey	Amount of time mist netting (net metre hours)	Observation Hrs
Nguru South Forest Reserve - Jengale Camp	E 37^0 34', 54" S 6^0 00' 28"	1360-1500	Montane forest with cardamom cultivation in the understorey.	7 days 8 – 14/03/2005	5544	u/k
Nguru South Forest Reserve – Lukindo River Camp	E 37^0 35' 00" S 6^0 02' 28"	1600-1760	Montane Forest, with cardamom cultivation in the understorey.	7 days 15- 21/03/2005	7392	13
Nguru South Forest Reserve – Ubiri Camp	E 37^0 33' 39" S 6^0 04' 10"	900	Submontane forest, with cardamom cultivation in the understorey.	4 days 22-25/03/2005	0	18
Mkwajuni Marsh South of Turiani.	E 37^0 35' 15" S 6^0 03' 05"	350	Marsh with papyrus, surrounded by rice cultivation.	3 days 26-28/03/2005	0	14
Nguru South Forest Reserves - Maskati /Kwegoba	E 37^0 29'51'' S 6^0 03'28	2000	Montane forest with bamboo. Some disturbance from cultivation.	7 days 27/09 – 3/10/2004	9180	22
Nguru South Forest Reserve - Maskati/Kwemasilu	E 37^0 28'55'' S 6^0 05 58''	1800-2000	Undisturbed montane forest with some shambas on the way near the camp.	7 days 5 – 11/10/2004	9180	12
Nguru South Forest Reserve - Manyangu Nguru South	E 37^0 33'55'' S 6^0 03' 30''	1100	Disturbed forest with cardamom and yam cultivation.	7 days 13 – 19/10/2004	8560	18
Nguru South Forest Reserve – Bazo Camp	E 37^0 33'15 S 6^0 01' 10	1240		6 days (including 3 days of heavy rain) 20 – 26/10/2004	5508	6
Kanga Forest Reserve – Mkange and Udaha camps	6^0 09's 37^0 29'E	900 and 1200		15 days 15 - 30/11/2003	u/k	u/k
Mkindo Forest Reserve	Various sites throughout the reserve		Woodland with areas of riverine and lowland forest	19 days 1 – 19/05/2006	0	u/k

u/k: unknown. Data not available.

6.1.4 Results

A total of 214 species from 53 families were recorded in the South Nguru Landsacpe. These are summarized in Table 4.

Table 4. Checklist of bird species recorded in the South Nguru landscape.

Species	Common name	Author	Habitat association	Range	Red list	South Nguru FR	Kanga FR	Mkindo	Mtibwa Teak	Woodland	Mkwajuni Marsh
PHALACROCORACIDAE											
Phalacrocorax africanus	Long-tailed cormorant	(Gmelin) 1789	O	W							1
ANHANGIDAE											
Anhinga rufa	African darter	(Daudin) 1802	O	W							1
ARDEIDAE											
Egretta garzetta	Little egret	(Linnaeus) 1758	O	W							1
Ardea melanocephala	Black-headed heron	Vigors and Children 1826	O	W							1
CICONIIDAE											
Anastomus lamelligerus	African open-billed stork	Temminck 1823	O	W							1
THESKIORNITHIDAE											
Bostrychia hagedash	Hadada ibis		O	W				1			
SCOPIDAE											
Scopus umbretta	Hamerkop	Gmelin 1789	O	W				1			1
ANATIDAE											
Anas sparsa	African black duck	Eyton 1838	F	W		1					
ACCIPITRIDAE											
Aviceda cuculoides	African cuckoo hawk	Swainson 1837	F	W			1			1	
Macheiramphus alicinus	Bat hawk	Westerman 1851	F	W						1	
Gypohierax angolensis	Palm nut vulture	(Gmelin) 1788	F	W		1		1	1		
Circaetus cinereus	Brown snake-eagle	Vieillot 1818	O	W						1	
Circaetus fasciolatus	Southern banded snake-eagle	Kaup 1850	O	W		1	1	1			
Terathopius ecaudatus	Bateleur	(Daudin) 1800	O	W			1			1	
Polyboroides typus	African harrier hawk	Smith, A. 1829	F	W		1					
Kaupifalco monogrammicus	Lizard buzzard	(Temminck) 1824	O	W						1	
Accipiter tachiro	African goshawk	(Daudin) 1800	F	W		1	1				
Buteo augur	Augur buzzard	(Ruppell) 1836	F	W		1	1			1	
Buteo oreophilus	Mountain buzzard	Hartert & Neumann 1914	F	W		1	1				
Stephanoaetus coronatus	African crowned eagle	(Linnaeus) 1766	F	W		1	1	1			
Aquila rapax	African tawny-eagle	(Temminck) 1828	O	W						1	
Hieraetus spilogaster	African hawk-eagle	(Bonaparte) 1850	O	W						1	
Lophaetus occipitalis	Long-crested eagle	(Daudin) 1800	O	W		1					
FALCONIIDAE											
Falco tinnunculus	Common kestrel	Linnaeus 1758	O	W						1	
Falco chicquera	Red-necked falcon	Daudin 1800	O	W						1	
Falco biarmicus	Lanner falcon	Temminck 1825	O	W		1					
NUMIDIDAE											

Species	Common name	Author	Habitat association	Range	Red list	South Nguru FR	Kanga FR	Mkindo	Mtibwa Teak	Woodland	Mkwajuni Marsh
Numida meleagris	Helmeted guineafowl	(Linnaeus) 1758	O	W				1		1	
Guttera pucherani	Crested guineafowl	(Hartlaub) 1861	FF	W		1	1				
PHASIANIDAE											
Fraoncolinus hildebrandti	Hildebrandt's francolin	Cabanis 1828	O	W						1	
Francolinus afer	Red-necked spurfowl	(Muller) 1776	O	W						1	
Coturnix delegorguei	Harlequin quail	Delegorgue 1847	O	W						1	
Pternistis squamatus	Scaly francolin	(Cassin) 1857	F	W		1					
JACANIDAE											
Actophilornis africanus	African jacana	(Gmelin) 1789	O	W							1
COLUMBIDAE											
Columba delegorguei	Eastern bronze-naped pigeon	Delegorgue 1847	F	W		1	1				
Columba arquatrix	Olive pigeon	Temminck 1809	F	W		1					
Columba larvata	Lemon dove	Temminck 1809	FF	W		1					
Streptopelia capicola	Ring-necked dove	(Sundevall) 1857	O	W						1	
Streptopelia semitorquata	Red-eyed dove	(Ruppell) 1837	F	W						1	
Turtur chalcospilos	Emerald-spotted wood-dove	(Wagler) 1827	O	W						1	
Turtur afer	Blue-spotted wood-dove	(Linnaeus) 1766	O	W						1	
Turtur tympanistria	Tambourine dove	(Temminck) 1809	F	W		1	1			1	
Treron calva	African green pigeon	(Temminck) 1808	F	W		1	1			1	
PSITTACIDAE											
Poicephalus cryptoxanthus	Brown-headed parrot	(Peters) 1854	O	W			1	1		1	
MUSOPHAGIDAE											
Tauraco livingstonii	Livingstone's turaco	(Gray, GR) 1864	F	W		1	1				
Musophaga porphyreolopha	Purple-crested tauraco	(Vigors) 1831	F	W						1	
CUCULIDAE											
Cuculus solitarius	Red-chested cuckoo	Stephens 1815	F	W		1					
Cuculus clamosus	Black cuckoo	Latham 1801	F	W						1	
Cercococcyx montanus	Barred long-tailed cuckoo	Chapin 1928		W		1					
Chrysococcyx klaas	Klaas' Cuckoo	(Stephens) 1815	O	W		1	1			1	
Chrysococcyx cupreus	African emerald cuckoo	(Shaw) 1792	O	W		1				1	
Chrysococcyx caprius	Diederic cuckoo	(Boddaert) 1783	O	W						1	
Centropus superciliosus	White-browed coucal	Hemprich and Ehrenberg 1833	O	W		1				1	
Ceuthmochares aereus	Yellowbill	(Vieillot) 1817	F	W			1				
STRIGIDAE											

Species	Common name	Author	Habitat association	Range	Red list	South Nguru FR	Kanga FR	Mkindo	Mtibwa Teak	Woodland	Mkwajuni Marsh
Bubo vosseleri	Usambara eagle-owl	Reichenow 1908	F	EA	VU	1					
Bubo lacteus	Verreaux's eagle-owl	(Temminck) 1820	F	W						1	
Strix woodfordii	African wood owl	(Smith, A) 1834	F	W		1		1		1	
CAPRIMULGIDAE											
Caprimulgus poliocephalus	Mountain nightjar	Ruppell 1840	O	W		1					
Caprimulgus pectoralis	Fiery-necked nightjar	Cuvier 1817	O	W						1	
APODIDAE											
Cypsiurus parvus	African palm swift	Lichtenstein 1823	O	W		1	1			1	
Neafrapus boehmi	Bohm's spinetail	(Schalow) 1882	F	W			1		1	1	
Apus affinis	Little swift	(Gray) 1830	O	W		1	1		1	1	1
Apus caffer	White-rumped swift	(Lichtenstein) 1823	O	W		1	1				
Telacanthura ussheri	Mottled spinetail	(Sharpe) 1870	F	W			1				
COLIIDAE											
Colius striatus	Speckled mousebird	Gmelin 1789	O	W		1				1	
TROGONIDAE											
Apaloderma vittatum	Bar-tailed trogon	(Shelley) 1882	FF	W		1	1				
Apaloderma narina	Narina's trogon	(Stephens) 1815	F	W			1	1			
ALCEDINIDAE											
Ceryle rudis	Pied kingfisher	(Linnaeus) 1758	O	W						1	1
Magaceryle maxima	Giant kingfisher	(Pallas) 1769	F	W		1				1	
Ispidina picta	African pygmy kingfisher	(Boddaert) 1783	O	W		1	1				
Halcyon albiventris	Brown-hooded kingfisher	(Scopoli) 1786	O	W						1	
Halcyon chelicuti	Striped kingfisher	(Stanley) 1814	O	W						1	
Alcedo cristata	Malachite kingfisher	Pallas 1764	O	W							1
MEROPIDAE											
Merops pusillus	Little bee-eater	Muller 1776	O	W		1	1		1	1	
Merops albicollis	White-throated bee-eater	Vieillot 1817	O	W		1				1	
Merops apiaster	European bee-eater	Linnaeus 1758	O	W						1	
Merops nubicus	Northern carmine bee-eater	Gmelin 1788	O	W						1	
CORACIIDAE											
Coracis caudata	Lilac-breated roller	Linnaeus 1766	O							1	
Eurystomus glaucurus	Broad-billed roller	(Muller) 1776	O	W						1	
PHOENICULIDAE											
Phoeniculus purpureus	Green wood-hoopoe	(Miller) 1784	O	W				1		1	
UPUPIDAE											
Upupa africana	African hoopoe	Bechstein 1811	O	W						1	
BUCEROTIDAE											

Species	Common name	Author	Habitat association	Range	Red list	South Nguru FR	Kanga FR	Mkindo	Mtibwa Teak	Woodland	Mkwajuni Marsh
Tockus deckenii	Von der Decken's hornbill	(Cabanis) 1869	O	W						1	
Tockus alboterminatus	Crowned hornbill	(Buttikofer) 1889	F	W		1	1	1			
Tockus nasutus	African grey hornbill	(Linnaeus) 1766	O	W						1	
Bycanistes buccinator	Trumpeter hornbill	(Temminck) 1824	F	W		1	1	1		1	
Bycanistes brevis	Silvery-cheeked hornbill	Friedmann 1929	FF	W		1	1				
CAPITONIDAE											
Stactolaema olivacea	Green barbet	(Shelley) 1880	FF	EA N		1	1	1			
Pogoniulus bilineatus	Yellow-rumped tinkerbird	(Sundevall) 1850	F	W		1	1				
Pogoniulus leucomystax	Moustached green tinkerbird	(Sharpe) 1892	FF	W		1					
Trachyphonus darnaudii	d'Arnaud's barbet	(Prevost and Des Murs) 1847	O	W						1	
INDICATORIDAE											
Indicator variegatus	Scaly-throated honeyguide	Lesson 1830	O	W		1	1				
Indicator indicator	Greater honeyguide	(Sparrman) 1777	O	W						1	
Indicator minor	Lesser honeyguide	Stephens 1815	F	W						1	
PICIDAE											
Dendropicos fuscescens	Cardinal woodpecker	(Vieillot) 1818	O	W				1		1	
Dendropicos griseocephalus	Olive woodpecker	(Boddaert) 1783	FF	W		1					
Campethera abingoni	Golden-tailed woodpecker	(Smith) 1836	F	W			1				
EURYLAIMIDAE											
Smithornis capensis	African broadbill	(Smith) 1840	F	W		1	1				
HIRUNDINIDAE											
Hirundo abyssinica	Lesser striped-swallow	Guerin-Meneville 1843	O	W				1	1		
Hirundo senegalensis	Mosque swallow	Linnaeus 1766	O	W					1	1	1
Hirundo fuligula	Rock martin	Lichtenstein 1842	O	W			1				
Psalidoprocne holomelas	Black saw-wing	(Ruppell) 1840	F	W		1	1	1			
MOTACILLIDAE											
Motacilla aguimp	African pied wagtail	Dumont 1821	O	W					1	1	1
Motacilla clara	Mountain wagtail	Sharpe 1908	F	W		1	1	1			
CAMPEPHAGIDAE											
Coracina caesia	Grey cuckoo-shrike	(Lichtenstein) 1823	FF	W		1					
Coracina pectoralis	White-breasted cuckoo shrike	(Jardine and Selby) 1828	FF	W						1	
Campephaga flava	Black cuckoo-shrike	Vieillot 1817	F	W						1	

Species	Common name	Author	Habitat association	Range	Red list	South Nguru FR	Kanga FR	Mkindo	Mtibwa Teak	Woodland	Mkwajuni Marsh
PYCNONOTIDAE											
Andropadus virens	Little greenbul	Cassin 1858	FF	W		1	1				
Andropadus masukuensis	Shelley's greenbul	Shelley 1897	FF	EA N		1	1				
Andropadus nigriceps	Mountain greenbul	(Shelley) 1889	FF	W		1					
Andropadus milanjensis	Striped-cheeked greenbul	(Shelley) 1894	F	W		1					
Andropadus chlorigula	Yellow-throated mountain greenbul	(Reichenow) 1899	FF	EA N		1	1				
Andropadus olivaceiceps[1]	Olive-headed greenbul	(Shelley) 1893	FF	EA N		1					
Phyllastrephus cabanisi	Cabanis's greenbul	(Sharpe) 1882	F	W		1	1				
Phyllastrephus flavostriatus	Yellow-streaked greenbul	(Sharpe) 1876	FF	W		1	1				
Phyllasterphus debilis	Tiny greenbul	(Sclater) 1899	FF	W		1	1				
Phyllastrephus fischeri	Fischer's greenbul	(Reichenow) 1879	FF	W			1				
Nicator gularis	Eastern nicator	Hartlaub and Finsch 1870	F	W			1				
Pycnonotus barbatus	Common bulbul	Desfontaines 1789	O	W		1		1	1	1	
TURDIDAE											
Neocossyphus rufus	Red-tailed ant thrush	(Fischer and Reichenow) 1884	FF	W			1				
Monticola saxatilis	Common rock thrush	(Linnaeus) 1766	O	W						1	
Zoothera gurneyi	Orange ground thrush	(Hartlaub) 1864	FF	W		1					
Turdus olivaceus	Olive thrush	Linnaeus 1766	F	W		1					
Turdus libonyanus	Kurrichane thrush	(Smith) 1836	O	W						1	
Saxicola torquata	Common stonechat	(Linnaeus) 1766	O	W		1					
Pogonocichla stellata	White-starred robin	(Vieillot) 1818	FF	W		1	1				
Sheppardia sharpei	Sharpe's akalat	(Shelley) 1903	FF	EA N		1					
Cossypha anomala	Olive-flanked robin-chat	(Shelley) 1893	F	W		1					
Cossypha heuglini	White-browed robin chat	Hartlaub 1866	O	W						1	
Cossphya natalensis[2]	Red-capped robin-chat		F	W		1	1				
Alethe fuelleborni	White-chested alethe	Reichenow 1900	FF	W		1	1				
Cercotrichas leucophrys	White-browed scrub-robin	(Vieillot) 1817	O	W						1	
SYLVIIDAE											
Chloropeta similis[3]	Mountain yellow warbler	Richmond 1897	FF	W		1					
Phylloscopus ruficapilla	Yellow-throated woodland warbler	(Sundevall) 1850	FF	W		1					
Bradypterus lopezi	Evergreen forest warbler	(Alexander) 1903	FF	W		1	1				

