Tanzania Forest Conservation Group
Shirika la Kuhifadhi Misitu ya Asili Tanzania

MUSEO TRIDENTINO DI SCIENZE NATURALI

TFCG Technical Paper 17

THE VERTEBRATE BIODIVERSITY AND FOREST CONDITION OF THE NORTH PARE MOUNTAINS

By N. Doggart, C. Leonard, A. Perkin, M. Menegon and F. Rovero

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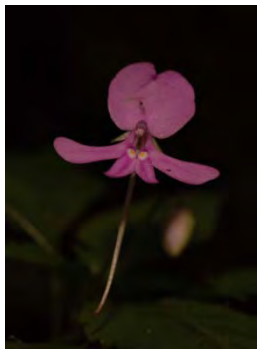

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Cover photographs by Michele Menegon. From left to right. View of North Pare Mountains. Forest scene. Hyperolius glandicolor and Impatiens sp.

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EXECUTIVE SUMMARY

The North Pare Mountains lie at the northern-most end of the Eastern Arc Mountains in Tanzania, just 30 kilometres east of Mount Kilimanjaro. Relative to other Eastern Arc Mountains, the North Pare Mountains are considered to be a low conservation priority due to the paucity of endemic species (Burgess *et al*. 2007; Burgess *et al*. 1998). The North Pare Mountains have also been subject to far less biodiversity research than some other Eastern Arc Mountain blocks such as the Udzungwas and East Usambaras. The correlation between research effort and documented biodiversity values has been demonstrated in other parts of the Eastern Arc such as the Rubehos (Doggart *et al.* 2006) and Ngurus (Doggart and Loserian 2007). The current surveys therefore set out to document the biodiversity values of the North Pare Mountains in order to assess whether their current ranking is a product of research effort or whether there really are few endemic species in this area. The surveys also aimed to assess the condition of the forests and to make recommendations on the conservation of this area.

Situated in Mwanga District, Kilimanjaro Region, the North Pare Mountains are a densely populated mountain range with approximately 2720 ha of forest remaining in 1999 (Forestry and Beekeeping Division 2006c). Most of the remaining forest lies within six Central Government Forest Reserves, Minja, Kindoroko, Mramba, Kamwalla I and II and Kiverenge. In addition there are over two hundred small sacred forests dotted across the mountain landscape (Mwihomeki *et al.* 1998).

This report documents the aims, methods, results and conclusions of biodiversity surveys carried out in the North Pare Mountains by a team from the Tanzania Forest Conservation Group and the Museo Tridentino di Scienze Naturali, Italy. The survey was financed by the Critical Ecosystem Partnership Fund as part of the partnership project 'Filling the Knowledge Gap: Surveys of Poorly Known Sites and Species in the Eastern Arc and Coastal Forests'.

The surveys were conducted between October and November 2005 by a team of four researchers for a total of eight days. In addition, camera traps were deployed for a total of 516 trap-days. The surveys covered mammals, reptiles and amphibians. The team used a combination of observations, sound recordings, pit fall traps and camera trapping in order to record vertebrate species. The condition of the forest was also assessed and interviews were conducted to document indigenous knowledge. The team carried out surveys in Kindoroko, Mramba and Minja Forest Reserves which range in altitude from 760 m to 2113 m asl (Table 1). The reserves contain a mosaic of forest, heath, woodland and thicket although the survey team focused on forested areas. A brief visit was also made to Kileo Local Authority Forest Reserve at the base of the North Pare Mountains.

Table 1. Summary of area, altitudinal range and vegetation of forest reserves visited.

Forest Reserve	Area (ha)	Altitudinal range (m)	Vegetation
Kindoroko	885	1600 - 2113	Montane forest and heath
Minja	520	1500 - 1850	Mainly montane forest with a small area of submontane forest in valley bottoms
Mramba	3355	760 - 1700	Mainly woodland and thicket with some dry montane forest

The survey team recorded 92 vertebrate species including 56 birds, 19 mammals, 11 reptiles and 6 amphibians. The overall species list from the survey is provided in Table 2.

Table 2. Vertebrate species recorded during the current survey in the North Pare Mountains.

Scientific name	Common name	Minja	Mramba	Kindoroko	Village land	IUCN	Endemism	Habitat
BIRDS								
Accipiter tachiro	African goshawk	x	x	x		LC	W	F
Buteo oreophilus	Mountain buzzard	x	x	x		LC	W	F
Stephanoaetus coronatus	African crowned eagle	x	x	x		LC	W	F