Species	Common name	Author	Habitat association	Range	Red list	South Nguru FR	Kanga FR	Mkindo	Mtibwa Teak	Woodland	Mkwajuni Marsh
Apalis flavida	Yellow-breasted apalis	(Strickland) 1852	F	W						1	
Apalis melanocephala	Black-headed apalis	(Fischer and Reichenow) 1884	FF	W		1					
Apalis thoracica	Bar-throated apalis	(Shaw) 1811	F	W		1					
Apalis chapini	Chapin's apalis*	Friedmann 1928	FF	EA N		1					
Orthotomus metopias	African tailorbird	(Reichenow) 1907	F	EA N		1					
Camaroptera brachyura	Grey-backed camaroptera	(Vieillot) 1820	F	W			1			1	
Macrosphenus kretschmeri[4]	Kretchmer's longbill	(Reichenow & Friedmann) 1895	F	W		1					
Eremomela scotops	Green-capped eremomela	Sundevall 1850	O	W						1	
Sylvietta whytii	Red-faced crombec	(Shelley) 1894	O	W						1	
Cisticola natalensis	Croaking cisticola	(Smith) 1843	O	W						1	
Cisticola chinianus	Rattling cisticola	(Smith) 1843	O	W						1	
Prinia erythroptera	Red-winged warbler	(Jardine) 1849	O	W						1	
Prinia subflava	Tawny-flanked prinia	(Gmelin) 1789	O	W		1			1		
MUSCICAPIDAE											
Muscicapa striata	Spotted flycatcher	(Pallas) 1764	O	W						1	
Muscicapa adusta	African dusky flycatcher	(Boie) 1828	O	W		1					
MONARCHIDAE											
Trochocercus albonotatus	White-tailed crested flycatcher	Sharpe 1891	FF	W		1					
Trochocercus cyanomelas	Blue-mantled flycatcher	(Vieillot) 1818	F	W		1	1				
Terpsiphone viridis	Paradise flycatcher	(Statius Muller) 1776	F	W		1	1	1		1	
PLATYSTEIRIDAE											
Batis soror	Pale batis	Reichenow 1903	O	W						1	
Batis mixta	Forest batis	(Shelley) 1889	FF	EA N		1	1				
TIMALIIDAE											
Modulatrix stictigula	Spot-throat	(Reichenow) 1906	F	EA N		1	1				
Turdoides jardineii	Arrow-marked babbler	(Smith) 1836	O	W						1	
Illadopsis abyssinica	African hill babbler	(Ruppell) 1840	F	W		1					
Illadopsis rufipennis	Pale-breasted illadopsis	(Sharpe) 1872	FF	W		1	1				
REMIZIDAE											
Anthoscopus caroli	African penduline tit	(Sharpe) 1871	O	W						1	
ZOSTEROPIDAE											

Species	Common name	Author	Habitat association	Range	Red list	South Nguru FR	Kanga FR	Mkindo	Mtibwa Teak	Woodland	Mkwajuni Marsh
Zosterops senegalensis	Yellow white-eye	Bonaparte 1850	FF	W		1					
NECTARINIIDAE											
Anthreptes rubritorques	Banded green sunbird	Reichenow 1905	F	EA		1					
Anthreptes neglectus [5]	Uluguru violet-backed sunbird		FF	W		1					
Hedydipna collaris	Collared sunbird	(Vieillot) 1819	F	W		1	1				
Nectarinia amethystina	Amethyst sunbird	(Shaw) 1812	O	W						1	
Nectarinia senegalensis	Scarlet-chested sunbird	(Linnaeus) 1766	O	W						1	
Nectarinia moreaui	Moreau's sunbird	(Sclater) 1933	FF	EA		1					
Cyanomitra olivacea	Olive sunbird	(Smith, A) 1840	F	W		1	1				
MALACONOTIDAE											
Telophorus sulfureopectus	Sulphur breasted bush-shrike	(Lesson) 1831	O	W						1	
Malaconotus blanchoti	Grey-headed bush-shrike	Stephens 1826	O	W						1	
Prionops plumatus	White-crested helmet-shrike	(Shaw) 1809	O	W						1	
Prionops retzii	Retz's helmet-shrike	Wahlberg 1856	O	W						1	
Prionops scopifrons	Chestnut-fronted helmet-shrike		O	W				1			
Telophorus nigrifrons	Black-fronted bush-shrike	(Reichenow) 1896	FF	W		1	1				
Laniarius fuelleborni	Fulleborn's black boubou	(Reichenow) 1900	FF	EA N		1					
Laniarius aethiopicus	Tropical boubou	(Gmelin) 1788	O	W		1		1		1	
Dryoscopus cubla	Black-backed puffback	(Shaw) 1809	F	W		1	1	1		1	
Tchagra senegala	Black-crowned tchagra	(Linnaeus) 1766	O	W						1	
DICRURIDAE											
Dicrurus ludwigii	Square-tailed drongo	(Smith) 1834	F	W		1	1				
Dicrurus adsimilis	Fork-tailed drongo	(Bechstein) 1794	O	W				1		1	
CORVIDAE											
Corvus albus	Pied crow	Muller 1776	O	W					1	1	1
Corvus albicollis	White-naped raven	Latham 1790	F	W		1	1				
ORIOLIDAE											
Oriolus chlorocephalus	Green headed oriole	Shelley 1896	FF	EA N		1	1	1			
Oriolus larvatus	African black-headed oriole	Lichtenstein 1823	F	W				1		1	
PASSERIDAE											
Passer griseus	Grey-headed sparrow	(Vieillot) 1817	O	W					1		1
Lonchura bicolor	Black and white mannikin	(Fraser) 1843	F	W			1				
STURNIDAE											
Poeoptera kenricki [6]	Kenrick's starling	Shelley, 1894	FF	EA N		1					

Species	Common name	Author	Habitat association	Range	Red list	South Nguru FR	Kanga FR	Mkindo	Mtibwa Teak	Woodland	Mkwajuni Marsh
Onychognatus morio	Red-winged starling	(Linnaeus) 1766	O	W		1	1	1			
Onychognathus walleri	Waller's starling	(Shelley) 1880	FF	W		1					
Cinnyricinclus leucogaster [7]	Violet-backed starling	(Boddaert) 1783	O	W						1	
PLOCEIDAE											
Ploceus bicolor	Forest weaver	Vieillot 1819	F	W		1	1	1			
Ploceus intermedius	Lesser masked weaver	Ruppell 1845	O	W						1	
Ploceus ocularis	Spectacled weaver	Smith 1839	O	W		1					
Ploceus cucullatus	Black-headed weaver	Muller 1776	O	W						1	
Amblyospiza albifrons	Grosbeak weaver	(Vigors) 1831	O	W		1					
Quelea quelea	Red-billed quelea	(Linnaeus) 1758	O	W						1	
Anaplectes rubriceps	Red-headed weaver	(Sundevall) 1850	O	W						1	
Euplectes hordeaceus	Black-winged red bishop	(Linnaeus) 1758	O	W						1	
Euplectes axillaris	Fan-tailed widowbird	(Smith) 1838	O	W						1	
Euplectes capensis	Yellow bishop	(Linnaeus) 1766	O	W						1	
EMBERIZIDAE											
Hypargos niveoguttatus	Peter's twinspot	(Peters, W.) 1868	O	W			1				
Mandingoa nitidula	Green-backed twinspot	(Hartlaub) 1865	FF	W			1				
Cryptospiza reichenovii	Red-faced crimsonwing	(Hartlaub) 1874	FF	W		1					
Pytilia melba	Green-winged pytilia	(Linnaeus) 1758	O	W						1	
Logonosticta senegala	Red-billed firefinch	(Linnaeus) 1766	O	W						1	
Uraeginthus bengalus	Red-cheeked cordonbleu	(Linnaeus) 1766	O	W						1	
Estrilda quartinia	Yellow-bellied waxbill	Bonaparte 1851	O	W		1					
Estrilda astrild	Common waxbill	(Linnaeus) 1758	O	W						1	
Lonchura cucullata	Bronze mannikin	(Swainson) 1837	O	W				1		1	
Vidua hypocherina	Steel-blue whydah	Verreaux and Verreaux 1856	O	W						1	
Vidua macroura	Pin-tailed whydah	(Pallas) 1764	O	W						1	
Emberiza cabanisi	Cabanis's bunting	(Reichenow) 1875	O	W						1	
FRINGILLIDAE											
Serinus citrinelloides	African citril	Ruppell 1838	F	W		1					
Serinus mozambicus	Yellow-fronted canary	(Muller) 1776	O	W		1				1	1
Serinus reichenowi	Yellow-rumped seedeater	Salvadori 1888	O	W						1	
Linurgus olivaceus	Oriole finch	(Fraser) 1842	F	W		1					

[1] Andropadus milanjensis is listed by Burgess *et al*., (2007) as being present in the South Ngurus although it was not listed as being present by Kiure. This may reflect changes in the greenbul taxonomy.

[2] *Cossphya anomala* was not recorded during the current survey. Recorded by Romdal in Nguru South Forest Reserve and by Rabøl in Kanga (in Romdal, 2001). A submontane to lowland species.
[3] *Chloropeta similis* was not recorded during the current survey. Romdal reports that this species was recorded by Fuggles-Couchman in 1937 who netted a female at 1800 m. It is a species that frequents a variety of habitats apart from primary forest, including bamboo and heath scrub. Both Arundinaria bamboo thickets and Erica healthland are found in montane parts of the Ngurus and *C. similis* may be found if searched for in such habitat.
[4] *Macrosphenus kretschmeri* was not recorded in this survey. This species was recorded by Sclater and Moreau (1932) between 420 m – 1,450 m in Nguru South and was heard by David Moyer in forest patches between Mhonda and Ubiri in August 1997. Romdal (2001) notes that it is probably sparsely distributed in suitable foothill forest habitat.
[5] *Anthreptes negelectus* was not recorded in this survey. A female specimen is reported by Keith (1968), while Britton (1980) describes it as scarce in the Ngurus at 1300 – 1,500m. Romdal (2001) notes that it may still be present, most likely remaining in the foothill forests.
[6] *Poeoptera kenricki* was not recorded in this survey. Recorded by David Moyer in August 1997 at 1,800 m (in Romdal, 2001).
[7] *Cinnyricinclus leucogaster* was not recorded in this survey. Romdal (2001) notes that Jon Fjeldså recorded this species at Kanga and that it was also reroded by Stuart and Willigen (1978) and by Stuart (1981).

6.1.5 Discussion

Range extensions

Southern banded snake eagle: These sightings confirm the presence of this near-threatened species. Baker and Baker (2002) note that Collar & Stuart (1985) erroneously quote Britton (1980), stating that this sepcies occurs in the Nguru Mts. It may be a low density resident in lower altitude forest, as it is in the Nguu Mts to the north (Seddon *et al.*, 1995).'

Species richness

Of the 214 bird species recorded in the landscape, 115 were recorded from forest in Kanga and/or Nguru South forest reserves. The remaining 109 species were recorded from woodland, teak plantation, marsh land and village land of which 14 were recorded in the woodland and riverine forest of Mkindo FR. The total number of birds recorded from the South Nguru forests is less than records from the Uluguru Mountain forests where 140 birds were recorded in forest reserves (Doggart *et al.,* 2004) and similar to species richness of the Rubeho Mountains where 106 species were recorded (Doggart *et al.,* 2003). These comparisons should be treated with caution given differences in sampling effort (Doggart *et al.,* 2006).

As noted above the forest habitats have the highest species richness followed by the woodland. Only 11 bird species were observed in the teak plantation where the absence of an understorey means that the habitat required by many forest dependent birds is missing. Again comparisons should be treated with some caution given differences in sampling effort. Although the species richness in the woodlands and forest is quite similar, only 24 species are found in both habitats. The majority (77%) of bird species found in forests were only found in the forests. This highlights that while species richness may be similar between habitats, the species are different hence it is important to conserve a mosaic of natural habitats. The results also highlight the fact that teak plantations with a clear understorey can not replace natural forest in providing habitat for birds.

Table 5. Comparison of bird species richness between habitats in the South Nguru landscape

Habitat	Total number of bird species recorded
Forest	116
Woodland	104
Teak	11
Marsh land	15

Table 6. Number of overlapping bird species between forest and other habitats

Category	Number of bird species
Forest only	89
Forest birds also found in woodland	24
Forest birds also found in teak	6
Forest birds also found in marsh land	2

Species richness varies considerably between reserves with Nguru South FR having the higest species richness with 106 species, while Kanga FR contains at least 66 species and Mkindo FR has 28 species. Again, these comparisons should be treated with caution given differences in sampling effort.

Birds not recently recorded

Six birds that have been recorded in the past from the South Ngurus were not recorded during the present survey including: Uluguru violet-backed sunbird (*Anthreptes neglectus*), Kenrick's starling (*Poeoptera kenricki*), Black-bellied starling (*Lamprotrornis corruscus*), Mountain yellow warbler (*Chloropeta similis*), Red-capped robin-chat (*Cossypha natalensis*) and Kretschmer's longbill (*Macrosphenus kretschmeri*). Of these, two are dependent on lowland and submotane forest, the Kreschmer's longbill and the Uluguru violet-backed sunbird. Additional survey work to determine their status in the landscape would be valuable as both have restricted ranges although neither qualify as Eastern Arc near endemics (Burgess *et al.,* 2007).

Endemism

There are three bird species found in the South Nguru Mountains landscape that are endemic to the Eastern Arc Mountains and twelve bird species that are near-endemic to the Eastern Arc Mountains. There are no known bird species endemic to the South Ngurus. The ranges that have been used in this report are based on Burgess *et al.* (2007).

All of the Eastern Arc endemic and near endemic species that have been recorded in the landscape, were found in Nguru South Forest Reserve and five species, *Modulatrix stictigula*, *Stactolaema olivacea*, *Batis mixta, Andropadus chlorigula* and *Oriolus cholorocephalus* were also found in Kanga Forest Reserve. Mkindo Forest Reserve contains two Eastern Arc endemic species *Oriolus cholorocephalus* and *Stactolaema olivacea*. This highlights the importance of Nguru South Forest Reserve. Additional sampling in Kanga Forest Reserve may result in additional records for this forest.

Table 7. Eastern Arc endemic and near-endemic birds found in the South Nguru Mountains and their ranges.

Species	**Range**[1]	**Recorded from**
Eastern Arc endemic species		
Anthreptes rubritorques	W. Usambara, E. Usambara, Nguu, Uluguru and Udzungwa.	Nguru South F.R.
Bubo vosseleri	W. Usambara, E. Usambara, Nguu, Uluguru, Rubeho and Udzungwa.	Nguru South F.R.
Nectarinia moreaui	Nguu, Ukaguru, Rubeho and Udzungwa	Nguru South F.R.
Eastern Arc near-endemic species		
*Andropadus chlorigula**	All E. Arc except Taita and Malundwe and the Southern Rift.	Nguru South F.R. and Kanga F.R.
Andropadus masukuensis	South Pare, W. Usambara, E. Usambara, Nguu, Uluguru, Rubeho, Mahenge, Udzungwa and Southern Rift	Nguru South F.R.
Andropadus milanjensis	All E. Arc except Mahenge and Malundwe plus the Southern Rift and Coastal Forests	Nguru South F.R.
Apalis chapini	Uluguru, Ukaguru, Nguu, Rubeho, Udzungwa, Coastal Forests and Southern Rift	Nguru South F.R.
Arsitornis metopias	W. Usambara, E. Usambara, Uluguru, Ukaguru, Rubeho, Udzungwa and the Southern Rift.	Nguru South F.R.
Batis mixta	North Pare, South Pare, W. Usambara, E. Usambara, Nguu, Uluguru, Rubeho, Udzungwa and the Southern Rift	Nguru South F.R. and Kanga F.R.
Laniarius fuelleborni	W. Usambara, Uluguru, Ukaguru, Rubeho, Udzungwa and the Southern Rift.	Nguru South F.R.
Modulatrix stictigula	W. Usambara, E. Usambara, Uluguru, Ukaguru, Rubeho, Udzungwa and the Southern Rift.	Nguru South F.R. and Kanga F.R.
*Oriolus chlorocephalus**	W. Usambara, E. Usambara, Uluguru, Nguu, Udzungwa and Coastal Forests	Nguru South F.R., Kanga F.R. and Mkindo F.R.
Poeoptera kenricki	South Pare, W. Usambara, E. Usambara, Nguu, Uluguru, Rubeho, Udzungwa, Southern Rift and Kilimanjaro, Meru and / or Kenya Highlands.	Nguru South F.R.
Sheppardia sharpei	South Pare, W. Usambara, E. Usambara, Uluguru, Ukaguru, Rubeho, Udzungwa and Southern Rift.	Nguru South F.R.
*Stactolaema olivacea**	W. Usambara, E. Usambara, Uluguru, Ukaguru,	Nguru South F.R.,

Species	Range[1]	Recorded from
	Nguu, Rubeho, Udzungwa, Coastal Forests and Southern Rift	Kanga F.R. and Mkindo F.R.

[1] Ranges based on Burgess *et al.* (2007)

Threatened species

There are two bird species found in the South Nguru Mountains that are considered vulnerable by IUCN: the Usambara eable owl (*Bubo vosseleri*) and the banded green sunbird. The southern banded snake eagle and Moreau's sunbird are considered to be near threatened species.

6.2 Mammals

By Francesco Rovero, Claire Bracebridge, David Loserian, Abrahaman Mndeme, Andrew Perkin and Nike Doggart

6.2.1 Introduction

The most comprehensive survey of mammals that has been conducted in the South Nguru Mountains, prior to the present survey, was conducted by Bill Stanley from the Chicago Field Museum in Nguru South Forest Reserve. Small mammals were the focus of Stanley's work.

Across the Eastern Arc there are 6 endemic and 14 near endemic mammal species and one endemic sub-species. The majority (11) are shrews and rodents of which three were recorded by Bill Stanley in the South Ngurus.

The focus of the current survey was on primates, antelopes, carnivores, sengis and other medium to large mammals. Small mammals and bats were not surveyed.

The aim of the survey was:

- To conduct an inventory of mammal species in Mkindo, Kanga and Nguru South Forest Reserves.
- To provide a baseline data set for monitoring the forest mammal fauna of the South Nguru Mountains.

6.2.2 Methods

Literature review

A review was made of recent literature on the mammal fauna of the South Nguru Mountains. Documented species records have been included in the list of species in Table 9.

Tape recording and night surveys for galagos and other nocturnal fauna

Trails within the forest were walked slowly each night and with the aid of torches and binoculars galagos and other nocturnal mammals could be observed. This is assisted by the reflective properties of the eyes of nocturnal mammals which greatly help researchers to locate them. Tape recordings of galago vocalizations were also made to help identify species. A Sony WM-C6C tape recorder and Sennheiser K6-ME66 directional microphone were used.

Camera trapping

Camera traps are small cameras that are attached to infrared sensors. When an animal enters the infrared beam it triggers the camera to take a picture. Depending on the size and types of the animals to be photographed, the sensitivity of the infrared sensor can be adjusted. This method is very useful to survey elusive and nocturnal animals. Typically this method is best suited to take pictures of ground dwelling mammals including carnivores, antelopes and rodents. In Nguru South and Kanga the camera traps were set to take pictures of small mammals such as elephant shrews, genets, and small duikers. Four TrailMaster TM550 attached to two Olympus weatherproof T-35 camera kits and three Cam Trakker cameras were used. The traps were set with 36-exposure, 200 ISO film, and where retrieved at the end of the sampling period. In Mkindo Forest Reserve, four Deercam 300 camera traps were used with 36-exposure, 200 ISO film. The sensitivity was set to high with a delay of one minute. Camera traps in Mkindo FR were baited with dried fish. The date and time of photographs was automatically imprinted on the film.

Observations

Observations of mammals were made on a non-systematic basis by all members of the survey team. When mammals were observed data was recorded on the species and locality.

6.2.3 Survey effort

Camera trapping was carried out at seven sites in each forest reserve. A total of 655 camera trapping days were recorded between June 2005 and June 2006. Of these 240 camera trapping days were recorded in Nguru South Forest Reserve; 278.5 camera trapping days in Kanga Forest Reserve and 137 camera trapping days in Mkindo (mean sampling period per camera unit being 30, 40 and 34 days in the three forests, respectively). Cameras were placed mainly on wildlife trails that were previously inspected for signs, within an area of about 5 km^2 in each of the two forests. Cameras ran continuously 24 hours per day and were inspected every 2 weeks.

Table 8. Sampling intensity and location of sample sites for camera trapping.

Forest Reserve	Sample site	Altitude (m asl)	Habitat	Start (mm/dd/yr)	End (mm/dd/yr)	Total Days
Nguru South FR	336388, 9333288	1,150	Dense forest	6/24/2005 10:20	7/24/2005 3:22	30
Nguru South FR	336825	950	Forest on sandy river	6/25/2005	7/24/2005	29

Forest Reserve	Sample site	Altitude (m asl)	Habitat	Start (mm/dd/yr)	End (mm/dd/yr)	Total Days
	9333210		bank	9:35	11:20	
Nguru South FR	336825, 9333210	1,250	Dense, ridge forest and understorey	6/24/2005 13:47	7/24/2005 13:40	30
Nguru South FR	336388, 9333288	1,050	Dense forest on steep slope.	6/23/2005 16:47	7/24/2005 15:46	30
Nguru South FR	337221, 9332692	970	Dense forest close to a river	6/23/2005 16:47	7/24/2005 15:46	30
Nguru South FR	335657, 9332924	1,300	Dense forest along ridge with forest gaps nearby.	6/24/2005 11:51	7/24/2005 14:38	30
Nguru South FR	3373669, 9332502	950	Dense understorey near to a river	6/23/2005 13:45	7/24/2005 16:33	31
Nguru South FR	336388, 9333288	1,150	Dense forest and understorey	6/24/2005 10:20	7/24/2005 3:22	30
Kanga FR	356547, 9341632	1,380	Dense forest	7/29/2005 10:12	9/16/2005 12:32	49
Kanga FR	356087, 9341524	1,350	Dense forest	7/29/2005 12:03	8/2/2005 20:24	2.5
Kanga FR	356098, 9340858	1,145	Dense forest, open understorey	7/30/2005 8:35	7/16/2005 14:26	48
Kanga FR	358812, 9336174	1,155	Forest with open understorey	7/29/2005 14:21	7/16/2005 13:52	49
Kanga FR	356087, 9341524	1,350	Dense forest close to a large forest gap.	7/29/2005 12:32	7/16/2005 13:08	49
Kanga FR	356547, 9341632	1,470	Dense forest	7/29/2005 11:12	7/16/2005 12:19	49
Kanga FR	356098, 9340858	1,180	Forest near valley bottom. Dense understorey with more open canopy.	7/30/2005 9:28	8/31/2005 9:36	32
Mkindo FR	0337331 / 9314854	770	Lowland forest with a closed canopy in a small valley / gully with a dry stream bed running west to the Kitungwi river below.	08/05/2006 13:00	13/06/06 15:00	37
Mkindo FR	0337331 / 9314824	790	Lowland forest with a closed canopy with small bamboo On a steep slope leading down to the small gully where Deercam 2 is placed.	11/05/2006 11:00	13/06/06 15:10	34
Mkindo FR	0337275 / 9314307	774	Miombo woodland on a ridgetop near to the northern end of Mkindo leading to riverine and lowland forest.	12/05/2006 10:30	13/06/06 16:20	33
Mkindo FR	0337313 / 9314238	765	Miombo woodland on a ridgetop near to the northern end of Mkindo leading to riverine and lowland forest.	12/05/2006 10:45	13/06/06 16:30	33
TOTAL						**655.5**

6.2.4 Results

The survey team recorded 34 mammal species from 15 families in the South Nguru landscape. This includes ten species of shrew and rodent recorded in Nguru South Forest Reserve by W. Stanley (Stanley, 2000).

Table 9. Checklist of mammal species from the South Nguru landscape.

Species	Common name	Habitat	Range	IUCN status	Nguru South	Kanga	Mkindo	Recording method
CERCOPITHECIDAE								
Cercopithecus mitis monoides I. Geoffroy Saint-Hilaire 1841	Sykes' monkey	F	W		1	1	1	OB, CT (MKINDO)
Colobus angolensis palliatus Peters 1868	Angola pied colobus palliates	F	W		1	1	1	OB
Papio cyanocephalus	Yellow baboon	O	W				1	OB
GALAGONIDAE								
Galagoides orinus Lawrence and Washburn 1936	Usambara galago	FF	EA	DD		1		VR
Galagoides zanzibaricus	Zanzibar galago	FF	EA N	VU		1	1	OB, CT (MKINDO)
Otolemur garnettii	Small-eared greater galago	FF	W		1	1		OB
Otolemur crassicaudatus	Larged-eared greater galago	O	W				1	OB
SORICIDAE								
Crocidura monax sensu lato	White-toothed shrew	F	EA N	VU	1			TR
Crocidura olivieri	White-toothed shrew	F	W		1			TR
Sylvisorex howelli	Climbing shrew	F	EA	VU	1			TR
Sylvisorex megalura	Climbing shrew	F	W		1			TR
RHYNCHONCYONINAE								
Rhynchocyon petersi Bocage, 1880	Black and rufous elephant shrew	FF	EA N			1	1	OB
SCIURIDAE								
Paraxerus lucifer (Thomas, 1897)	Tanganyika mountain squirrel	FF	W		1			OB
ANOMALURIDAE								
Anomalurus derbianus (Gray, 1842)	Lord Derby's anomalure	F	W		1			OB & P
CRICETOMYINAE								
Beamys hindei	Lesser pouched rat	F	EA N	VU	1			TR
Cricetomys gambianus Waterhouse, 1840	Giant pouched rat	F	W			1	1	OB, CT
MURIDAE								
Lophuromys flavopunctatus	Brush-furred mouse		W		1			TR
Praomys delectorum	East-African soft-furred rat		W		1			TR
Hylomyscus acromontensis			EA N		1			TR
Otomys anchietae	Angolan vlei rat		W		1			TR
Rattus rattus	House rat	O	W		1			TR
Graphiurus murinus	Woodland dormouse	F	W		1			TR
HERPESTIDAE								
Bdeogale crassicauda (Peters, 1852)	Bushy-tailed mongoose	F	W		1		1	CT

Species	Common name	Habitat	Range	IUCN status	Nguru South	Kanga	Mkindo	Recording method
Herpestes sanguinea	Slender mongoose	O	W				1	OB
Atilax paludinosus	Marsh mongoose	O	W				1	D
MUSTELIDAE								
Aonyx capensis (Schinz, 1821)	African clawless otter	O	W		1			D
Mellivora capensis	Honey badger	O	W			1		CT
VIVERRIDAE								
Genetta genetta (Linnaeus 1758)	Common Genet	O	W			1		CT, OB & P
Genetta sevalina lowei	Servaline genet	FF	(EA)*			1		CT
CANIDAE								
Panthera pardus	Leopard	F	W			1		CT
PROCAVIDAE								
Dendrohyrax validus True 1890	Tree hyrax	FF	EA N	VU	1	1		CT & VR
SUIDAE								
Potamochoerus larvatus (Cuvier, 1822)	Bush pig	F	W		1	1	1	D
BOVIDAE								
Cephalophus harveyi (Thomas, 1893)	Harvey's duiker	F	W			1	1	D & CT
Tragelaphus scriptus	Bushbuck	F	W				1	D

Recording method CT = Camera Trap; D = Dung or other signs observed and photographed; OB = Observation; P = Photographed (not including camera trap photographs); VR = Vocalisation Recorded.
*Sub-species endemic to the Eastern Arc although the species is found from Cameroon to Zanzibar.

6.2.5 Discussion

Range extensions

Dendrohyrax validus: this species has been recorded from most Eastern Arc Mountains including Taita, North Pare, West Usambara, East Usambara, Nguu, Uluguru, Rubeho and Udzungwa Mountains. Its range also extends to Kilimanjaro and Mount Meru. Calls were recorded by Michele Menegon in Nguru South and Kanga Forest Reserve. It was also camera-trapped in Kanga Forest Reserve.

Genetta servalina lowei: Until 2002 this secretive animal was known only from an incomplete skin collected in 1930. Since then it has been recorded from several sites and forests in the Udzungwa Mountains, some 220 km away from Nguru South Mountains as well as from Uluguru North Forest Reserve (Rovero *et al.,* 2006). It is a sub-species of a genet whose range extends across the Congo basin with another isolated sub-species in Zanzibar. The animal was photographed by one of the camera traps in Kanga Forest Reserve at 1,180 m a.s.l at 05° 57.74' S and 37° 41.99' E. The trap site was in a valley bottom near a permanent stream with discontinuous canopy cover but dense understorey and forest floor layers.

Species richness

The total number of mammals recorded in the South Ngurus is considerably less than has been documented from some other Eastern Arc Mountains. In the Ulugurus, 76 mammal species from 26 families were recorded (Doggart *et al.,* 2004). This difference may result from the lower sampling intensity in the South Nguru Mountains and in particular, the absence of an inventory of the bats of the South Ngurus.

Although a greater number of mammal species have been recorded from Nguru South Forest Reserve (19) relative to Kanga Forest Reserve (12) and Mkindo Forest Reserve (13) this result is deceptive as ten of the 19 species from Nguru South are shrews or rodents which were not surveyed in Kanga FR or Mkindo FR. The abundance and diversity of medium and large mammals was significantly lower in Nguru South than Kanga and this was demonstrated clearly by the camera trapping success rates. There were only two events (i.e. photographs of

mammals taken more than 1 hour apart in the case of same species being photographed multiple times) in Nguru South Forest Reserve (Table 11) compared to 63 events in Kanga FR and 16 events in Mkindo FR. In Nguru South, both photographs were of bushy-tailed mongoose from the same camera while in Kanga Forest Reserve 12 species were photographed with between 3 and 21 events on each camera (Table 10) and in Mkindo FR six species were photographed with between 1 and 7 events on each camera (Table 12).

The areas surveyed in Kanga FR and Nguru South FR are comparable in size, elevation and forest habitat type. The intensity was also very similar, and even though it was longer in Kanga FR, increasing the likelihood of obtaining a larger number of species, it cannot account for the extreme differences recorded. Therefore, the differences obtained from the survey largely reflect real differences in occurrence and abundance of mammals, probably indicating severe depletion due to hunting occurring in Nguru South FR in comparison to Kanga FR. Many snares were observed in Nguru South whereas at higher altitude in Kanga, there were few signs of disturbance. This suggests that the populations of most larger mammal species have been significantly reduced in Nguru South with the possibility of local extinctions.

The results from Mkindo FR suggest that, while not as diverse as Kanga, the reserve continues to hold good populations of Harvey's duiker and giant pouched rat suggesting that hunting pressure may not be as high as in Nguru South FR.

Camera-trapping is confirmed as a reliable technique to study elusive mammals and obtain much needed information on presence and relative abundance; in this particular case, camera-trapping revealed and quantified very clearly the effect of human disturbance on forest wildlife.

Table 10. Camera trapping rates in Kanga Forest Reserve ordered by trapping rate, that gives an indication of relative abundance

Species	Trapping rate (events/trap-days * 100)							
	Camera 1	Camera 2	Camera 3	Camera 4	Camera 5	Camera 6	Camera 7	All*
Bushy-tailed Mongoose	10.2	160						85.1
Harveys' duiker					6.1	26.5		16.3
Giant-pouched rat		40		4.1	2	10.2	6.1	12.5
Honey badger			4.2		14.3	4.1		7.5
Bush buck					6.1			6.1
Squirrel (Paraxerus cf lucifer)	4.1							4.1
Bush pig	2			4.1		2		2.7
Lowe's servaline genet							2	2
Tree hyrax					2			2
Sykes' monkey				2				2
Leopard					2			2
Common genet	2							2

*Mean trapping rate for those sites where the species was recorded.

Table 11. Camera trapping rates in Nguru South Forest Reserve

Species	Trapping rates (events/trap-days * 100)							
	Camera 1	Camera 2	Camera 3	Camera 4	Camera 5	Camera 6	Camera 7	All*
Bushy-tailed Mongoose	0	0	6.7	0	0	0	0	6.7

Table 12. Camera trapping rates in Mkindo Forest Reserve

Species	Trapping rates (events/trap-days * 100)			
	Camera 1	Camera 2	Camera 3	Camera 4
Harvey's duiker	18.9			
Giant pouched rat		11.8		
Zanzibar galago				6.1
Sykes's monkey			3.0	
Black and rufous elephant shrew		2.9		
Bushy-tailed mongoose		2.9		

Endemism

The majority (25) of the mammal species from the South Nguru Mountains are widespread species with only six Eastern Arc near-endemic species and 2 Eastern Arc endemic species (and one Eastern Arc endemic sub-species). There are no mammal species known to be endemic to the South Nguru Mountains.

The distribution of restricted range species is more or less equal between the two main reserves with Kanga Forest Reserve having one Eastern Arc endemic and three Eastern Arc near-endemics while Nguru South has one Eastern Arc endemics and four Eastern Arc near-endemics. The number of endemic species is lower in Mkindo FR where only one Eastern Arc near-endemic species was recorded.

Threatened species

There are five mammal species considered to be vulnerable in the South Nguru Mountains. These are: *Galagoides zanzibaricus*, *Crocidura monax*, *Sylvisorex howelli*, *Beamys hindei* and *Dendroyrax validus*. No Endangered or Critically Endangered mammal species were recorded. The galago, *Galagoides orinus* is considered to be Data Deficient although proposals have been submitted to classify this primate as Vulnerable (Perkin, pers. comm.)

Monitoring

The data outlined in this report can be used for monitoring at two levels. At a basic level it is recommended that these surveys be repeated periodically, at least every ten years with a focus on documenting the continued presence of the Eastern Arc endemic, Eastern Arc near-endemic and threatened species.