Scientific name	Common name	Minja	Mramba	Kindoroko	Village land	IUCN	Endemism	Habitat
Polyboroides typus	African harrier hawk	x				LC	W	F
Buteo augur	Augur buzzard	x	x	x		LC	W	O
Circeatus gallicus	Short toed snake eagle		x?			LC		O
Guttera pucherani	Crested guineafowl	x	x	x		LC	W	F
Columba arquatrix	Olive pigeon	x	x	x		LC	W	F
Columba larvata	Lemon dove	x	x	x		LC	W	F
Turtur chalcospilos	Emerald spotted wood dove	x	x	x		LC	W	F
Tauraco hartlaubi	Hartlaub's turaco	x	x	x		LC	W	FF
Centropus superciliosus	White-browed coucal	x				LC	W	O
Strix woodfordii	African wood owl	x	x	x		LC	W	F
Caprimulgus poliocephalus	Mountain nightjar	?				LC	W	O
Apaloderma vittatum	Bar-tailed trogon	x	x	x		LC	W	FF
Tockus alboterminatus	Crowned hornbill	x				LC	W	F
Ceratogymna bucinator	Trumpeter hornbill	x	x	x		LC	W	F
Ceratogymna brevis	Silvery-cheeked hornbill	x	x	x		LC	W	FF
Pogoniulus leucomystax	Moustached green tinkerbird	x	x	x		LC	W	F
Indicator variegatus	Scaly-throated honeyguide	x				LC	W	F
Indicator minor	Lesser honeyguide	x				LC	W	F
Dendropicos griseocephalus	Olive woodpecker	x	x	x		LC	W	FF
Psalidoprocne pristoptera	Black saw-wing	x	x	x		LC	W	O
Andropadus milanjensis	Striped-cheeked greenbul	x	x	x		LC	N	FF
Phyllastrephus cabanisi	Cabanis's greenbul	x	x	x		LC	W	FF
Pycnonotus barbatus	Common bulbul	x	x	x		LC	W	F
Chlorocichla flaviventris	Yellow-bellied greenbul	x	x	x		LC	W	FF
Alcippe abyssinica	African hill babbler	x	x	x		LC	W	F
Saxicola torquata	Stonechat	x	x	x		LC	W	O
Pogonocichla stellata	White-starred robin	x	x	x		LC	W	F
Cossypha semirufa	Rüppell's robin-chat	x	x	x		LC	W	FF
Zoothera gurneyi	Orange ground thrush	x	x	x		LC	W	FF
Turdus roehli	Usambara thrush			?		LC	EA	FF
Phylloscopus umbrovirens	Brown woodland-warbler	x	x	x		LC	W	FF
Bradypterus lopezi	Evergreen forest warbler	x	x	x		LC	W	FF
Apalis thoracica	Bar-throated apalis	x	x	x		LC	W	FF
Apalis melanocephala	Black headed Apalis	x	x	x		LC	W	FF
Camaroptera brachyura	Grey back camaroptera	x	x	x		LC	W	F
Muscicapa adusta	African dusky flycatcher		x			LC	W	F
Zosterops senegalensis	Yellow white-eye	x		x		LC	W	F
Trochocercus cyanomelas	White-tailed crested flycatcher	x	x	x		LC	W	F
Terpsiphone viridis	Paradise flycatcher	x				LC	W	F
Bradornis microrhynchus	African grey flycatcher		x			LC	W	O
Batis mixta	Forest batis	x				LC	N	FF
Malaconotus nigrifrons	Black-fronted bush-shrike		x			LC	W	F
Dryoscopus cubla	Black-backed puffback	x	x	x		LC	W	F
Tchagra australis	Brown-headed tchagra		x			LC	W	O
Coracina caesia	Grey cuckoo-shrike			X		LC	W	FF
Cinnyricinclus femoralis	Abbott’s starling	x		x		VU	N	FF
Corvus albicollis	White-naped raven	x				LC	W	O
Hedydipna collaris	Collared sunbird	x	x	x		LC	W	FF

Scientific name	Common name	Minja	Mramba	Kindoroko	Village land	IUCN	Endemism	Habitat
Nectarinia mediocris	Eastern double-collared sunbird	x	x	x		LC	W	FF
Cyanomitra olivacea	Olive sunbird	x	x	x		LC	W	F
Cinnyris venustus	Variable sunbird			x		LC	W	F
Ploceus ocularis	Spectacled weaver	x	x	x		LC	W	O
Cryptospiza reichenovii	Red-faced crimsonwing	?		x		LC	W	F
MAMMALS								
Genetta tigrina	Blotched genet	x				LC	W	FF
Genetta maculata	Cape's genet		x	x		LC	W	FF
Civettictis civetta	African civet	x		x		LC	W	F
Bdeogale crassicauda	Bushy-tailed mongoose	x		x		LC	W	FF
Herpestes ichneumon	Ichneumon mongoose	x					W	FF
Nandinia binotata	African palm civet	x	x			LC	W	FF
Cercopithecus mitis kibonotensis	Sykes's monkey	x	x	x		LC	W	FF
Papio cynocephalus	Yellow baboon	x				LC	W	O
Otolemur garnettii	Garnett's galago	x	x	x		LC	?	
Cricetomys gambianus	Giant Pouched rat	x	x	x		LC	W	FF
Beamys hindei	Lesser pouched rat		x			LC	W	F
Paraxerus sp.	Squirrel	x	x	x		?	?	?
Rhynchocyon petersi	Black and rufous sengi	x	x	x		EN	N	FF
Petrodromus tetradactylus	Four-toed sengi		x			LC	W	FF
Procavia johnstoni	Rock hyrax	x	x	x		LC	W	O
Tragelaphus scriptus	Bush buck		x			LC	W	F
Potamochoerus larvatus	Bush pig	x	x	x		LC	W	F
Cephalophus harveyi	Harveys' duiker	x	x	x		LR/cd	W	FF
Neotragus moschatus	Suni	x	x			LR/cd	W	F
AMPHIBIANS								
Callulina sp. Nov.		x		x		NL	E	FF
Hyperolius mitchelli		x				LC	N	F
Hyperolius glandicolor ssp.					x	LC	W	O
Phrynobatrachus natalensis		x				LC	W	O
Scolecomorphus sp. Nov.		x		x		NL	EA	FF
Leptopelis flavomaculatus		x				LC	W	F
REPTILES								
Cnemaspis africana		x		x			N	FF
Lygodactylus sp.					x		?	O
Kinyongia tavetana				x	x		N	F
Chamaeleo dilepis					x		W	O
Rhampholeon viridis		x		x			EA	FF
Rieppeleon kerstenii					x		W	O
Adolfus jacksoni				x			W	F
Leptosiaphos kilimensis		x					N	F
Lamphrophis fuliginosus					x		W	O
Dispholidus typus					x		W	O

Scientific name	Common name	Minja	Mramba	Kindoroko	Village land	IUCN	Endemism	Habitat
Thelotornis mossambicanus			x	x	x		W	F

A further 128 vertebrate species have been recorded by other authors such as Cordeiro and Kiure (1995), Cordeiro *et al.* (2005) and Stanley *et al.* (2007) including 111 birds, 13 mammals and two amphibians. The total number of vertebrate species recorded from the North Pare Mountain forests is therefore 220 species (Table 3). This excludes fish and most bats since these were not covered by the survey and data were not available on these taxa at the time of preparing this report. Based on the survey data, Minja Forest Reserve appears to be the most diverse whilst Mramba has the lowest species richness.

Table 3. Summary of vertebrate species richness in the North Pare Mountains.