The continued use of camera trapping within the South Nguru forests would also provide a valuable tool for monitoring the relative abundance of larger mammals. This is linked with monitoring the impact of forest management, particularly in terms of whether hunting is being controlled. At present the evidence suggests that hunting may have reached unsustainable levels in Nguru South Forest Reserve. By setting camera traps for two months per year in each reserve, changes in the abundance of mammals can be monitored over the period of PEMA's activities. TFCG staff working on the PEMA programme have been trained in setting and collecting the traps and on recording the necessary data. Some external technical input is still required to identify the animals photographed.

6.3 Amphibians and reptiles

By Michele Menegon and Nike Doggart

6.3.1 Introduction

Prior to these surveys conducted by Michele Menegon of the Museo Tridentino di Scienze Naturali in partnership with TFCG as part of the PEMA Programme the amphibian and reptile fauna of the South Ngurus were poorly known (Burgess *et al.*, 1998). Previous work had been conducted by Simon Loader and Jean Mariaux in Nguru South Forest Reserves in 2002 and by Dietmar Emmrich in Nguru South Forest Reserve between 1986 and 1990 (Emmrich, 1994). We found no records of herpetological surveys in Kanga Forest Reserve.

The aim of the survey was:

- To conduct an inventory of amphibian and reptile species in Kanga and Nguru South Forest Reserves and in woodland on village land.
- To provide a baseline data set for monitoring reptile and amphibian fauna.

6.3.2 Methods

Four sites at different elevations within the two forest reserves were sampled extensively through systematic sampling surveys and pit fall traps with drift fences (Table 13). Searches were conducted during the day and by night to ensure that both nocturnal and diurnal species were sampled. Further records were obtained from local people living in the villages at the forest edge. Voucher specimens have been collected and, when possible, frog calls were recorded. Specimens, photographs and sound recordings have been deposited at the Museo Tridentino di Scienze Naturali, Trento, Italy, and at the Department of Zoology and Marine Biology, University of Dar es Salaam, Dar es Salaam, Tanzania.

Visual encounter surveys

Visual encounter surveys (VES) were conducted at each site for a prescribed time by visually searching for animals. The number of animals collected were noted along with time elapsed during the survey. Surveys were conducted for three hours starting at dusk. During these surveys, the recorder focused on searching for arboreal species such as tree frogs, tree toads, arboreal snakes, geckoes and chameleons. Further surveys were carried out during the day to detect the presence of fossorial species (especially for fossorial microhylids, leaf litter toads, leaf litter skinks and caecilians) using a quadrat sampling method. The combined sampling methods (walks and quadrats) were used at each sampling site.

Minimum data recorded during visual encounter surveys included, number of each species encountered, size (e.g. length or acreage) of the area searched and total search time.

Pitfall Traps with Drift Fences

As a supplementary method pitfall traps with drift fences were installed at one site. This device is especially useful for recording epigeic organisms and to detect the presence of rare species. Capture success may vary greatly between species and the capture rate can be low in forests. Anurans that are strong jumpers are particularly difficult to trap. This method was used in Nguru South Forest Reserve only. Each trap consists of a central 10 litre plastic bucket buried with its opening flush with the surface with two triangular fence segments (8 m length each = 4 m each side of the triangle; 30 cm in height) channeling animals towards the central bucket. The drift fences were made of durable plastic sheeting. Each segment was tightened around a 10-liter plastic bucket with an opening angle of 45°. To prevent animals from passing through, fences were entrenched in the soil. The ends of each segment are flanked with additional 10-litre plastic buckets, one on either side.

Acoustic sampling

In most frog species, males in reproductive condition use distinctive species-specific calls to advertise their position to potential mates and rivals, this species-specific behavior was exploited using acoustic monitoring techniques to sample individual species.

6.3.3 Survey effort

Six sites have been sampled, two in the Nguru South Forest Reserve, two in Kanga Forest Reserve and two on village land. All species listed in Table 14 and Table 15 have been recorded in Forest Reserves and / or in

neighbouring areas; these latter are a mosaic of scattered cultivated fields and forest edges outside the boundaries of the reserves.

The study sites were located at different elevations giving a sampled altitudinal range from 750 m to 2200 m. All sample sites were characterised by the presence of mature rain forest and ecotones of both anthropogenic and natural origins.

The first site was surveyed between 26th October and 2nd November 2004 and was located about 3 hrs walking south, sout-east from Maskati village at about 2,000 m. asl in the Nguru South F.R. The site has mature montane and upper montane forest. Dominant trees include *Ocotea usambarensis*, *Podocarpus* sp., *Sygyzium* sp. and *Macaranga kilimandscharica*. The outer belt of the forest (approximately 2 km wide) is highly disturbed from cultivation and extensive burning. In contrast, there were few signs of disturbance in the forest interior. Rocky outcrops were present at about 2,200 – 2,300 m asl, and had a different vegetation type dominated by *Erica arborea* with *Aloe* sp. *Impatiens* sp. and several orchid species.

The second site was surveyed between 8th – 12th November, 2004 and was located 2 hrs walking south-east from Pemba village at about 1,000 m asl. The area surveyed lies on a wide valley and is characterised by the presence of closed canopy, submontane forest with many trees exceeding 50 m in height. Tree species include *Cephalosphaera usambarensis*, *Allanblackia stuhlmanii* and *Parinari excelsa*. In this area within a few hundred meters of the path there were signs of logging; cardamom, maize and bean cultivation; and trapping for small and large animals (from duiker to squirrel).

The third site was located in Kanga Forest Reserve, at about 750 m asl., and was surveyed between 3rd – 6th November, 2004. At lower elevation the trail passes through an interesting ground water forest dominated by *Pandanus* sp.. At the collecting site the forest appears transitional between the Zanzibar – Inhambane forest and the Afromontane rain forest. In this areas tree species include *Parinari excelsa*, *Macaranga capensis* and *Tabernaemontana* sp. There were few signs of disturbance in this area.

The fourth site was in Kanga Forest Reserve on the western side of Kanga Forest Reserve. Access to the site was from Difinga village. At lower altitude there were signs of timber harvesting. Above 800 m asl no signs of human disturbance were recorded. Collecting took place between 1,000 m and 1,300 m in undisturbed, closed canopy, submontane forest with tree species such as as *Cephalosphaera usambarensis* and *Allanblackia stuhlmanii*. On rocky outcrops at around 1,200 m asl, *Aloe* sp. and *Erica arborea* were abundant.

Table 13. Location and main characteristics of the sampling sites

Sample site	**UTM co-ordinates**	**Elevation range m asl**	**Main vegetation Type**	**Main habitats investigated**	**Collecting methods***	**Sampling effort**
Site 1 'Maskati'	37M0333779 9329236	1900-2200	Montane and upper montane rain forest	Open canopy forest, small bogs	D, N, PFT	15 bucket PFT for 6 days. 6 days at about 15h/man per day
Site 2 'Pemba'	37M0336825 9333210	950-1020	Submontane rain forest	closed canopy forest, small wetland, ecotone	D, N	4 days at about 15h/man per days
Site 3 'Kanga'	37M0358812 9336174	750-850	Submontane semi-deciduous forest	closed canopy forest,	D, N	3 days at about 15h/man per days
Site 4 'Difinga'	37M0356024 - 9340888	1000-1300	Submontane rain forest	closed canopy forest,	D, N	4 days at about 15h/man per days
Village belt (two sites)		1000 - 2000	Farmland	Synantropic habitats	Opportunistic, Local people	Total of 13 days (nights) in the field

D = day search; N = night search; PFT = pit fall traps with drift fences.

6.3.4 Results

A total of 38 species of amphibians belonging to seven families and 43 species of reptiles belonging to 11 families were recorded during 14 days of survey (Table 14 and Table 15). An additional two species of amphibian and two species of reptile were recorded by Emmrich (1994) and one species of reptile recorded by Spawls (2002) have been included in the checklists.

Table 14. Checklist of amphibian species from the South Nguru landscape.

Species	Habitat	Range	IUCN status	Nguru South F.R.	Kanga F.R.	Village belt	Call recorded	Notes
ARTHROLEPTIDAE								
Arthroleptis affinis (Ahl, 1939)	FF	EA N		1	1		X	Range extension. Species belonging to this genus need further investigation in order to get a final identification.
Arthroleptis cf. xenodactyloides (Hewitt, 1933)		W		1	1		X	
Arthroleptis sp.				1	1		X	
Arthroleptis sp. nov.		E	EN*	1				
Arthroleptis xenodactylus		EA		1				Recorded by Emmrich (1994) but not by current survey
BUFONIDAE								
Bufo brauni (Nieden, 1910)	FF	EA	EN	1			X	Range extension
Bufo gutturalis Power, 1927		W		1	1			
Nectophrynoides tornieri (Roux, 1906)	FF	EA		1	1		X	
Nectophrynoides sp. Nov. 1	FF	E	EN*	1			X	This specimen belongs to an undescribed taxon, clearly recognisable both on morphological and acoustical grounds
Nectophrynoides sp. Nov. 2	FF	E	EN*		1			
Schismaderma carens (Smith, 1849, "1848")		W				1		
HYPEROLIIDAE								
Afrixalus sp.					1			
Afrixalus fornasini		W		1				Recorded by Emmrich (1994) but not by current survey
Afrixalus uluguruensis (Barbour and Loveridge, 1928)	FF	EA	VU	1	1		X	
Afrixalus sp. A (Poynton & Broadley)		W		1			X	Could be *A.* sp *sensu* Poynton & Broadley
Hyperolius mitchelli (Loveridge, 1953)		W		1			X	
Hyperolius spinigularis (Stevens, 1971)	F	EA N		1				Range extension
Hyperolius puncticulatus (Bocage, 1895)		W		1		1	X	
Hyperolius sp.					1			
Leptopelis uluguruensis Barbour & Loveridge, 1928	FF	EA	VU	1	1		X	
Leptopelis flavomaculatus (Gunther, 1864)		W		1			X	
Leptopelis vermiculatus (Boulenger, 1909)	FF	EA N		1			X	
Leptopelis cf barbouri Ahl, 1929	FF	EA N	VU		1		X	Range extension

Species	Habitat	Range	IUCN status	Nguru South F.R.	Kanga F.R.	Village belt	Call recorded	Notes
MICROHYLIDAE								
Callulina sp. 1	FF	E	EN*	1			X	
Callulina sp. 2	FF	E	EN*	1			X	
Callulina sp. 3	FF	E	EN*	1				
Callulina sp. 4	FF	E	CR*		1			
Hoplophryne uluguruensis (Barbour & Loveridge, 1929)	FF	EA		1				Range extension
Probreviceps macrodactylus macrodactylus (Nieden, 1926)	FF	EA		1	1			Range extension
RANIDAE								
Rana angolensis (Bocage, 1866)		W		1	1			
Ptychadena anchietae (Bocage, 1867)		W		1	1			
Arthroleptides cf. yakusini		EA	EN	1	1			Range extension
Phrynobatrachus uzungwensis Grandison & Howell, 1983		EA		1	1			Range extension
Phrynobatrachus cf. parvulus (Boulenger, 1895)		W			1			
Phrynobatrachus sp.		W			1			
PIPIDAE								
Xenopus cf. petersii		W		1				
Gymnophiona								
CAECILIIDAE								
Boulengerula uluguruensis (Barbour & Loveridge, 1928)	F	EA		1	1			
Scolecomorphus cf. kirkii Boulenger, 1883		W		1				

Table 15. Checklist of reptile species from the South Nguru landscape

Species	Habitat	Range	IUCN status	South Nguru F.R.	Kanga F.R.	Village belt	Notes
Reptilia							
CHAMAELEONIDAE							
Chamaeleo werneri Tornier 1899	F	EA		1			Range extension
Chamaeleo deremensis Matschie 1892	FF	EA		1		1	
Chameleo melleri (Gray 1864)	O	W				1	
Chamaeleo dilepis (Leach 1819)	O	W				1	
Chamaeleo fischeri Reichenow 1887	FF	EA		1			
Chamaeleo oxyrhinum Klaver & Bohme (1988)	FF	EA		1			Range extension
Rieppeleon brachyurus Gunther 1893		W		1			
Rieppeleon brevicaudatus (Matschie 1892)	F	EA N		1	1		Range extension
Rhampholeon sp. Nov.		E			1		
AGAMIDAE							

Species	Habitat	Range	IUCN status	South Nguru F.R.	Kanga F.R.	Village belt	Notes
Agama montana Barbour & Loveridge 1928	F	EA		1			Female was collected sleeping on reeds, in a small swamp in the forest. Male at the forest edge
Agama agama (Linnaeus 1758)	O	W				1	
GEKKONIDAE							
Cnemaspis africana (Werner 1895)		EA N			1		
Urocotyledon wolterstorffi Tornier (1900)	FF	EA			1		Range extension
LACERTIDAE							
Holaspis laevis Gray 1963							
Gastropholis prasina Werner (1904)							Recorded in Spawls (2002)
SCINCIDAE							
Lygosoma afer (Peters 1854)		W		1			Recorded by Emmrich 1994 but not by present study.
Melanoseps loveridgei		W		1			Recorded by Emmrich 1994 but not by present study.
Trachylepis varia (Peters 1867)		W		1			
Trachylepis maculilabris (Gray 1845)		W			1		Obs., not collected
Trachylepis striata (Peters 1844)		W				1	
Scelotes uluguruensis Barbour & Loveridge 1928	FF	EA		1	1		
VARANIDAE							
Varanus niloticus	O	W				1	
TYPHLOPHIDAE							
Rhinotyphlops mucruso (Peters 1854)	O	W				1	
Rhinotyphlops lineolatus	FF/F	W		1			
COLUBRIDAE							
Thelotornis usambaricus Broadley 2001	F	EA N		1	1	1	
Dipsadoboa werneri Boulenger 1895	FF	EA			1		Range extension
Crotaphopeltis tornieri Werner 1908	FF	EA N		1	1		Range extension
Crotaphopeltis hotamboeia (Laurenti 1768)	O	W				1	
Dispholidus typus (Smith 1829)	O	W				1	
Lamprophis fuliginosus (Boie 1827)	O	W				1	
Lycophidion capense loveridgei (Smith 1831)		W				1	
Lycophidion meleagre (Boulenger 1893)		W		1		1	
Natriciteres sylvatica		W		1			

Species	Habitat	Range	IUCN status	South Nguru F.R.	Kanga F.R.	Village belt	Notes
Philothamnus cf. hoplogaster (Günther 1863)		W		1			
Philothamnus punctatus Peters 1866		W		1			
Philothamnus macrops Boulenger 1895	F	EA N		1			Range extension
Prosymna stuhlmanni Pfeffer 1893		W				1	
ATRACTASPIDAE							
Aparallactus jacksoni		W		1		1	Second and third upper labial touching the orbit (*A. jacksoni* should have third and fourth). To check.
Aparallactus guentheri Boulenger 1895		W				1	
Atractaspis bibronii Smith 1849		W				1	
ELAPIDAE							
Elapsoidea nigra Günther 1888	F	EA		1			Range extension
Dendroaspis angusticeps (Smith 1849)	F	W				1	
VIPERIDAE							
Bitis arietans (Merrem 1820)	O	W				1	

6.3.5 Discussion

Range extensions

The present study recorded for the first time from the South Nguru Mountains the presence of sixteen amphibian species and fifteen reptile species endemic or near-endemic to the Eastern Arc Mountains (Table 16).

Table 16. Range extensions for Eastern Arc endemic and near-endemic amphibian and reptile species

Species	Known range prior to the present study based on Burgess *et al.* (1998)
AMPHIBIANS	
Arthroleptides cf. yakusini	
Arthroleptis cf. affinis	Usambara, Udzungwa (Pugu and Rondo Coastal Forests)
Bufo brauni	Usambara, Uluguru and Udzungwa
Hoplophryne uluguruensis	Uluguru and Usambara
Hyperolius spinigularis	Usambara, Udzunga and Mulanje
Leptopelis cf barbouri	Usambara and Udzungwa
Probreviceps macrodactylus	Usambara, Uluguru, Udzungwa and Rungwe
Phrynobatrachus uzungwensis	Udzungwa and Uluguru
REPTILES	
Chamaeleo werneri	Uluguru and Udzungwa
Chamaeleo oxyrhinum	Uluguru and Udzungwa
Crotaphopeltis tornieri	Usambara, Uluguru, Udzungwa, Southern Highlands and Northern Malawi
Dipsadoboa werneri	Usambara
Elapsoidea nigra	Usambara and Uluguru
Philothamnus macrops	Usambara
Rieppeleon brevicaudatus	Usambara, Uluguru, Udzungwa and Coastal forests
Urocotyledon wolterstorffi	Usambara and Uluguru

New species

At least seven species of amphibian collected during the current survey are thought to be new to science on the basis of the available morphological and bioacoustical data. This includes four species of *Callulina*, two species of

Nectophrynoides and one species of *Arthroleptis*. Six of the new species were recorded in Nguru South Forest Reserve and one *Callulina* species was recorded from Kanga Forest Reserve. These species are now being described.

A further four species require additional analysis to determine whether they are sufficiently different from other populations to justify being split into a separate taxon. This includes *Arthroleptides cf yakusini*, *Leptopelis cf barbouri*, *Scolecomorphus cf kirkii* and a *Rhampholeon* sp. which may be conspecific with an undescribed species of *Rhampholeon* referred to in Burgess *et al.* (1998).

Species richness

Relative to other Eastern Arc Mountains, the herpetofauna of the South Ngurus is significantly richer than that of the Rubeho Mountains with 9 species of reptile and 9 species of amphibian documented (Doggart *et al*., 2003) but is not as rich as the Uluguru Mountains with 47 reptile species and 44 amphibian species (Doggart *et al*., 2004). However comparisons between mountain blocks are unreliable given the significant differences in survey effort between Eastern Arc Mountains (Doggart *et al.,* 2006).

Within the South Nguru landscape, Nguru South Forest Reserve has the highest species richness with 21 species of reptile and 30 species of amphibian relative to Kanga Forest Reserve or the sites on village land. This may reflect the larger forest area in this reserve relative to Kanga.

Endemism

It appears that the South Nguru Mountains have exceptional numbers of endemic amphibians based on the current surveys. Burgess *et al.* (2007) have record 29 reptiles and 38 amphibians endemic to the Eastern Arc of which 6 of the amphibians and 8 of the reptiles are found in the Nguru Mountains. This does not include the undescribed species recorded during this survey.

Within the landscape, Nguru South Forest Reserve has the highest number of South Nguru endemics (6), Eastern Arc endemics (18) and Eastern Arc near endemcis (18). Again this may reflect the size of the reserve.

Few of the restricted range species were recorded at more than one site. This suggests a high rate of species turnover both altitudinally and from one valley to another. This highlights the importance of conserving as much as possible of the remaining forest area.

The results show clearly the importance of the forests for the restricted range species. Only two restricted range species: the chameleon, *Chamaeleo deremensis* and the snake, *Thelotornis usambaricus* were found on village land. In both cases they were recorded from close to the forest edge at Maskati.

Table 17. Distribution of restricted range amphibian species across the landscape

Site	Widespread	Eastern Arc near endemic	Eastern Arc endemics	South Nguru Endemics
Kanga	6	2	5	2
Nguru South	10	3	10	6
Village land	2	0	0	0

Table 18. Distribution of restricted range reptile species across the landscape

Site	Widespread	Eastern Arc near endemic	Eastern Arc endemics	South Nguru Endemics
Kanga	1	4	3	1
Nguru South	9	4	8	0
Village land	17	1	1	0

Threatened species

Based on the recent Global Amphibian Assessment there are **three vulnerable** and **two endangered** species in the South Nguru landscape. The species considered to be endangered are *Bufo brauni* and *Arthroleptides yakusini*. The species considered to be vulnerable are*: Afrixalus uluguruensis*, *Leptopelis uluguruensis* and *Leptopelis barbouri.*

In addition, proposals are being developed to classify as Endangered six of the seven new species of amphibian referred to in this study (Menegon and Doggart, In prep). This proposal is based on the extent of occurrence and area of occupancy for these species being significantly less than 100 km^2 (the maximum area of occupancy based on IUCN criteria for Endangered species) combined with the high levels of disturbance within this habitat.

In the case of the *Callulina* sp nov. 4, it is proposed that this species be considered Critically Endangered. It appears that its area of occupancy and extent of occurrence may be less than 10 km^2 and under heavy pressure as it was only recorded at low altitude in Kanga Forest Reserve. This highlights the importance of conserving forest at different altitudes.

The reptile species from the Eastern Arc have not yet been classified according to IUCN criteria however it is likely that many of the restricted range species will be considered as threatened. The pressure on these species comes from both habitat loss / degradation as well as a trade in chameleons and some snakes.

Monitoring

By returning periodically to the areas sampled during this survey, it should be possible to monitor whether the species recorded in this survey continue to be present. Particular effort should be made to monitor the presence of those species considered endemic to the South Nguru Mountains. Monitoring should be conducted by someone with considerable expertise and familiarity with the Eastern Arc herpetofauna as many species are cryptic and difficult to identify. Repeat surveys should be conducted at least every ten years, preferably every five years.

7 Forest use

By Nike Doggart, Claire Bracebridge, Abrahaman Mndeme and David Loserian

7.1 Introduction

The aim of the forest use study was to assess the rates of forest use and disturbance within Nguru South and Mkindo Forest Reserve using a combination of observations and disturbance transects. In Nguru South this work was undertaken in collaboration with the Conservation and Management of the Eastern Arc Mountain Forests Project (CMEAMF). Similar research was conducted by CMEAMF in Kanga Forest Reserve and we have included some of the results from Kanga FR in section 7.4.

Two separate reports are available which provide additional details on the forest use and disturbance work undertaken in the landscape. For Nguru South and Kanga FRs, additional information is available in FBD (2005 b) (available at www.easternarc.or.tz) and for Mkindo more detailed information is available in Bracebridge (2006) (available at www.easternarc.or.tz). The report prepared by FBD (2005 b) also includes the results of threat reduction analyses for Nguru South and Kanga Forest Reserves. In addition it is anticipated that by mid-2007, additional reports will be available from Frontier-Tanzania with data on Nguru South and Kanga Forest Reserves.

Many people living around the forests in the South Nguru Mountains rely on the forests as a source of building materials, firewood, honey, bush meat, thatching material and medicinal plants primarily for domestic use (Raben *et al.*, 2005). The forests are also a source of timber and *Allanblackia* fruits for cash income. There is also some collection of wild birds and chameleons for trade (Kiure, pers. comm. and Raben *et al.,* 2006). The importance of the forests to stakeholders in the South Nguru landscape is documented in more detail in two separate reports prepared as part of the PEMA programme (Raben *et al.,* 2006 and Boesen *et al.,* 2005). The focus of this section is to describe the types of disturbance visible within the forests and to provide an indication of the intensity of resource use. Understanding the impact of the different kinds of forest use on the forest structure and species composition is important for management planning. There are no clear guidelines as to what rates of utilization are sustainable in Eastern Arc Mountain Forests. Defining a process for determining sustainable forest utilization rates would be an important activity for PEMA to consider.

Historically, the greatest threat to the South Nguru Forests has been clearance for agricultural land. Estimates regarding historical changes in forest area and land use vary. Monela and Solberg (1998) describe a loss of 26% of the continuous forest area in the South Nguru Mountains and 56% of the area covered by forest patches between 1949 and 1993. Newmark (1998) describes a loss of 82% of natural forest over 2000 years (although Newmark's calculations lumped the South Nguru Mountains with the Nguu Mountains). While FBD (2006) estimate a 3.5% loss of forest between 1975 and 2003 based on an analysis of satellite images. More recent estimates suggest that there is now 340.4 km^2 of forest left based on SPOT XS images from June 2002 (Burgess *et al.,* 2007). All analyses document a significant reduction in the area under forest and an increase in agricultural land. These analyses also demonstrate that forest loss has occurred at all altitudes with the most rapid rates occurring at lower altitude and to the smaller forest fragments. FBD (2006) also highlight the threat to the woodlands around the main forest reserves where they estimate that 63% of the woodland has been cleared between 1975 and 2003.

The increased demand for land is largely a result of increasing populations. Pressure on the forest resources is high particularly around Nguru South Forest Reserve. The eastern, wetter, base of the mountains has been settled for many years. There are several well–established missions in the area including at Mhonda and Maskati. A combination of improved infrastructure, the presence of the Mtibwa sugar plantation and the relatively rich soils found at the base of the mountains has encouraged people to immigrate to the area. This has resulted in increasing demand for forest products and forested land.

Another significant cause of forest loss historically has been commercial timber operations. Between 1939 and 1992, forest loss accelerated in the area close to Manyangu in the north-eastern part of the main South Nguru mountain as a result of intensive logging using heavy harvesting machinery to supply timber to the Manyangu Sawmill. The sawmill processed various timber species including *Milicia excelsa*, *Ocotea usambarensis* and

Khaya nyasica and had an average output of 1,500 m^3 of sawn timber per year (Monela and Solberg, 1998). The saw mill closed in 1992 when the Government banned timber harvesting in catchment forests although the impact of the mill is still visible in the areas cleared and in the continued presence of the logging roads.

As with other Eastern Arc Mountain forests, the forests of the South Nguru landscape are sensitive to pressure from human use. Tree cutting, fire, clearance for agriculture and even fire wood collection change the structure and species composition of forests. Given the dependence of many species on a forest habitat, the change or removal of that habitat will result in the loss of some or all of those species from an area depending on the intensity and extent of the disturbance and the requirements of the species.

7.2 Methods

7.2.1 Observations of forest use

Over the course of conducting the biological surveys and the disturbance transects, observations were made on the different ways in which the forests are being used and on the distribution of those uses. These observations are complemented by discussions with people from the villages surrounding the forest reserves.

7.2.2 Disturbance transects

The methodology used for the forest condition assessment was modified by TFCG from that used by Frontier-Tanzania in the East Usambara and Udzungwa Mountain forests (Frontier Tanzania, 2001). The main variation is that the between-transect distance was not uniform. In addition, the transects did not extend across the entire forest reserve. Thus the procedure for recording data along the transect is the same as has been used by Frontier-Tanzania but the sampling strategy is different. The decision to adopt a lower sampling intensity for work by TFCG in Nguru South Forest Reserve also served to avoid duplicating the more intensive sampling that was conducted subsequently by Frontier-Tanzania in Nguru South and Kanga Forest Reserves with finance from the Critical Ecosystem Partnership Fund (data to be available in a report during 2007). In Mkindo Forest Reserve, the TFCG team adopted a more intensive sampling strategy as Frontier-Tanzania was not planning to work in this reserve and there therefore remained a need for more intensive sampling in this area.

At all sites, disturbance was assessed in a series of plots 50 m long and 10 m wide. The level of disturbance was assessed as the number of standing, dead or cut trees and poles along the 10 m wide strip (5 m on either side of the 50 m transect) Trees were defined as all standing woody plants with straight stems for at least 3 m and with a diameter (dbh) over 15 cm. For Mkindo, a further category was adopted to distinguish large timber trees. These were defined as all trees with straight stems at least 3 m in length and exceeding 30 cm dbh (note that Frontier-Tanzania define large timbers as exceeding 50 cm dbh, however as this survey was conducted in miombo woodland a definition of 'exceeding 30 cm dbh' was deemed appropriate).

Poles/saplings were defined as all standing woody plants with straight trunks at least 2m in length and with a diameter (dbh) of 5 – 15 cm.

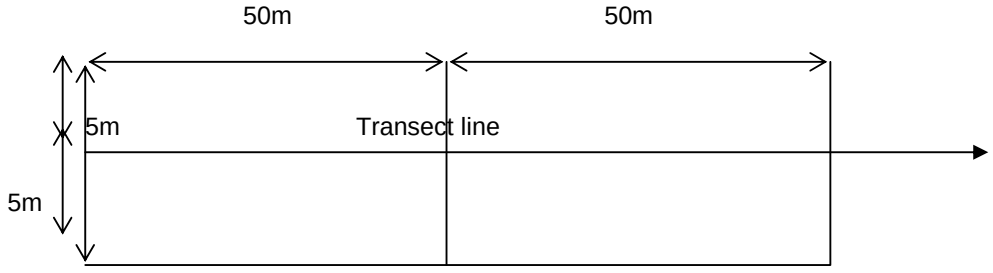


Figure 1. Dimensions of a typical disturbance transect.

Within each plot, the following information was recorded:

- Number of Live trees (or live poles/saplings)
- Number of Naturally dead trees (or naturally dead poles/sapling)
- Number of New cut trees (or new cut poles/saplings) – in this case the cut should still be fresh and not blackened.
- Number of Old cut trees (or old cut poles/saplings) – in this case the cut should have blackened)

Fallen trees, branches and woody plants with a diameter smaller than 5 cm were not included.

Other disturbances such as fire, cultivation, signs of hunting were also recorded.

In Nguru South transect lines were located systematically from a randomly chosen starting point on the forest edge. The starting point and direction of the transect line was recorded using a GPS and a compass respectively to allow transects to be relocated. The end of each transect line was also recorded for the same purpose. The transects followed an East – West trajectory. This sampling strategy is the same as the strategy used by the CMEAMF team in other Eastern Arc forests including Kanga.

In Mkindo Forest Reserve, a different sampling strategy was adopted. This involves four transects placed within a 2 km^2 grid system (a worksite) each starting from a 'centre point' in the middle. These transects follow the compass direction of north, east, south and west for one km and a GPS fix is taken at the start and end of the transect.

7.3 Sampling intensity

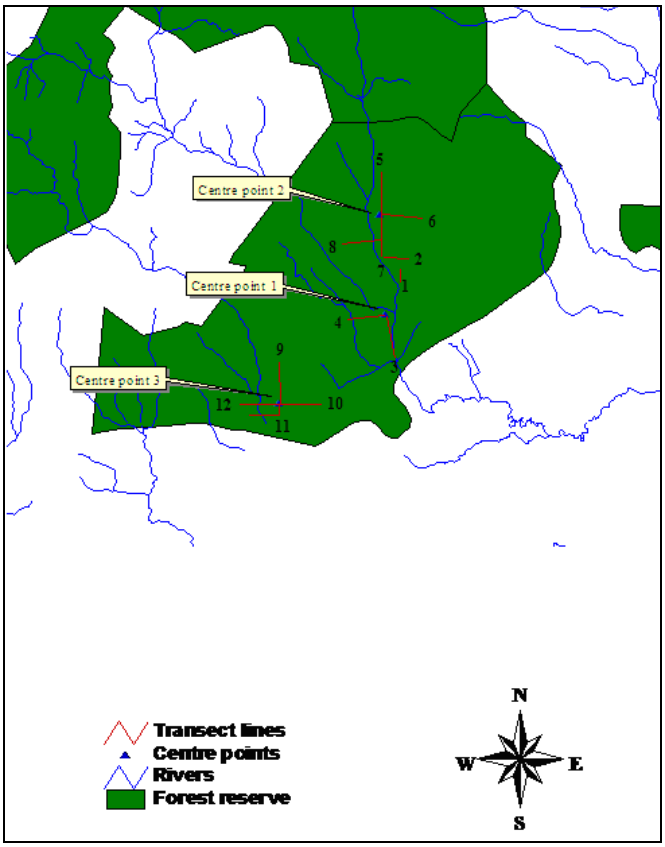
Disturbance was recorded along seven transects in Nguru South Forest Reserve and twelve transects in Mkindo Forest Reserve. In Nguru South, the work was undertaken by a TFCG team. The Regional Catchment Forest office and the Division Forest officer also took part in this work. In Mkindo Forest Reserve, the work was undertaken by a consultant, Claire Bracebridge with a team from TFCG.

Table 19. Locations and lengths of disturbance transects in Nguru South Forest Reserve

Transect numer	Starting point		Altitude (m asl)	Transect length (m)
1	339200 E	9322276 S	513	300
2	339467 E	9323033 S		400
3	338824 E	9325363 S		50
4	338751 E	9325538 S	1061	500
5	339200 E	9322276 S	1000	650
6	334405 E	9336052 S	1213	1000
7	339904 E	9328034 S	725	1000

Table 20. Locations and lengths of transects in Mkindo Forest Reserve

Transect numer	Starting point		Altitude (m asl)	Transect length (m)
	E	S		
1	0337735	9312280	451	300
2	0337330	9312849	495	700
3	0337391	9311479	420	1000
4	0337338	9311528	427	1000
5	0337275	9313860	700	1000
6	0337313	9313858	677	1000
7	0337270	9313861	670	1000
8	0337284	9313267	590	1000
9	0334923	9309467	480	1000
10	0334934	9309455	469	1000
11	0334920	9309439	460	1000
12	0334906	9309453	470	1000



Map 3. Disturbance transects in Mkindo Forest Reserve.

7.4 Results

The main types of forest use / disturbance categories that were recorded in Nguru South, Mkindo and Kanga Forest Reserve reserves are described below:

Agricultural encroachment

Within Nguru South Forest Reserve, there is widespread cultivation of cardamom, bananas, yams, cocoa and beans. Of these cardamom is the most prevalent. Cardamom is used as a spice for seasoning throughout much of Asia and to flavor coffee in the middle-east. Cardamom production has grown rapidly since its introduction to Tanzania in the 1960s. Initially 90 % of production was from the East Usambara Mountains and it has only recently been introduced to the South Nguru Mountains. Cardamom is often cultivated alongside bananas and yams.

The trade in both yams and cardamom is seasonal. In 2005, a trader from Dar es Salaam (Fida Hussein) established an office at Mhonda to buy cardamom from the forest reserves. During that year, the price of 1 kg of cardamom varied from TSh 1,400 (US$ 1.20) to TSh 2,000 (US$ 1.80) depending on the quality and time of year.