Taxon	Minja	Mramba	Kindoroko	Village land	Total number of species recorded during the current surveys	Total number of species documented from North Pares
Birds	48	41	42		56	167
Mammals	15	14	11		19	32
Amphibians	5	0	2		6	8
Reptiles	3	1	5	7	11	11
Total	**71**	**56**	**60**	**7**	**92**	**220**

The majority (79) of the species recorded during the current surveys are widespread, nine are near-endemic, three are Eastern Arc endemics (*Rhampholeon viridis*, *Scolecomorphus* sp. Nov. and *Turdus roehli*) and one is endemic to the North Pare Mountains (*Callulina* sp. Nov.). An additional two amphibian species, recorded by other researchers are also endemic to the Eastern Arc (*Phyrnobatrachus kreffti* and *Scolecomorphus vittatus)*. These results indicate that, whilst the North Pare Mountains have more restricted range species than was previously thought, the levels of endemism are lower than most other Eastern Arc Mountains. In comparing the three reserves, Minja Forest has the most Eastern Arc endemic species.

Table 4. Summary of endemism in the North Pare Mountains

Endemism	Minja	Mramba	Kindoroko	Village land	Total
Endemic	1	0	1	0	1
Eastern Arc endemic	2	0	3	0	3
Eastern Arc near-endemic	7	2	5	1	9
Total	**10**	**2**	**9**	**1**	**12**

In terms of how threatened the vertebrate species of the North Pares are, two species are considered Endangered, the amphibian *Phrynobatrachus kreffti* and the mammal *Rhynchocyon petersi*, and one species, Abbott's starling, is consider Vulnerable by the IUCN red list. The reptiles have not been assessed and so are not included in these tallies.

The survey team recorded several different signs of resource use and disturbance within the forest reserves including fire, paths, bee hives, sandalwood harvesting, snares, pitsawing, tree and pole cutting. Of these, pole and timber cutting were the most prevalent and were recorded in all reserves. The lowest rates of pole cutting but highest rates of timber cutting occurred in Minja Forest Reserve. Hunting was most intensive in Mramba Forest reserve.

Although joint forest management has been introduced in Kindoroko, it does not seem to have fully addressed the issue of illegal pole harvesting and other destructive activities. There is a need to evaluate the success of the Joint Forest Management initiative that has been started. Management impact is also low in the other forest reserves, particularly in Mramba where hunting is prevalent.

In order to assess indigenous knowledge about the fauna of the North Pare's, 29 people from three forest-adjacent villages were interviewed. Respondents mentioned nine primate, ungulate and sengi

species. With only one exception, all of these species were also recorded by the survey team. The one exception was Abbott's duiker which was mentioned by respondents close to Minja Forest but was not recorded through camera-trapping or dung surveys. Respondents also confirmed that red colobus, black and white colobus and tree hyrax are not present in the North Pare Mountains.

In conclusion, the North Pare Mountains have higher levels of endemism and diversity than was previously known with Minja Forest Reserve having the highest rates of endemism and diversity. This includes one strictly endemic vertebrate species (*Callulina* sp. Nov.). However, relative to most other Eastern Arc Mountains, the North Pare Mountains have lower levels of endemism and species richness, particularly in terms of the herpetofauna as such they remain a lower conservation priority within the context of the exceptional levels of endemism found in other Eastern Arc Mountain blocks. The forests are threatened by pole cutting, timber harvesting, clearance for agricultural land and fire with approximately 6 % having been lost over the last quarter of a century. Pressure on the woodlands is even higher with 55 % having been lost in the same time period. Woodland areas may have been acting as a buffer zone to the forests, providing wood and land to an increasing human population. The clearance of the woodlands may result in more significant pressure on the forests in the near future. As such, more active management of the forests is required with a particular focus on Minja. Further research is needed to assess the biodiversity of forests not visited by this survey including Kiverenge.

View of Mramba Forest from Kileo Reserve. Photo by M. Menegon

Indigenous knowledge surveys. Photo by A. Perkin

View of Lake Jipe from Minja. Photo by M. Menegon

Forest scene. Photo by M. Menegon.

Hyperolius mitchelli. Photo by M. Menegon

View of North Pare Mountains.

Silvery-cheeked hornbill. Photo by M. Menegon

Thelotornis mossambicanus. Photo by M. Menegon.

Kinyongia tavetana in Kindoroko FR.
Photo by M. Menegon

Rhampholeon viridis in Kindoroko FR.
Photo by M. Menegon

Sykes monkey in Mramba FR.
Photo by F. Rovero

Rhynchocyon petersi in Minja Forest Reserve
Photo by F. Rovero.

Genetta maculata in Mramba FR.
Photo by F. Rovero

Ichneumon mongoose in Minja Forest Reserve.
Photo by F. Rovero

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Tanzania Forest Conservation Group
The Tanzania Forest Conservation Group (TFCG) is a Tanzanian non-governmental organisation that has been promoting the conservation of Tanzania's forests since 1985. TFCG's mission is to conserve and restore the biodiversity of globally important forests in Tanzania for the benefit of present and future generations. We achieve this through capacity building, advocacy, research, community development and protected area management, in ways that are sustainable and foster participation, cooperation and partnership.

TFCG supports field based projects promoting participatory forest management, environmental education, community development, advocacy and research in the Eastern Arc and Coastal Forests. TFCG also supports a community forest conservation network that facilitates linkages between communities involved in participatory forest management. To find out more about TFCG please visit our website www.tfcg.org

TFCG is a partner in the Filling the Knowledge Gap project.

Museo Tridentino di Scienze Naturali
The Museo Tridentino di Scienze Naturali (MTSN), founded in 1922, is an Italian institution dedicated to conservation, education and research in natural sciences. The mission of the MTSN is to promote knowledge and conservation of the mountainous environment through the transfer of up-dated information to a wide audience. The MTSN promotes both its own research activities and connections with national and international universities and research centres.

MTSN has been conducting research in the Eastern Arc Mountains of Tanzania since 1998. MTSN also supports community education and other conservation projects in the Udzungwa Mountains, and manages the Udzungwa Ecological Monitoring Centre, a training and monitoring facility belonging to the Udzungwa Mountains National Park.