During Ramadhan, yams are in high demand for the Zanzibari market and at this time dealers come to villages such as Mhonda and Kombora to buy the yams.

Within the Nguru South Forest Reserve, the areas that have been most affected are close to the following villages:

Ubiri, Mafuta, Kwelikwiji, Mhonda (Kawawamanga sub-village), Digoma, Digarama, Maskati and Msolokelo in Mhonda Ward;
Pemba in Kibati Ward;
Semwali and Kinda in Maskati Ward (where beans are also being grown);
Kamtonga (Kwamafiri sub-village) and Mboto (Kungwi sub-village) in Sungaji Ward.

Cardamom cultivation involves the clearance of the forest understorey. Cultivation in the understorey prevents forest regeneration as well as changing significantly the habitat for species dependent on the understorey. The impact on different species of replacing the natural understorey with cardamom is not known. It appears that the

potential negative impact of this practice is not well understood and there were reports that forest officers had issued informal 'permits' to farmers to pursue this activity.

In the lowlands, especially in the vicinity of Kanga Forest Reserve, farmers are being encouraged to clear the woodland to plant sugar cane and maize. Newly opened areas include land on the western side of the Magomondo area and in the Mnesa area of Nguru South. In the lowlands on the western slope side of Kanga Forest Reserve near to Difiniga village, there are also signs of recent forest clearance for agricultural land.

On the slopes below Nguru South Forest Reserve, the forest has been replaced by a combination of bananas, cardamom, coffee, cocoa and in the lowlands sugar cane and rice.

In Mkindo FR, cultivation was recorded in 1.8 % of all 50 m sections. An area of farmland was recorded at the end of transect eight in the north-west of the reserve. The local labourers present (who were not the actual farmers) stated that permission to farm this land (a valley) had been granted by Forestry. There were more than three different farmers producing maize and other crops in the area. The main Mdera village path crossed the edge of this farmland. Further south along transect three there was evidence of clearance for new farmland inside the reserve on the west side of the Mkindo river which acts as the FR border at this point.

Shifting cultivations and Livestock keeping

Cattle grazing occurs throughout most of the lowland woodland and thicket in the South Nguru Mountain landscape. In Mkindo Forest Reserve, signs of grazing were recorded in 41 % of all 50 m sections (90 out of 220 50 m sections). Evidence was a mixture of cattle paths / old dung and was found throughout the central and western parts of the reserve.

Hunting

Hunting in the South Nguru landscape targets various mammal species using a variety of different types of snares and traps as well as dogs and spears. Target species include bush pig, duiker, blue monkeys, bush buck, colobus monkey, hyrax and larger rodents. Hunting is both for food and to reduce numbers of crop-raiding species. Although no systematic data is available on the hunting pressure, observations by various field researchers noted that the hunting pressure appears to be particularly high in Nguru South Forest Reserve relative to the higher altitude forest in Kanga Forest Reserve (Rovero, pers. comm.; Loserian, pers. comm.; Perkin, pers. comm.. and Menegon, pers. comm.). This is reflected in the results of camera trapping in Nguru South in comparison to Kanga Forest Reserve (p. 30).

In Mkindo FR, there also appears to be less hunting pressure than in Nguru South. An animal trap was recorded in only one of the 220 50 m sections. This was located in riverine / lowland forest along transect six and appeared to be a trap for the Giant pouched rat. Additional opportunistic observations noted the same type of trap at the end of transect one near the Kigombezi river. Another small mammal trap was noted near the Dizingwi river where a small cave had an old fire, a rag and the small mammal trap outside. It is possible that medium to large mammals have already been over-hunted, as there were very few signs of animals such as bush pig and small antelope within the reserve. According to local residents, some villagers do hunt but only for crop raiding species, such as Yellow baboon (*Papio cynocephalus*), Syke's monkey (*Cercopithecus mitis monoides*) and Bushpig (*Potamochoerus larvatus*). Gunfire was heard from base camp two after alarm calls from baboons (all from the same direction). In a shamba, on the opposite side of the Mkindo river to base camp one (thus out of the reserve), two large steel traps were found. These had been set by the river, where baboons were seen to cross by the survey team. Animals had already been trapped that morning as there was a strong smell of baboon and one trap had hair on it that may have been from the Marsh mongoose (*Atilax paludinosus*) (R. Rajabu, pers. comm.).

Live bird trade

Around Nguru South Forest Reserve there are at least ten people actively involved in live bird trapping for sale to a middle man living in Dumila who sells the birds to exporters in Dar es Salaam. Target species include: *Tauraco livingstonii*, *Bycanistes brevis*, *Bycanistes bucinator* and *Cyptospiza reichenovii*. The trappers are reported to live in Maskati and Kombora villages.

Insect trade

Collection of insects from Nguru South Forest Reserve for the international trade has been going on at least since 1995. Target species include beetles and butterflies. Local people reported that some traders are Tanzanian while others are foreigners (mostly French). The trade is reported to be most active from Maskati and Kombora Villages.

Timber and pole cutting

Timber and pole cutting occur in all three reserves. Poles are cut for local building and for sale. Timber is largely for sale to middlemen from Mtibwa, Morogoro and Dar es Salaam.

The results of the disturbance transects in Nguru South and Mkindo Forest Reserves are presented in Tables 21 and 22 respectively.

Table 21. Rates of pole and timber cutting per hectare in Nguru South Forest Reserve.

	Number of trees per hectare				Number of poles / saplings per hectare			
Transect Number	Live	Nat. Dead	Old Cut	New Cut	Live	Nat. Dead	Old Cut	New Cut
1	110	20	20	3	103	17	7	0
2	283	20	15	0	200	40	18	0
3	100	40	100	60	160	60	0	0
4	160	16	94	30	376	24	72	12
5	415	12	2	18	423	57	11	3
6	239	14	21	9	206	18	38	10
7	96	2	93	2	276	22	146	12

Table 22. Rates of pole and timber cutting per hectare in Mkindo Forest Reserve.

Transect	Number of poles / saplings per hectare				Number of timbers per hectare				Number of large timbers per hectare			
Number	Live	Nat. Dead	Old Cut	New Cut	Live	Nat. Dead	Old Cut	New Cut	Live	Nat. Dead	Old Cut	New Cut
1	153	7	10	3	130	63	3	0	87	3	3	0
2	66	3	4	1	56	27	1	0	37	1	1	0
3	116	2	2	1	149	24	14	2	25	0	1	2
4	223	6	7	2	173	7	6	0	84	6	2	0
5	230	36	8	0	256	56	6	0	101	11	1	0
6	158	5	0	0	259	14	10	0	89	6	1	0
7	162	16	12	1	339	26	3	5	81	5	0	0
8	71	12	8	1	181	15	4	5	34	5	0	0
9	240	13	9	0	236	17	3	0	57	8	0	0
10	130	10	20	0	169	23	6	3	67	2	0	0
11	249	20	27	0	238	22	19	0	102	12	0	0
12	133	12	7	1	161	18	9	0	67	1	0	0

In Nguru South Forest Reserve, a total of 1,105 trees and 1,443 poles were surveyed along seven transect lines covering a total distance of 9,550 m and out of these 75.7 % of the trees and 73.7 % of the poles were alive. Forest extraction was fairly high in this reserve with 19 trees per ha and 25 poles per ha recorded as old cut stems. Conversely 4 trees per ha and 3 poles per ha were recorded in the new cut stems category. Natural mortality contributed to about 4.3 % of the trees and 7.8 % of the poles and may be within the normal range of variation (FBD, 2005 b).

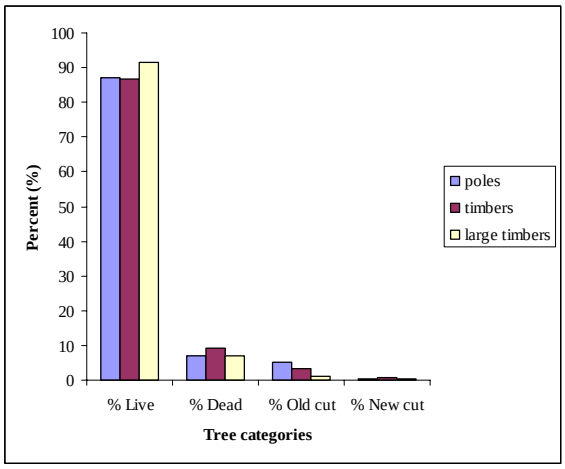
Rates of timber cutting on the edge of Nguru South FR were the twelfth highest recorded by FBD (2005b) in a study of 15 Central Government Forest Reserves in the Eastern Arc Mountains. However, this may be deceptive as logging appears to be quite localised within the reserve. For example the recent renovation of the Magunga to Maskati road by TASAF has resulted in a significant increase in commercial logging from this part of Nguru South.

Target species include *Ocotea usambarensis*, *Khaya anthotheca*, *Podocarpus usambarensis* and *Newtonia* sp. Timber is purchased by a dealer from Mtibwa. Some timber also passes via Mdera Village to Mkindo Village where planks are loaded onto trucks.

In Kanga Forest Reserve, CMEAMF (2005b) reported a total of 1,182 trees and 854 poles surveyed along six transect lines covering a total distance of 4,250 m and out of these 74% of the trees and 79 % of the poles were alive (FBD 2005b). During the survey 39 trees per ha and 25 poles per ha were recorded as old cut stems. Conversely 2 trees per ha and 0.5 poles per ha were recorded in the new cut stems category. The traditional cultural values, which restrict access to the forest area, are not well observed here due to the mixed culture of the communities around the reserve. Natural mortality contributed to about 11 % of the trees and 8% of the poles perhaps as a result of gaps created due to illegal harvesting and pests. Other human related disturbances such as grazing and fire could contribute to the death of some stems (FBD, 2005b).

Rates of timber cutting on the edge of Kanga FR were the fifth highest recorded by FBD (2005b) in a study of 15 Central Government Forest Reserves in the Eastern Arc Mountains. During the CMEAMF survey, the team observed at least ten pit sawing camps. Each of the sites is close to the reserve boundary with the highest concentration of sites being in the north-east near to Kwabeko sub-village and Mziha Village. Other sites were close to Kanga Village and Difinga Village. However, it should be noted that the clustering of the disturbance survey transects in woodland, close to the edge of the reserve means that the results do not reflect the condition of the higher altitude forests. Kanga's steep slopes have made the higher altitude forest less accessible. In some of the forest at higher altitude, there were no signs of cutting within this reserve (Perkin pers. Comm.).

In Mkindo Forest Reserve, a total of 2,125 poles, 2,696 timbers and 826 large timbers were surveyed along the transect lines. The majority of these were live poles or timbers (87.4 % live poles, 86.7 % live timbers and 91.6 % live large timbers) with a small percentage of naturally dead trees recorded (7. 0% dead poles, 9.4 % dead timbers and 7.1 % dead large timbers). Most of these dead trees were the result of the fires that are an integral part of the miombo woodland ecosystem, but many are caused by villagers, either spreading from farmland nearby or deliberately set to encourage a new flush of grass for cattle grazing in the dry season within the reserve.



The level of cutting in Mkindo FR was low relative to the other two forest reserves with 5.5 % of total poles being cut, 3.9 % for timbers and 1.2 % for large timbers. When assessing the old and new cut trees separately, it was found that the levels of old cutting (three months and over) is greater than new cutting with 5.2 old and 0.3 new poles cut per hectare. Timber cutting per hectare was 3.3 old cut and 0.6 new cut with large timbers having an average of 1.0 old cut and 0.2 new cut large timbers per hectare. Poles have the highest cutting per hectare, which suggests that villagers utilise the forest more for local building materials (poles) than for commercial building materials (timber and planks).

Figure 2 Percentage of poles and timbers within disturbance categories from Mkindo FR.

In Mkindo FR, old and new pitsawing sites were recorded along the transects. 78 % of all pitsaw sites were old (seven out of nine 50m sections), however in total across all the transects only 3.2 % and 0.9 % of 50 m sections recorded old pitsaw and new pitsaw sites (7 out of 220 and 2 out of 220 respectively). Five of the old pitsaw sites were recorded along transect six in riverine and lowland forest. Casual observations along the Kigombezi river also confirmed that people are currently cutting many trees along this river and generally in this forested area. The two new pitsaw sites were located along transect seven and transect four, both in miombo woodland. Three additional fresh pitsaw sites were recorded opportunistically, two on the ridge to centre point two (where the well trodden path is located that accounted for 64.4 % of recordings) and one by the Kitungwi river.

Fire

In Mkindo FR, fire, although a necessary and natural part of the miombo woodland ecosystem, is still mainly a human caused activity and relates directly to the pressure on the reserve for grazing cattle. 91.4 % (201 out of 220 50m sections) of all sections were noted as having previous fires including areas of riverine and lowland forest. Transect six, which is 65 % riverine / lowland forest, had signs of previous fire along the whole transect.

Charcoal production

In Mkindo FR, charcoal production was observed in 1.8 % of all 50 m sections (4 out of 220 50 m sections).

Roads and paths

In Mkindo FR, 26.8 % of 50 m sections crossed or followed human paths (59 out of 220 50 m sections). However 64.4 % of these records (38 out of 59) refer to a single path which followed a ridge and was recorded along transect five and seven. Most human paths were encountered on ridge tops or by rivers and reflect areas of use rather than access to other villages.

Only one path runs through the reserve which is used for access to another village – the Mdera path; this is used on a daily basis to travel between Mdera and Mkindo villages, particularly on market day.

In Mkindo FR, 3.2 % of 50 m sections recorded vehicle tracks / roads (7 out of 220 50 m sections). Two tracks lead to the intake pipes at Dizingwi river, although one was also a logging track and another was an old logging track by Mkindo river. All tracks were wide enough for tractors.

Mining

In Mkindo FR, an old mining site was located along transect three. It was approximately 10 m deep and according to a local resident, the site was approximately three years old and targeted mining of rubies.

7.5 Discussion

Disturbance as a result of human activities is visible in Kanga, Nguru South and Mkindo Forest Reserves as well as in the woodland between the two reserves. The rates of disturbance vary between the reserves and within the reserves. Accessibility appears to be a key factor in determining the levels of agricultural encroachment and tree cutting. Kanga's steep slopes appear to have deterred timber harvesting and agricultural encroachment in the forest at higher altitude although in the lowlands the rates of cutting are high. In Nguru South, agricultural encroachment from cardamom and yams appears to be more widespread although, again the highest concentration is close to the forest edge. In Mkindo Forest Reserve, fire was the most widespread form of disturbance (Figure 3) followed by cattle grazing and paths.

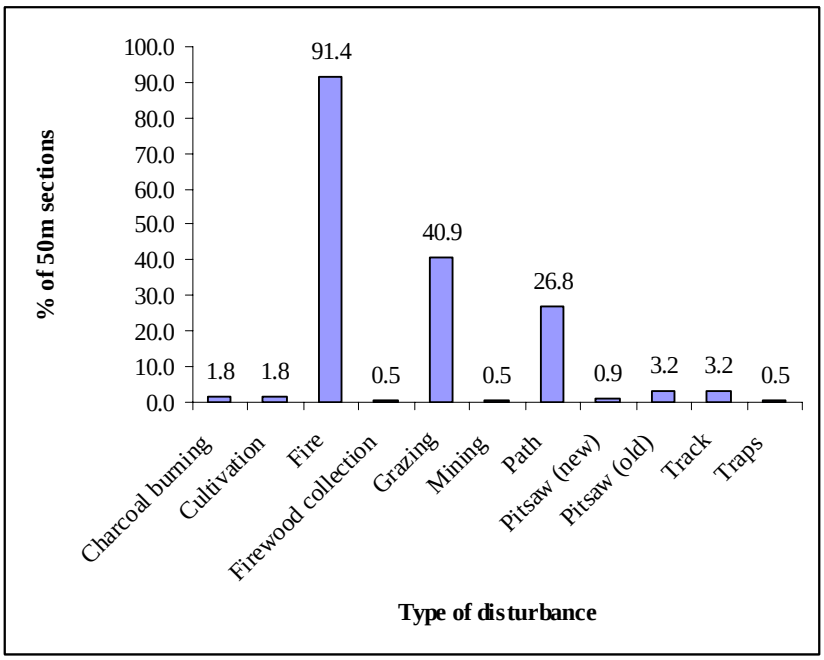


Figure 3. Percentage of 50 m transect sections in Mkindo FR with various types of human disturbance

Outside of the two central government forest reserves, the clearance of the woodland close to the Mjonga river is of particular concern. This woodland may play an important role as a natural corridor for species between Nguru South and Kanga. It may also play an important role for birds that migrate seasonally from high altitude to low altitude.