MTSN is a partner in the Filling the Knowledge Gap project.

Critical Ecosystem Partnership Fund
The Critical Ecosystem Partnership Fund (CEPF) is a joint initiative of Conservation International, the French Development Agency, the Global Environment Facility, the Government of Japan, the John D. and Catherine T. MacArthur Foundation and the World Bank. Conservation International administers the fund. CEPF provides strategic assistance to nongovernmental organizations, community groups and other civil society partners to help safeguard Earth's biodiversity hotspots. A fundamental goal is to ensure civil society is engaged in biodiversity conservation. The partnership invests in biodiversity hotspots, Earth's biologically richest and most threatened areas. CEPF focuses on hotspots in the developing world and strategically targets priority areas in the hotspots for maximum impact.

Between 2004 and 2008 the Critical Ecosystem Partnership Fund has invested US$ 7 million in the Eastern Arc and Coastal Forests of Kenya and Tanzania.

CEPF has financed the Filling the Knowledge Gap project.

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Abbreviations and acronyms

AP	Andrew Perkin
a.s.l.	above sea level
CEPF	Critical Ecosystem Partnership Fund
CMEAMF	Conservation and Management of the Eastern Arc Mountain Forests
Dbh	Diameter at Breast Height
DNRO	District Natural Resources Office(r)
FBD	Forestry and Beekeeping Division
FR	Francesco Rovero
FTKG	Filling the Knowledge Gap
IUCN – SSC	International Union for the Conservation of Nature Species Survival Commission
KI	Kindoroko
MI	Minja
MR	Mramba
MTSN	Museo Tridentino di Scienze Naturali
TFCG	Tanzania Forest Conservation Group

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Survey Team

Team Leader:	Nike Doggart
Mammal specialist:	Francesco Rovero
Primatologist:	Andrew Perkin
Herpetologist:	Michele Menegon
Research Officer:	Charles Leonard
Field Assistants:	John Msirikale and Amani Maundu

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Report writing
The report has been written by Francesco Rovero, Michele Menegon, Andrew Perkin, Charles Leonard and Nike Doggart. Authors of the individual chapters are indicated in the text.

Editing
The overall editing of the report was carried out by Nike Doggart and Charles Leonard.

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We are grateful to all those who have provided technical advice in the development and implementation of the project in particular the project's scientific advisors**:** Neil Burgess, Galen Rathbun, Simon Bearder, Tom Butynski, Simon Loader, Andrew Marshall and Kim Howell.

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Other
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1) Introduction

1.1 Background to the project

This report documents the results of biodiversity surveys carried out in the North Pare Mountains through the 'Filling the Knowledge Gap' project. 'Filling the Knowledge Gap (FTKG): Surveys of Poorly Known Sites and Species in the Eastern Arc and Coastal Forests of Tanzania' is a partnership project between the Tanzania Forest Conservation Group (TFCG) and the Museo Tridentino di Scienze Naturali (MTSN). The project is financed by the Critical Ecosystem Partnership Fund, a joint initiative between the French Development, Agency, Conservation International, the Global Environmental Facility, the World Bank, the Government of Japan and the MacArthur Foundation.

The purpose of the project is that:

> *Protected area authorities, conservation organizations and other stakeholders within the Eastern Arc and Coastal Forests are planning and implementing conservation activities using current, relevant and accurate information on the status of selected sites and species.*

The project focuses on increasing the knowledge of the vertebrate biodiversity of the Tanzanian Eastern Arc Mountains with a particular focus on three isolated montane forest sites (the North Pare, Udzungwa (Mufindi side) and Rubeho (Mpwapwa side) Mountains) as well as selected coastal forests in Tanga, Coast and Lindi regions. The taxonomic focus of the project is on vertebrates, particularly primates, hyraxes, sengis, carnivores, forest antelopes, birds, amphibians and reptiles. The sites and taxa have been selected on the basis of gaps in our knowledge of the biodiversity of the hotspot, consultation with other researchers and also based on the strengths of TFCG and MTSN's research scientists.

The overall objectives of the surveys were:

1. To conduct field surveys of the vertebrate fauna and habitat condition of the North Pare forests.
2. To address key gaps in our knowledge of the distribution and conservation status of diurnal primates, duikers, galagos, sengis, tree hyraxes, selected amphibians (bufonids and microhylids) and reptiles in the North Pare forests.
3. To provide data on the distribution and relative abundance of duikers, galagos, diurnal primates, sengis, tree hyraxes, selected amphibians (bufonids and microhylids) and reptiles to the relevant IUCN-SSC Specialist Groups
4. To document indigenous knowledge of diurnal primates, duikers, galagos, sengis and tree hyrax amongst people living in the North Pare Mountains.
5. To train protected area authority staff in monitoring and surveys techniques.
6. To train members of local communities in monitoring techniques.

The North Pare Mountains are amongst the least surveyed sites in the Eastern Arc. In keeping with FTKG's objectives, biodiversity surveys were conducted in three forests of the North Pare Mountains: Kindoroko, Mramba and Minja Catchment Forest Reserves. Kileo forest, which is a Local Authority Forest Reserve, was also visited briefly. The surveys were carried out between October and November, 2005.

As part of the FTKG project, training was conducted in the North Pare forests to one division forest officer and two village environmental committee members in November, 2005. They were trained in forest disturbance survey techniques. The aim of the training was to improve the capacity building of the protected area staff on conserving and monitoring the North Pare forests.

1.2 Report structure

The report is organised in 11 sections. The report begins with an executive summary followed by an introduction which contains an overview of the Filling the Knowledge Gap project and a description of the study area, including an overview of the location, geology, climate, hydrology, altitudinal range and vegetation of the North Pare Mountains. This section also includes a history of biological research and conservation initiatives in the North Pares.

Section 2 provides descriptions of each forest surveyed including general information about the forest such as location, soils, climate, vegetation, catchment and timber values.

The next four sections have information on the mammals, nocturnal primates, birds and herpetofauna of the North Pare Mountains. Each section includes an introduction, aims, methods, sampling intensity, results and discussion.

The next section describes signs of resource use that were recorded within the forests including timber extraction, pole cutting, wildlife trapping and fire.

A separate section documents the indigenous knowledge of local people in the North Pares. This includes information on sacred sites, traditions and observations of local wildlife including myths, behavioural observations, local names, hunting techniques and human – wildlife conflicts.

In the final two sections, conclusions and recommendations are presented.

A detailed description of the methods used during these surveys is provided in Doggart *et al.* (2006).

1.3 An overview of North Pare Mountains

1.3.1 Location

The North Pare Mountains are one of 13 mountain blocks that comprise the Eastern Arc in Tanzania. The Eastern Arc is a chain of block-faulted, crystalline mountains under the climatic influence of the Indian Ocean (Lovett 1985). The North Pares are located in Mwanga district, Kilimanjaro region, Tanzania between coordinates 03°35´ and 03°46´S and between 37°33´´E and 37°40´E, 220 km away from the coast of Tanzania (Lovett and Pócs 1993, also in Cordeiro and Kiure 1995). These mountains, with an area of 45,340 ha (FBD 2006c) lie just 30 km south, south-east of Mt Kilimanjaro, but their geological affinities are with the Eastern Arc Mountains, of which they represent the northernmost tip within Tanzania. To the south-east of the North Pare Mountains lie the South Pare Mountains while to the north-east lie the Taita Hills in Kenya. The central plateau area has been settled for many years and most of the forest is long gone, having been replaced by local farms and exotic trees.

There are six Central Government Forest Reserves on the North Pare Mountains: Mramba (3,355 ha, but less than 200 ha of forest), Minja (520 ha), Kindoroko (885 ha, but more forest lies outside the reserve), Kamwala I (117 ha), Kamwala II (293 ha) and Kiverenge (2155 ha) containing Eastern Arc forest totalling some 7,407 ha (Baker and Baker 2002). There are also 230 clan forests that cover 371 ha and which afford excellent protection for these small forest patches (Mwihomeki *et al*. 1998).

1.3.2 Geology and soils

The geology of Mwanga district can be divided into highlands and lowlands. On the highlands, the metamorphic rocks of the North Pare Mountains are assigned to the Usagaran system of the Precambrian. The main rock types are high-grade metamorphic rocks, predominantly granulites and granulitic gneiss (Mwanga District Council 2002).

On the lowland plains, however, the Precambrian rocks are extensively covered by superficial Neogene deposits, which include calcareous, tuffaceous material derived from the volcanic activity of neighbouring Mount Kilimanjaro (Mwanga District Council 2002). According to Lovett and Pócs (1993) the soils of the North Pares consist of acidic lithosols or ferralitic latosols.

1.3.3 Climate

According to Lovett and Pócs (1993), the climate is characterized by oceanic rainfall with oceanic temperatures. The nearest rainfall stations are at Kilomeni Mission, Kisangara Sisal, Shigatini Mission and Usangi Rural. Rainfall ranges between 700 – 1400 mm / year with a mist effect at higher altitudes. The dry season extends between June and October. Temperatures vary from 25 °C max (March) to 16 °C min (July).