The three teams who undertook the work described in this report encountered some difficulties in carrying out the disturbance transect methods. The steep slopes and frequent rock outcrops encountered in both Nguru South and Kanga made it difficult to set long transects. This resulted in a higher sampling intensity along the forest boundary. Additional surveys are required to obtain quantitative data on the levels of disturbance at higher altitude.

In Mkindo FR, transect 8 (west) had to be moved approximately 500m south of the centre point as the original transect hit a cliff almost immediately. In addition, some problems were encountered in trying to identify the reserve boundary. This led to one transect being out of the reserve and repeated (transect 2) (but due to some unforeseen health and safety issues was not completed) and one transect was short (transect 1). Transect 11 was completed but had to change direction from south to west as the transect met the border (as indicated by a few discontinuous teak trees).

8 Conclusions

Relative to other Eastern Arc Mountains, the Nguru South Mountains have received little research attention. The current study has significantly increased our knowledge of the biodiversity values of the area. The discovery of seven new species and the documentation of at least 18 Eastern Arc endemic and near-endemic animal species not previously known from the area highlights the biological importance of the mountains. Research by PEMA on other characteristics of the landscape including the hydrology, soils, climate and geology has been limited to reviews of the literature. This has revealed that there are significant limitations in the data available on the area and highlights the need for additional original research and monitoring.

Data on the biodiversity and ecological values of the South Nguru Mountains landscape are crucial in underpinning discussions between stakeholders on the future of the landscape. These are not idle academic considerations. If we are to persuade local communities, government and the international community to commit to the sustainable management of the landscape's natural resources we need to know what those resources are and how they can be used sustainably. It is also important that this information is shared widely, particularly with the communities. Through the PEMA programme the results of this report have been translated into Swahili and summarised in a booklet that has been distributed to communities and other stakeholders within the South Nguru landscape. Many people in the South Nguru landscape live according to a fragile balance with their natural environment. Discussions about forest and natural resource management are discussions about their livelihoods. Finding solutions to some of the conservation issues outlined in this report is also about finding solutions to the issues underlying poverty and livelihood insecurity in the area. This report represents one part in the process of negotiating, planning and implementing more sustainable natural resource management practices. In November 2005, with the support of PEMA, key stakeholders in the South Nguru landscape developed a plan for the sustainable management of the area's resources. With the support of the communities, government, civil society organisations and international community this could represent a unique opportunity to embark on a path towards a future in which people can live along side the unique biodiversity and habitats of the South Nguru Mountains. Only time will tell whether this will be achieved.

9 Recommendations

This chapter is divided into two sections. The first section includes recommendations for additional research and monitoring some of which should be included in the Phase II planning of PEMA, the second section includes recommendations relating to other conservation and management initiatives.

9.1 Recommendations for additional research and monitoring

Soil erosion and soil fertility

- Assess and map soil erosion rates particularly on the slopes around Nguru South Forest Reserve.
- Identify areas at risk from landslides.
- Investigate the relationship between agricultural practices, forest clearance and soil erosion / fertility. This research should contribute to identifying appropriate agricultural practices that will conserve soil structure and fertility and reduce the loss of top soil. A more detailed understanding of the role of the forest in mitigating soil erosion and conserving soil fertility would be of value in discussions on payments for environmental services.

Hydrology

- Collect accurate river flow data. This is particularly important for discussions on payments for environmental services.
- Provide additional support to the relevant authorities for the monitoring of river flows.
- Monitor water quality particularly downstream of the sugar and teak plantations and rice paddies. Improved data on water flows and water quality should be used for studies on the relationship between the hydrology of the area and different land uses.

Climate

- Investigate the possibility of establishing a rainfall station at higher altitude.
- Provide support to the relevant authorities for improved meteorological monitoring.
- More detailed studies on the relationship between changing land use and the climate.

Vegetation

- Additional work to understand the different vegetation types within the landscape with particular reference to changes with altitude, aspect and levels of disturbance.
- Research to determine sustainable harvesting levels of plants that contribute to the livelihoods of people living in the villages surrounding the reserve.
- Research to determine whether there are other plants with medicinal or other properties which can be harvested sustainably and in a way that contributes to the livelihoods of the surrounding communities. This work could be conducted in collaboration with ICIPE.
- Research to identify appropriate species and cultivation techniques of indigenous tree species appropriate for agroforestry.

Biodiversity

Birds

- More detailed surveys to determine the importance of the lowland forest and woodland between Kanga and Nguru South as a corridor for forest bird species between the two reserves.
- More detailed surveys to assess the status of those species not observed during the current survey (p. 27).
- Surveys of the bird populations of Mkindo, Lusunguru and Dunduma Forest Reserves.
- Investigate further the possible new species of owl mentioned by Romdal and others.

Mammals

Key gaps in the baseline data include:

- a survey of the bats of the South Nguru Mountains (i.e. Nguru South, Kanga and Mkindo Forest Reserves and of the woodland);
- a survey of the small mammals (rodents and shrews) of Kanga and Mkindo Forest Reserves and of the woodland between Nguru South and Kanga.
- a inventory of the larger mammals of Mkindo Forest Reserve through camera trapping and transects.
- Some of this work is included in the proposed activities of Frontier-Tanzania with support from the Critical Ecosystem Partnership Fund. Upon completion of their work, it is recommended that PEMA review any outstanding gaps.

- There should be follow-up on the low camera trapping results from Nguru South Forest Reserve. Additional camera trapping should be carried out to determine the status of larger mammals in this reserve and to understand the causes of the apparent low populations of larger mammals in this forest.

Reptiles and amphibians

- Surveys of the herpetofauna of Mkindo, Dunduma and Lusunguru Forest Reserves.
- Given the apparent high species turnover rates of amphibians in both Nguru South and Kanga Forest Reserve, it is recommended that more intensive surveys of the herpetofauna be conducted in these reserves.

Invertebrates

- In the context of payments for environmental services, investigate the role that forest species are playing as pollinators for surrounding agricultural crops.
- Survey the butterfly, jewel beetle and other ornamental beetle fauna of the South Nguru Mountains and investigate the possibilities of encouraging surrounding villages to farm these species in an ecologically sustainable way for trade.

Forest use

- Disturbance transects should be carried out in forest at higher altitude in both Nguru South and Kanga Forest Reserves and at other sites in the two reserves to give a more representative sampling intensity. This should be carried out as part of Phase II of PEMA. Repeat surveys should be conducted at least every 5 years as part of the monitoring programme for Phase II of PEMA.

- Finalise the threat reduction assessment baselines during Phase I.

- Additional research to understand the impact of cardamom cultivation on the ecology of the forest and to identify ways of mitigating the negative impact of in-forest agriculture.

9.2 Recommendations for conservation and management interventions

Management

- Clear the boundaries of the forest reserves and mark them by planting quick-growing non-invasive tree species.
- Enforce laws prohibiting harvesting of timber from the reserves.
- Improve the controls on hunting.
- Enforce laws prohibiting cultivation with the reserves.
- Resolve the issue of Ubiri Village, a growing village within Nguru South Forest Reserve to prevent further forest loss.

Education, awareness raising and communication

- Raise awareness on the values of the forests of the South Nguru Mountains to local, national and international audiences.
- Raise awareness on forest laws, policies and regulations.
- Raise awareness on the importance of applying appropriate agriculturual techniques in the vicinity of water sources.
- Sensitise communities not to tamper with or remove rainfall and stream flow gauging stations.

Training

- Provide additional training to division forest officers so that they are more aware of their roles and responsibilities.
- Provide additional training on monitoring techniques including disturbance transects and threat reduction assessment.
- Increase communities capacity to participate in forest management.

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Appendix 3. Checklist of plant species recorded from the South Nguru Mountains.

Genus	specific epithet	Infra-species	IUCN status	Range	Kanga	Nguru South	Mkindo	Dunduma	Village land	Recorded by Lovett or Mwangoka exact location not known
Acanthaceae										
Asystasia	*Albiflora*				1					
Asystasia						1				
Brillantaisia	*Cicatricosa*				1					
Brillantaisia	*madagascariensis*					1				
Isoglossa	*lactea*					1				
Justicia	*pseudorungia*				1					
Justicia	*schimperiana*							1		
Mellera	*lobulata*						1			
Phaulopsis	*imbricata*				1	1				
Pseuderanthemum	*tunicatum*					1				
Rhinacanthus	*gracilis*					1				
Sclerochiton	*vogelii*	subsp. holstii			1					
Stenandrium	*warneckii*			EA						1
Whitfieldia	*sp.*				1					
Amaranthaceae										
Cyathula	*prostrata*					1				
Anacardiaceae										
Rhus	*sp.*					1				
Sorindeia	*madagascariensis*					1	1	1		
Anisophyllaceae										
Anisophyllea	*obtusifolia*			EA						1
Annonaceae										
Enantia	*kummeriae*			EA						1
Monanthotaxis	*buchananii*					1				
Uvariodendron	*usambarense*			EA		1				
Uvariodendron	*gorgonis*			EAN						1
Apocynaceae										
Carvalhoa	*campanulata*					1				
Diplorhynchus	*condylocarpon*				1					
Funtumia	*africana*					1				
Landolphia	*buchananii*						1			
Mascarenhasia	*arborescens*							1		
Rauvolfia	*caffra*						1			
Schizozygia	*coffaeoides*				1					
Tabernaemontana	*elegans*								1	
Tabernaemontana	*ventricosa*				1					
Tabernaemontana	*sp.*					1				
Araceae										
Amorphophallus					1					
Culcasia	*orientalis*				1					
Araliaceae										
Polyscias	*stuhlmannii*			EA						1
Schefflera	*myriantha*					1				
Asclepiadaceae										
Kanahia	*laniflora*							1		
Pergularia	*daemia*				1					

Genus	specific epithet	Infra-species	IUCN status	Range	Kanga	Nguru South	Mkindo	Dunduma	Village land	Recorded by Lovett or Mwangoka exact location not known
Sacleuxia	*newii*			EA						1
Aspleniaceae										
Didymochlaena	*truncatula*					1				
Asteraceae										
Aspilia	*mossambicensis*				1					
Crassocephalum						1				
Emilia						1				
Microglossa	*pyrifolia*					1				
Mikania						1				
Senecio						1				
Senecio	*maranguensis*					1				
Vernonia	*exsertiflora*					1		1		
Vernonia	*glabra*				1					
Vernonia	*lasiopus*					1				
Vernonia						1				
Balsaminaceae										
Impatiens	*confusa*					1				
Impatiens	*lukwangulensis*			EA		1				
Impatiens	*raphidothrix*					1				
Impatiens	*walleriana*					1				
Impatiens					1					
Basellaceae										
Basella	alba					1				
Begoniaceae										
Begonia	*oxyloba*					1				
Begonia	*wakefieldii*				1					
Bombacaceae										
Bombax	*rhodognaphalon*					1				
Campanulaceae										
Lobelia	*longisepala*			EA		1				
Lobelia	*sp.*					1				
Capparaceae										
Capparis	*sp.*							1		
Ritchiea	*albersii*							1		
Caricaceae										
Cylicomorpha	*parviflora*					1				
Cecropiaceae										
Myrianthus	*holstii*				1					
Celastraceae										
Elaeodendron						1				
Maytenus	*acuminata*					1				
Maytenus	*undata*				1	1				
Maytenus	*sp.*				1					
Salacia	*sp.*					1				
Chrysobalanaceae										
Hirtella megacarpa				EA						1
Parinari	*excelsa*					1				

Genus	specific epithet	Infra-species	IUCN status	Range	Kanga	Nguru South	Mkindo	Dunduma	Village land	Recorded by Lovett or Mwangoka exact location not known
Clusiaceae										
Allanblackia	*stuhlmannii*		V	EA		1				
Allanblackia	*ulugurensis*		V	EA		1				
Garcinia	*kingaensis*					1				
Garcinia	*livingstonei*				1			1		
Garcinia	*volkensii*					1				
Garcinia	*semseii*		V	EA		1				
Harungana	*madagascariensis*					1				
Vismia	*orientalis*			EA						1
Combretaceae										
Combretum	*padoides*				1					
Combretum	*paniculatum*							1		
Combretum	*zeyheri*				1					
Commelinaceae										
Aneilema	*dispermum*						1			
Pollia	*condensata*				1					
Palisota	*orientalis*			EA						1
Connaraceae										
Agelaea	*pentagyna*					1				
Agelaea	*ugandensis*			W		1				
Crassulaceae										
Kalanchoe	*lateritia*				1					
Cucurbitaceae										
Coccinia	*grandiflora*					1	1			
Lagenaria	*abyssinica*					1				
Momordica	*glabra*			EA						1
Zehneria	*scabra*						1			
Cyperaceae										
Cyperus	*involucratus*				1					
Fimbristylis						1				
Scleria	*racemosa*						1			
Dichapetalaceae										
Tapura	*fischeri*				1					
Dioscoreaceae										
Dioscorea	*asteriscus*					1				
Dioscorea						1				
Ebenaceae										
Diospyros	*amaniensis*		V			1				
Diospyros	*kabuyeana*			EAN						1
Ericaceae										
Agarista	*salicifolia*					1				
Erica	*sp.*					1				
Euphorbiaceae										
Acalypha	*fruticosa*							1		
Alchornea	*hirtella*					1				
Alchornea	*laxiflora*					1				
Bridelia	*cathartica*				1					
Clutia	*abyssinica*					1				
Drypetes					1					

Genus	specific epithet	Infra-species	IUCN status	Range	Kanga	Nguru South	Mkindo	Dunduma	Village land	Recorded by Lovett or Mwangoka exact location not known
Drypetes	*usambarica*			EAN						1
Erythrococca	*sp.*									
Erythrococca	*trichogyne*				1	1				
Macaranga	*sp.*					1				
Manihot	*sp.*					1				
Rinorea	*ferruginea*						1			
Shirakiopsis	*elliptica*					1				
Tragia	*brevipes*						1			
Uapaca	*paludosa*					1				
Fabaceae										
Abrus	*precatorius*								1	
Afzelia	*quanzensis*						1			
Albizia	*sp.*				1					
Albizia	*sp.*					1				
Albizia	*gummifera*						1			
Angylocalyx	*braunil*			EAN						1
Crotalaria					1					
Crotalaria	*laburnoides*						1			
Dalbergia	*lactea*					1				
Desmodium	*repandum*					1				
Entada	*rheedei*					1				
Eriosema	*psoraleoides*						1			
Erythrophleum	*suaveolens*				1					
Indigofera	*trita*							1		
Isoberlinia	*scheffleri*			EAN						1
Millettia	*makondensis*			EAN				1		
Mucuna					1					
Newtonia	*buchananii*					1				
Newtonia	*paucijuga*			EAN						1
Parkia	*filicoides*						1			
Pseudarthria	*sp.*				1					
Rhynchosia	*sp.*					1				
Scorodophloeos	*fischeri*			EAN						1
Tetrapleura	*tetraptera*					1				
Zenkerella	*capparidacea*			EA						1
Zenkerella	*egregia*		V	EAN		1				
Flacourtiaceae										
Dasylepis	*integra*		V			1				
Grandidiera	*boivinii*				1					
Rawsonia	*sp.*							1		
Gentianaceae										
Urogenilias	*ulugurensis*					1				
Gesneriaceae										
Streptocarpus	*kirkii*			EA		1				
Streptocarpus						1				
Saintpaulia	*brevipilosa*			E		1				
Saintpaulia	*nitida*			E		1				
Saintpaulia	*grotei*			EA						1
Saintpaulia	*velutina*			EA		1				

Genus	specific epithet	Infra-species	IUCN status	Range	Kanga	Nguru South	Mkindo	Dunduma	Village land	Recorded by Lovett or Mwangoka exact location not known
Hamamelidaceae										
Tricholadus	*goetzei*		V							1
Hippocrateaceae										
Salacia						1				
Hyacinthaceae										
Albuca	*abyssinica*					1				
Icacinaceae										
Alsodeiopsis	*schumannii*		V			1				
Leptaulus	*holstii*					1				
Leptaulus						1				
Lamiaceae										
Achyrospermum	carvalhoi				1					
Hoslundia	opposita					1				
Plectranthus	edulis					1				
Lauraceae										
Beilschmidia	*kweo*		V	EA		1				
Cryptocarya	*liebertiana*					1				
Ocotea	*usambarensis*					1				
Liliaceae										
Asparagus	*asparagoides*					1				
Asparagus	*setaceus*				1					
Chlorophytum	*stenopetalum*				1					
Dracaena	*laxissima*					1				
Dracaena	*mannii*				1					
Dracaena	*usambarensis*						1			
Loganiaceae										
Nuxia	*floribunda*					1				
Strychnos	*cocculoides*					1				
Strychnos	*lucens*					1				
Strychnos	*madagascariensis*				1					
Marantaceae										
Marantochloa	*leucantha*				1					
Melastomataceae										
Calvoa	*orientalis*					1				
Cincinnobotrys	*oreophila*					1				
Dissotis	*polyantha*					1				
Gravesia	*sp.*					1				
Heterotis	*rotundifolia*				1	1				
Memecylon	*cogniauxii*			EA		1				
Memecylon	*deminutum*			EA						
Memecylon	*verruculosum*				1					
Memecylon						1				
Warneckea	*mouririifolia*			EA		1				
Meliaceae										
Toona	*ciliata*					1				
Turraea	*holstii*				1	1				
Monimiaceae										
Xymalos	*monospora*					1				
Moraceae										