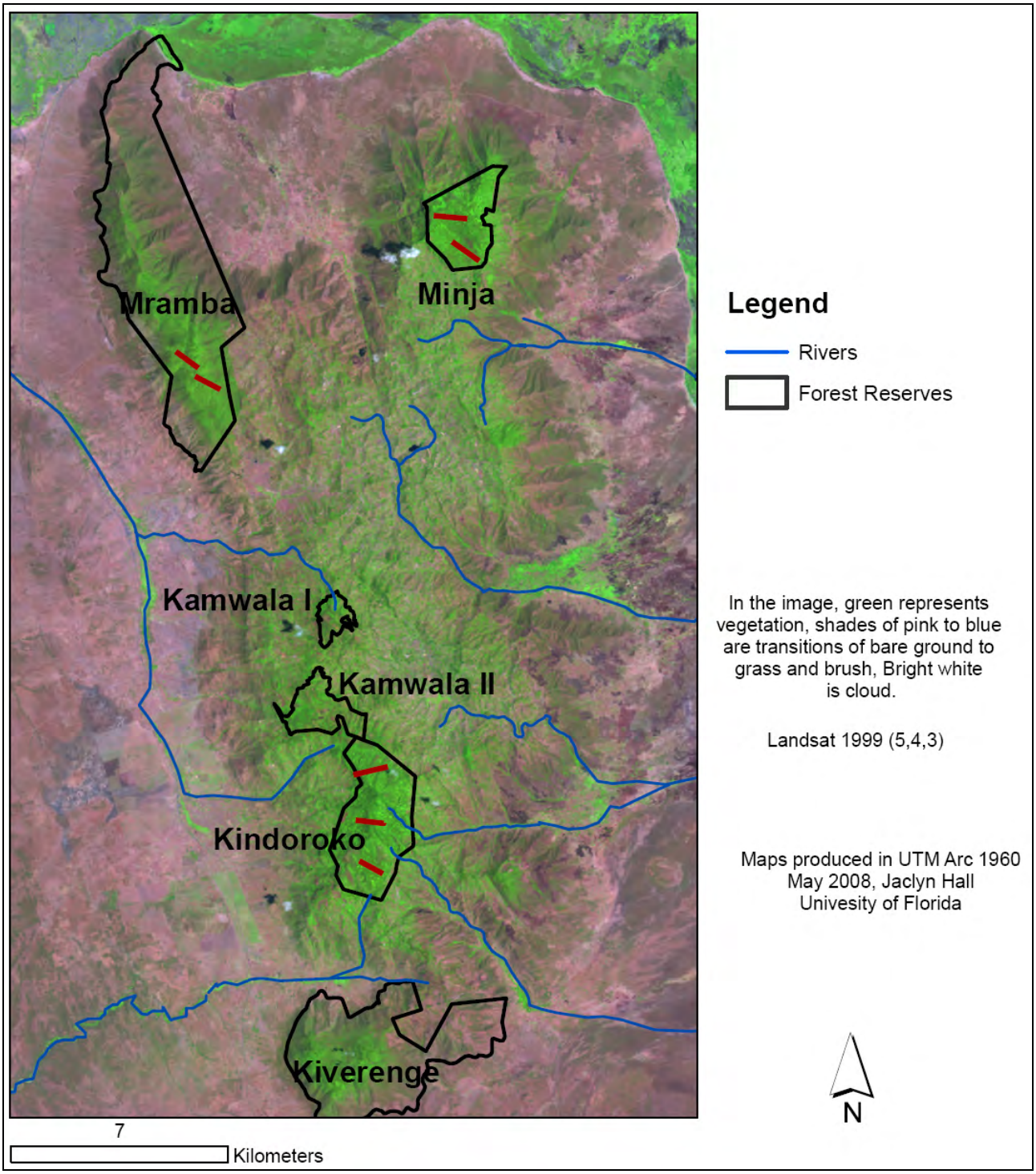


Figure 1. Satellite image of the North Pare Mountains showing Forest Reserves and disturbance transects.

1.3.4 Hydrology

The Eastern Arc Mountain forests are the catchment area for most of the rainfall feeding into the larger rivers in eastern Tanzania. The Pare and Usambara Mountains supply water to the Pangani River. The Pangani River basin covers about 42,000 km^2, and is shared by Tanzania and Kenya (www.pangani.com 2007). One source of the Pangani is the Ruvu River that flows from Lake Jipe located in the eastern lowlands of North Pare Mountains. Lake Jipe receives water from several streams flowing from the North Pares including the Vulue, Mkunwa, Isau, Moviro and Munguu streams as well as the Ngofi River that flows from Minja forest. The other tributary of the Pangani River is the

Kikuletwa River which flows from the slopes of Mts Meru and Kilimanjaro. These two tributaries join at Nyumba ya Mungu reservoir, on the western lowlands of the North Pare Mountains. The Pangani River drains the Nyumba ya Mungu reservoir, flowing for 432 km before emptying into the Indian Ocean.

The forests of the North Pares are also the source of water for domestic use in surrounding villages including Vuchama - Ngofi and Mcheni (close to Minja forest), Chanjale and Simbomu (close to Kindoroko and Mramba forests respectively). The streams flowing from Minja forest also provide water for irrigation schemes in the lowlands including in the Kambi ya Simba plains to the south-east of the mountains.

The waters of the Pangani River are used to generate electricity at Hale and Nyumba ya Mungu hydropower plants. Pangani together with other Eastern Arc Mountain rivers including the Kihansi and Ruaha rivers have important hydropower plants that provide roughly 50% of the power in the National grid. Pangani also supports various irrigation schemes producing food and cash crops as well as providing employment for rural communities.

The mean annual flow of the Pangani has decreased over the last four decades (www.pangani.com 2007). The river's reduced flow is likely to be a result of several factors including climate change and forest loss in the North Pares (see Section 1.3.6 of this report). These factors are thought to have affected the quantity and quality of water flowing from the mountains. Myers (1989) reports that increased sediment loads as a result of deforestation can cause siltation in rivers; reduce the capacity of dams supplying water to hydropower plants; and cause blockages in irrigation systems. These sediments also increase the export of absorbed mineral nutrients such as nitrates. Deforestation also causes increased soil temperatures and therefore increases in the temperature of runoff. The increased temperature in addition to increased nutrient levels in rivers and streams increases the growth of certain algae (Wayne *et al*., 1981 and Lynch *et al*., 1990), with a corresponding risk of eutrophication. This in turn may have negative economic impacts on people relying on fishing for their livelihoods. Eutrophication is already a problem in Lake Jipe where fisher people's livelihoods have been negatively affected.

1.3.5 Altitudinal range

The North Pare Mountains extend for 40 km. The western edge of the mountains rise sharply while the eastern side has a more gradual slope. Altitude ranges from 730 m in the lowlands to 2113 m a.s.l. at Kindoroko Hill in Kindoroko Forest Reserve.

1.3.6 Forest loss

In the North Pare Mountains, a recent study by the Forestry and Beekeeping Division (FBD 2006c) indicated that the area of forest in the North Pares has declined from 2880 ha in the 1970s to 2720 ha by the 1999. This represents a decline of 5.6 % over 24 years. Similarly, Newmark suggested that forest area was originally 15,100 ha with only 2,800 ha remaining in the 1990s.

1.4 Summary of biodiversity research in the North Pare Mountains

Relative to some other Eastern Arc Mountain blocks such as the Usambara and Udzungwa Mountains, less research has been carried out on the biodiversity of the North Pare Mountains. In part this may reflect the relatively small size of the remaining forest area and the perceived (relative) paucity of its biodiversity. Five key studies are referred to in this report (listed chronologically), Cordeiro and Kiure's (1995) study of the birds; Lovett and Pócs's (1998) work on the vegetation and biodiversity of the catchment forest reserves; Mwihomeki *et al*'s (1998) paper on the mountain's traditional forests; Cordeiro *et al*'s (2005) work on the mammals; and the Forestry and Beekeeping Division's (2005) work on forest disturbance. Other studies, such as Baker and Baker (2002) and Burgess *et al* (2007) also include useful data on the North Pare's.

In this report Lovett and Pócs's (1998) work is covered extensively in the descriptions of the individual reserves as they provided detailed information on the vegetation of the reserves.

The study by Mwihomeki *et al.* (1998), that focused on traditionally protected forests, is referred to in the indigenous knowledge section of this report (Section 6). In brief, the study found that the 230 traditionally protected forests that they recorded in the North Pares, have retained important forest biodiversity. They also found that, while some are well protected, others are severely degraded from

farming, cutting of building poles, firewood, timber, forest fires, charcoal making and grazing. The study also made recommendations regarding the conservation of these areas.

Cordeiro *et al*'s (2005) research on the ecology and status of forest mammals in the North Pare's four Eastern Arc Mountains is referred to in the mammals section. The study included a list of 17 mammal species that had been recorded in the North Pare forests, of which five were of conservation concern including Eastern tree hyrax, black and rufous sengi and Harvey's duiker. In the forests of Kindoroko, Minja and Mramba 9, 13 and 9 species were recorded respectively. Newmark (2002) pointed out that populations of many of the mammal species in the Eastern Arc Mountains are threatened by forest loss and degradation. In agreement with this, Cordeiro *et al.* (2005) reported that pit-sawing, cultivation at the forest edge or within forests and livestock grazing posed the most serious threat to the forest mammals in the North Pare forests.