Genus	specific epithet	Infra-species	IUCN status	Range	Kanga	Nguru South	Mkindo	Dunduma	Village land	Recorded by Lovett or Mwangoka exact location not known
Dorstenia	*alta*				1					
Dorstenia	*hildebrandtii*					1				
Dorstenia	*sp.*				1	1				
Ficus	*obtusifolia*						1			
Ficus	*cyathistipula*					1				
Ficus	*exasperata*							1		
Ficus						1				
Mesogyne	*insignis*		V		1	1				
Trilepisium	*madagascariense*				1		1			
Myristicaceae										
Cephalosphaera	*usambarensis*		V	EAN		1				
Myrsinaceae										
Myrsine	*melanophloeos*					1				
Myrtaceae										
Syzygium						1				
Syzygium	*cordatum*						1			
Ochnaceae										
Gomphia	*scheffleri*	subsp. scheffleri				1				
Ochna	*holstii*					1				
Ochna	*thomasiana*		V							1
Ochna	*schweinfurthiana*						1			
Ouratea	*scheffleri*		V	EA						1
Octoknemataceae										
Octoknema	orientalis			EA						1
Olacaceae										
Strombosia	*scheffleri*					1				
Onagraceae										
Ludwigia	*erecta*						1			
Orchidaceae										
Eulophia	*schweinfurthii*					1				
Platylepis	*glandulosa*					1				
Passifloraceae										
Adenia	*gummifera*					1				
Piperaceae										
Peperomia	*molleri*	subsp. molleri			1	1				
Piper	*capense*					1				
Piper	*umbellatum*				1					
Poaceae										
Olyra	*latifolia*				1					
Panicum	*trichoides*					1				
Setaria	*megaphylla*				1					
Setaria					1					
Podocarpaceae										
Podocarpus	*latifolius*					1				
Polygalaceae										
Polygala	*paniculata*					1				

Genus	specific epithet	Infra-species	IUCN status	Range	Kanga	Nguru South	Mkindo	Dunduma	Village land	Recorded by Lovett or Mwangoka exact location not known
Pteridophyta										
Asplenium	*aethiopicum*					1				
Asplenium					1					
Asplenium						1				
Drynaria						1				
Marattia	*fraxinea*					1				
Microgramma	*lycopodioides*					1				
Nephrolepis	*undulata*					1				
Pellaea	*viridis*					1				
Pteris	*catoptera*				1					
Rhamnaceae										
Gouania	*longispicata*					1				
Rubiaceae										
Afrocanthium						1				
Breonadia	*salicina*					1				
Canthium						1				
Canthium	*oligocarpum*					1				
Catunaregam	*spinosa*	*subsp. taylorii*			1					
Chassalia	*albiflora*		V			1				
Chassalia	*christineae*					1				
Chassalia	*bonifacei*					1				
Chassalia	*discolor*					1				
Chazaliella	*abrupta*					1				
Cremaspora	*triflora*	*subsp. confluens*				1				
Didymosalpinx	*norae*					1	1			
Galiniera	*saxifraga*					1				
Geophila	*obvallata*					1				
Keetia					1					
Kraussia	*kirkii*									1
Lagynias	*pallidiflora*		V							1
Lasianthus	*macrocalyx*					1				
Lasianthus	*pedunculatus*		V	EA		1				
Leptactina						1				
Mussaenda	*monticola*		V	EA						1
Oxyanthus	*speciosus*				1					
Pauridiantha	*paucinervis*					1				
Pavetta					1					
Pavetta						1				
Pentas	*bussei*					1				
Pentas	*zanzibarica*					1				
Polysphaeria	*lanceolata*						1			
Psychotria	*megalopus*		V	EA	1					
Psychotria	*zombamontana*					1				
Psychotria	*sp.*				1		1			
Psychotria	*sp.*					1				
Rothmannia	*urcelliformis*					1				
Rytignia	*caudatissima*		V	EA		1				

Genus	specific epithet	Infra-species	IUCN status	Range	Kanga	Nguru South	Mkindo	Dunduma	Village land	Recorded by Lovett or Mwangoka exact location not known
Rytignia	*celastroides*						1			
Rytignia	*lichenoxenos*					1				
Rutidea	*orientalis*					1				
Spermacoce	*princeae*						1			
Tarenna	*sp.*				1					
Tarenna	*pavettoides*						1			
Tricalysia	*pallens*				1					
Tricalysia	*sp.*				1	1				
Tricalysia	*microphylla*			EA						1
Tricalysia	*ovalifolia*					1				
Vangueria	*infausta*				1					
Rutaceae										
Vepris	*amaniensis*			EA	1					
Vepris	*simplicifolia*				1					
Vepris	*sp.*				1	1				
Sapindaceae										
Allophylus	*melliodorus*			EA	1	1				
Allophylus					1					
Allophylus						1				
Blighia	*unijugata*					1				
Chytranthus	*prieurianus*									1
Deinbollia					1					
Deinbollia	*borbonica*						1	1		
Dodonaea	*viscosa*					1				
Paullinia	*pinnata*							1		
Sapotaceae										
Chrysophyllum	*gorungosanum*					1				
Englerophytum						1				
Malacantha	*alnifolia*						1			
Manilkara	*mochisia*				1					
Neohemsleya	*usambarensis*			EA						1
Synsepalum	*brevipes*					1				
Synsepalum	*msolo*					1				
Smilacaceae										
Smilax	*anceps*					1				
Solanaceae										
Solanum	*anguivi*					1				
Solanum	*terminale*					1				
Sterculiaceae										
Cola	*clavata*			W			1			
Cola	*greenwayi*				1					
Cola	*ulolomа*					1				
Dombeya	*mupangae*				1					
Leptonychia	*usambarensis*			EA	1					
Theaceae										
Ficalhoa	*laurifolia*					1				
Ternstroemia	*polypetala*		V	EA						1
Thymelaeaceae										
Peddiea	*fischeri*					1				

Genus	specific epithet	Infra-species	IUCN status	Range	Kanga	Nguru South	Mkindo	Dunduma	Village land	Recorded by Lovett or Mwangoka exact location not known
Synaptolepis	*alternifolia*					1				
Tiliaceae										
Grewia						1				
Grewia	*goetzeana*			EAN			1			1
Ulmaceae										
Trema	*orientalis*					1				
Urticaceae										
Boehmeria	*macrophylla*					1				
Elatostema	*orientale*					1				
Laportea					1					
Pilea	*holstii*				1					
Procris	*crenata*					1				
Verbenaceae										
Clerodendrum	*cephalanthum*				1		1			
Clerodendrum	*myricoides*					1				
Premna	*chrysoclada*			EA						1
Premna					1					
Vitex						1				
Vitex	*amaniensis*			EA						1
Vitex	*doniana*						1			
Violaceae										
Rinorea	*angustifolia*			EA		1				1
Rinorea	*squamosa*			EA		1				
Rinorea	*ferruginea*					1				
Rinorea						1				
Vitaceae										
Cissus	*integrifolia*						1			
Cissus	*producta*					1				
Zingiberaceae										
Aframomum						1				
Costus						1				
Renealmia	*engleri*					1				

[1]Recorded in Burgess et al. (2007). Exact location not specified

Appendix 4. List of amphibian and reptile specimens collected.

museum tag	*Species*	Locality	site coordinates UTM	elevation
MTSN 8177	*Afrixalus sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8375	*Afrixalus sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8383	*Afrixalus sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8359	*Arthroleptides cf. yakusini*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8364	*Arthroleptides cf. yakusini*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8378	*Arthroleptides cf. yakusini*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8382	*Arthroleptides cf. yakusini*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8384	*Arthroleptides cf. yakusini*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8348	*Arthroleptis sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8356	*Arthroleptis sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8363	*Arthroleptis sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8366	*Arthroleptis sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8369	*Arthroleptis sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8374	*Arthroleptis sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8376	*Arthroleptis sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8377	*Arthroleptis sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8379	*Arthroleptis sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8381	*Arthroleptis sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8373	*Arthroleptis sp. piccolo*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8234	*Boulengerula sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8355	*Bufo gutturalis*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8205	*Callulina sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8202	*Cnemaspis africana*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8212	*Cnemaspis africana*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8214	*Cnemaspis africana*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8235	*Crotaphopeltis tornieri*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8361	*Hyperolius sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8342	*Leptopelis uluguruensis*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8360	*Leptopelis uluguruensis*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8362	*Leptopelis uluguruensis*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8337	*Nectophrynoides tornieri*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8344	*Nectophrynoides tornieri*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8351	*Nectophrynoides tornieri*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8357	*Nectophrynoides tornieri*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8358	*Nectophrynoides tornieri*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8365	*Phrynobatrachus sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8370	*Phrynobatrachus sp.*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8372	*Phrynobatrachus sp. 1*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8367	*Phrynobatrachus uzungwensis*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8368	*Phrynobatrachus uzungwensis*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8371	*Phrynobatrachus uzungwensis*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8380	*Phrynobatrachus uzungwensis*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8339	*Ptychadena cf. anchietae*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8347	*Ptychadena cf. anchietae*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8220	*Rhampholeon brevicaudatus*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8226	*Rhampholeon brevicaudatus*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8222	*Urocotyledon wolterstorffi*	Kanga FR	37 M 0358812 / 9336174	760
MTSN 8163	*Afrixalus uluguruensis*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8135	*Arthroleptis sp. cf. giant*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8136	*Arthroleptis sp. cf. giant*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8137	*Arthroleptis sp. cf. giant*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8139	*Arthroleptis sp. cf. giant*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8142	*Arthroleptis sp. cf. giant*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006

MTSN 8143	*Arthroleptis sp. cf. giant*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8170	*Arthroleptis sp. cf. giant*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8168	*Arthroleptis sp. Piccolo*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8172	*Arthroleptis sp. Piccolo*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8176	*Arthroleptis sp. Piccolo*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8181	*Arthroleptis sp. Piccolo*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8138	*Callulina cf. krefftii*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8140	*Callulina cf. krefftii*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8192	*Callulina cf. krefftii*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8129	*Callulina sp. (Grande)*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8130	*Callulina sp. (Grande)*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8131	*Callulina sp. (Grande)*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8132	*Callulina sp. (Grande)*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8133	*Callulina sp. (Grande)*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8134	*Callulina sp. (Grande)*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8141	*Callulina sp. (Grande)*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8171	*Callulina sp. (Grande) juv.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8144	*Hoplophryne cf. uluguruensis*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8145	*Hoplophryne cf. uluguruensis*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8146	*Hoplophryne cf. uluguruensis*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8147	*Hoplophryne cf. uluguruensis*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8156	*Hoplophryne cf. uluguruensis*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8157	*Hoplophryne cf. uluguruensis*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8151	*Hoplophryne sp.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8153	*Hoplophryne sp.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8162	*Hyperolius puncticulatus*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8197	*Hyperolius puncticulatus*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8148	*Nectophrynoides sp. N.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8149	*Nectophrynoides sp. N.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8150	*Nectophrynoides sp. N.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8152	*Nectophrynoides sp. N.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8154	*Nectophrynoides sp. N.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8155	*Nectophrynoides sp. N.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8158	*Nectophrynoides sp. N.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8159	*Nectophrynoides sp. N.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8161	*Nectophrynoides sp. N.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8164	*Nectophrynoides sp. N.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8173	*Nectophrynoides sp. N.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8175	*Nectophrynoides sp. N.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8179	*Nectophrynoides sp. N.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8180	*Nectophrynoides sp. N.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8191	*Nectophrynoides sp. N.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8199	*Nectophrynoides sp. N.*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8160	*Rana angolensis*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8165	*Rana angolensis*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8166	*Rana angolensis*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8167	*Rana angolensis*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8174	*Rana angolensis*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8169	*Trachylepis varia*	Nguru South (Maskati)	37 M 0333779 / 9329236	2006
MTSN 8270	*Afrixalus sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8275	*Afrixalus sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8256	*Afrixalus uluguruensis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8262	*Afrixalus uluguruensis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8336	*Agama agama ssp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8346	*Agama agama ssp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8186	*Agama montana*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000

MTSN 8187	*Agama montana*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8301	*Apparallactus cf. jacksoni*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8323	*Apparallactus cf. jacksoni*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8352	*Apparallactus cf. jacksoni*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8353	*Apparallactus cf. jacksoni*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8341	*Apparallactus guentheri*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8255	*Arthroleptides cf. yakusini*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8276	*Arthroleptides cf. yakusini*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8264	*Arthroleptis sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8279	*Arthroleptis sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8285	*Arthroleptis sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8286	*Arthroleptis sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8263	*Arthroleptis sp. piccolo*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8274	*Arthroleptis sp. piccolo*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8288	*Arthroleptis sp. piccolo*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8289	*Arthroleptis sp. piccolo*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8354	*Atractaspis bibronii*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8209	*Bitis arietans*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8185	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8290	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8291	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8292	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8293	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8294	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8295	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8296	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8297	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8298	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8299	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8300	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8302	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8303	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8304	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8305	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8306	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8307	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8310	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8313	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8315	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8317	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8320	*Boulengerula sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8318	*Bradypodion fisheri*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8233	*Bufo brauni*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8248	*Bufo brauni*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8251	*Bufo brauni*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8254	*Bufo brauni*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8257	*Bufo brauni*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8281	*Bufo brauni*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8282	*Bufo brauni*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8237	*Callulina sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8242	*Callulina sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8195	*Chamaeleo deremensis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8334	*Crotaphopeltis hotamboeia*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8206	*Dendroaspis angusticeps*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8326	*Dendroaspis angusticeps*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8403	*Dendroaspis angusticeps*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000

MTSN 8410	*Dispholidus typus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8349	*Elapsoidea nigra*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8243	*Hyperolius mitchelli*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8277	*Hyperolius mitchelli*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8238	*Hyperolius spinigularis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8240	*Hyperolius spinigularis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8241	*Hyperolius spinigularis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8259	*Hyperolius spinigularis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8260	*Hyperolius spinigularis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8265	*Hyperolius spinigularis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8266	*Hyperolius spinigularis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8267	*Hyperolius spinigularis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8271	*Hyperolius spinigularis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8273	*Hyperolius spinigularis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8278	*Hyperolius spinigularis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8385	*Lamprophis fuliginosus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8386	*Lamprophis fuliginosus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8387	*Lamprophis fuliginosus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8388	*Lamprophis fuliginosus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8389	*Lamprophis fuliginosus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8390	*Lamprophis fuliginosus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8391	*Lamprophis fuliginosus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8393	*Lamprophis fuliginosus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8394	*Lamprophis fuliginosus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8395	*Lamprophis fuliginosus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8396	*Lamprophis fuliginosus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8398	*Lamprophis fuliginosus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8402	*Lamprophis fuliginosus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8406	*Lamprophis fuliginosus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8239	*Leptopelis flavomaculatus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8244	*Leptopelis flavomaculatus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8227	*Leptopelis uluguruensis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8232	*Leptopelis uluguruensis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8258	*Leptopelis uluguruensis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8229	*Leptopelis vermiculatus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8230	*Leptopelis vermiculatus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8345	*Lycophidion capense loveridgei*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8338	*Lycophidion meleagre*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8340	*Lycophidion meleagre*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8183	*Natriciteres sylvatica*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8201	*Natriciteres sylvatica*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8309	*Natriciteres sylvatica*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8316	*Natriciteres sylvatica*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8280	*Nectophrynoides sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8283	*Nectophrynoides sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8287	*Nectophrynoides sp.*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8178	*Philothamnus cf. battersby*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8204	*Philothamnus cf. battersby*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8200	*Philothamnus macrops*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8190	*Philothamnus punctatus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8228	*Phrynobatrachus uzungwensis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8261	*Phrynobatrachus uzungwensis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8272	*Phrynobatrachus uzungwensis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8236	*Probreviceps macrodactylus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8343	*Prosymna stuhlmanni*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8253	*Rana angolensis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000

MTSN 8268	*Rana angolensis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8188	*Rhampholeon brevicaudatus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8335	*Rhinothyphlops cf. brevis*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8231	*Schismaderma carens*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8193	*Thelotornis usambaricus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8196	*Thelotornis usambaricus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8400	*Thelotornis usambaricus*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8182	*Trachylepis striata*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8189	*Trachylepis striata*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8198	*Trachylepis striata*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8245	*Xenopus cf. petersii*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8246	*Xenopus cf. petersii*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8249	*Xenopus cf. petersii*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8250	*Xenopus cf. petersii*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000
MTSN 8252	*Xenopus cf. petersii*	Nguru South (Pemba)	37 M 0336825 / 9333210	1000