According to Baker & Baker (2002), the forest avifauna of the North Pare Mountains is less diverse than other Eastern Arc Mountains. Cordeiro and Kiure (1995) recorded only 54 forest / forest-edge bird species. Baker and Baker (2002) speculate that the presence of a low number of bird species in the North Pares may be due to its smaller overall size; relatively high human impact; its locality at the extreme end of the Eastern Arc Mountains; and its proximity to Mount Kilimanjaro. The eruptions of the latter may have caused extensive damage to the forests on the North Pares (Fjeldsa and Rabol 1995).

Stanley *et al.* (2007) report the results of a survey (also financed by CEPF) of small mammals carried out in Kindoroko and Minja Forest Reserves in 2006. The team recorded three species of shrew from the genus Crocidura (*Crocidura hildegardae*, *Crocidura* sp. and *Crocidura olivieri*), three bat species (*Rousettus aegypticus*, *Glauconycteris argentata* and *Pipistrellus hesperidus*), six rodent (*Graphiurus murinus*, *Cricetomys gambianus*, *Hylomyscus acrimontensis*, *Mastomys natalensis*, *Praomys delectorum* and *Heliophobius argentocinereus*) and one sengi species (*Rhynchocyon petersi*). Overall they concluded that Minja had a greater abundance of shrews and rodents but that overall some typical Eastern Arc species were notably absent.

The current study also builds on an assessment carried out by CMEAMF on the condition of the forest in Mramba and Kiverenge Forest Reserves. The CMEAMF study found that pole cutting, firewood collection, charcoal, fire and grazing are chronic problems in the lower drier parts of the reserve and in areas adjacent to the forests (FBD 2005). They found that timber extraction and pole cutting were high in Kiverenge Forest Reserve whereas in Mramba rates of cutting were low relative to other Eastern Arc forests. This could be due to the availability of an alternative source of forest products from the agroforestry plots, private woodlots and community education or as part of the reserve is being used as a sacred area.

1.5 Conservation initiatives in the North Pare Mountains

The studies outlined in the previous section have all highlighted the threats facing the North Pare Forests. Several conservation initiatives have attempted to address these threats. Some of the larger conservation initiatives in the North Pare Mountains are described briefly in this section.

Tanzania Forest Action Plan (TFAP) North Pare Project (1992 – 2002). The major aim of the project was to use forest and agricultural resources of the North Pare region in a sustainable way. Activities included land use planning, tree planting and improved agriculture. The project succeeded in developing many technical concepts for sustainable management of natural resources. As a follow up to TFAP, the *District Natural Resources Management (DNRM) project* was implemented between 2002 – 2005. Its focus was mainly on capacity building at village and district level (GTZ, 2004).

Participatory Forest Management (PFM) in Kindoroko forest. With funds from GTZ, Mwanga district natural resources office established Joint Forest Management in Kindoroko forest in 1998. Commuunity Based Forest Management was introduced in Kileo, Mbachi, Toni and Kilambeni village forests of Kileo, Vuchama-ngofi, Mramba and Simbomu, Masumbeni and Mriti villages respectively (Mwanga DNRO pers. comm.). Participatory Forest Management is a strategy to achieve sustainable forest management by encouraging the management or co-management of forest and woodland resources by the communities living close to them.

Traditional Irrigation Project and Environmental Development Organization (TIP) is a non-governmental organization which was registered in 1999. It operates in four districts of northern Tanzania including

Mwanga. TIP focuses on helping farmers to improve traditional irrigation; soil and water conservation, and participatory land use planning. TIPs mission is to contribute to a durable and gender-balanced improvement of standard of living of the community in traditionally irrigated areas in Tanzania through sustainable development of catchments with regard to irrigation, natural resources management, soil and water conservation, afforestation, land use planning and organizational development. TIP provides services to farmers through water user groups to achieve improvement of traditional and smallholder irrigation based on sustainable use of land and water resources.

Other conservation initiatives in the area include establishment of tree nurseries, agroforestry and natural resources awareness by KAHOKO Group around Lembeni village forest. CHILLA Group provides environmental education to young people on good forest management practices, forest patrols, agroforestry as well as natural resources awareness in villages adjacent to Kindoroko forest. The group also practices 'gap-filling'-planting of natural trees in forest gaps in Kindoroko forest (Mwanga DNRO pers. comm.). Also, in the villages across the North Pares, there are some village governments that provide extension services to the community. For example, in Kiverenge forest, village leaders provide extension services to the community on sustainable use of the forests (FBD 2005).

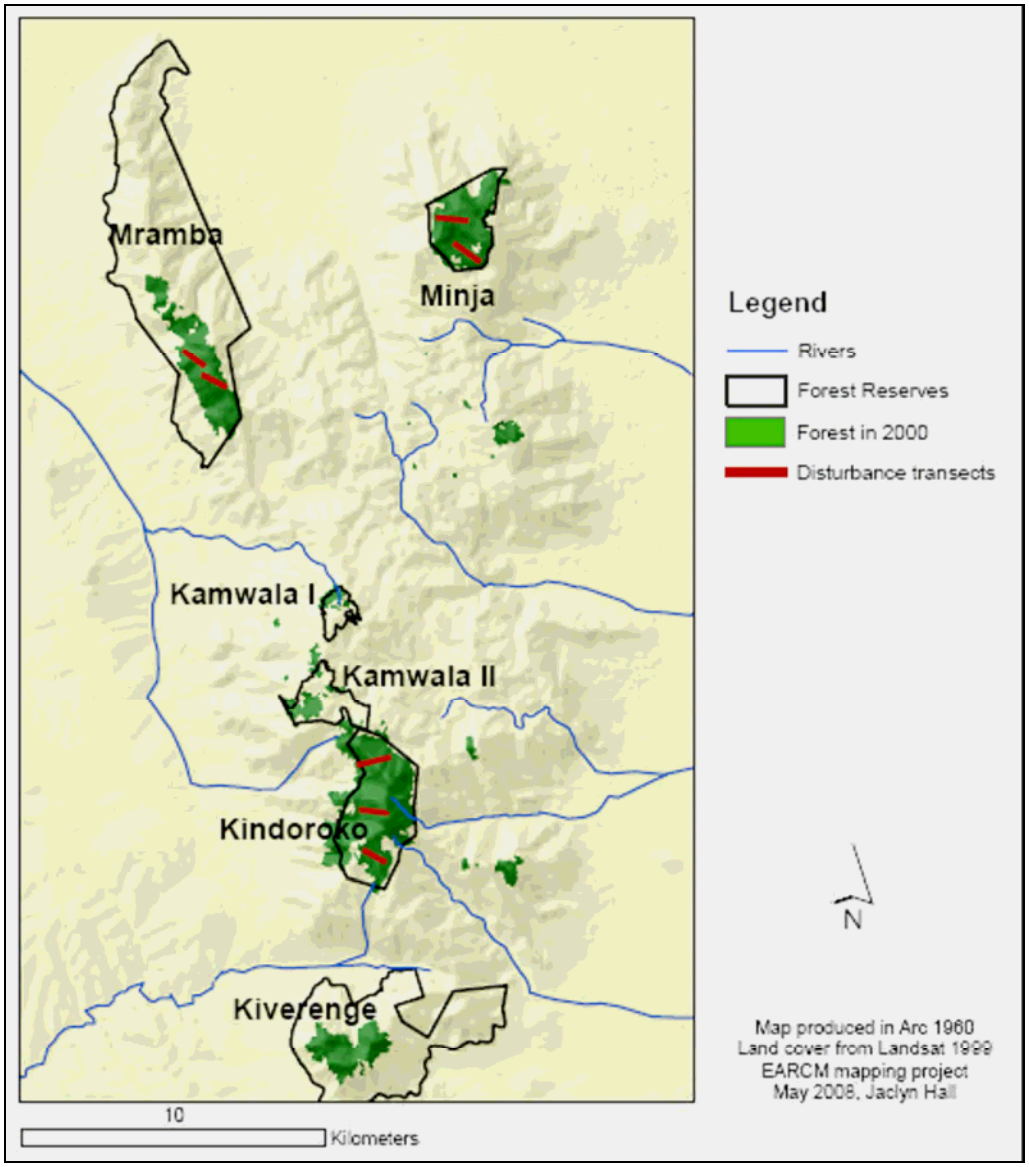
1.6 Socio-economic context

The predominant land use in the North Pare Mountains is agriculture. Approximately 56,640 people live in 40 villages in the highlands. Most people are from the Pare or Chagga tribes. There is a long tradition of forest use and the forests are an important source of building poles, fuel wood, fodder, medicines and fruit.

2) Forest Reserve descriptions

This section provides detailed descriptions of the three main forest reserves.

Map 1. Forest reserves of the North Pare Mountains.



2.1 Kindoroko Catchment Forest Reserve

General information
Mwanga District, Kilimanjaro Region

Year of establishment:	German administration
Declaration:	Supp. 59, Cap 389, p112
Variation order:	GN 341 of 29/09/61
Border map:	Jb 458 (1:100000) 1959; Jb 67 (1:25000) 1957 (traced from a German map)
Topographical maps:	73/1 and 73/3
Gazetted area:	885 ha
Gazetted boundary length:	13.6 km
Location	3°43' – 3°46' S, 37°38' - 37°40 E
Altitudinal range:	1600 – 2113 m

Access

Kindoroko forest can be accessed by road from Kisangara Chini before Mwanga town. From Kisangara Chini travel up to Chanjale village (in Ngujini ward) which is near to the forest. The distance from Mwanga town to Kindoroko is about 30 km. The forest can also be reached from Kilomeni mission, which is 20 km from Mwanga and 10 km south of Usangi village. The reserve covers the highest ridge and summit of the North Pare Mountains.

Soils
Acidic lithosols, or deeper, ferralitic latosols, have developed on gneiss Precambrian rocks (Lovett and Pócs 1993).

Climate
Oceanic rainfall with oceanic temperatures. Estimated rainfall: 1400 mm / year with a mist effect at higher altitudes. Dry season: June - September. Temperature: 22° c max. (March), 17° c min (July) (Lovett and Pócs 1993).

Vegetation
(This section is based on Lovett and Pócs 1993).
Montane forest covers the southern half of the Kindoroko ridge from 1600 - 1800 m above Kilomeni mission and village. On the shallow soils of the central ridge at 1800 - 1900 m there is heath with patches of stunted montane forest. The heath may be secondary, resulting from burning of the forest. Upper montane forests occur on the summit from 1900 - 2100 m.

Montane forest: Canopy 20 m high, without emergents. Dominated by: *Newtonia buchananii* and *Albizia gummifera*, with *Ficalhoa laurifolia*, *Garcinia volkensii*, *Macaranga kilimandscharica*, *Polyscias fulva*, and *Syzygium guineense* subsp. *afromontanum*. Smaller trees include: *Maesa lanceolata* (dominant) and *Tabernaemontana* sp. All trees are occupied by the hemi-epiphytic *Culcasia falcifolia*. The ground layer is dominated by the fern *Blotiella stipitata*.

Heath and forest patches: Dominated by *Erica arborea*, with *Lycopodium clavatum* in the ground layer. The forest patches are dominated by *Syzygium guineense* subsp. *afromontanum* with *Garcinia volkensii*. Shrubs include a *Memecylon* species. Herbs include: *Selaginella kraussiana*. Both heath and forest types have a rich moss layer covering the soil.

Upper montane forest: No data.

Catchment Values:
The reserve is an important catchment area supplying water to the dry slopes and basins surrounding it. About 20 villages in the Usangi area receive water from the forest reserve, including Kisangara town on the main road and the neighbouring coffee and sisal plantations. Water is piped straight from the forest to the villages.

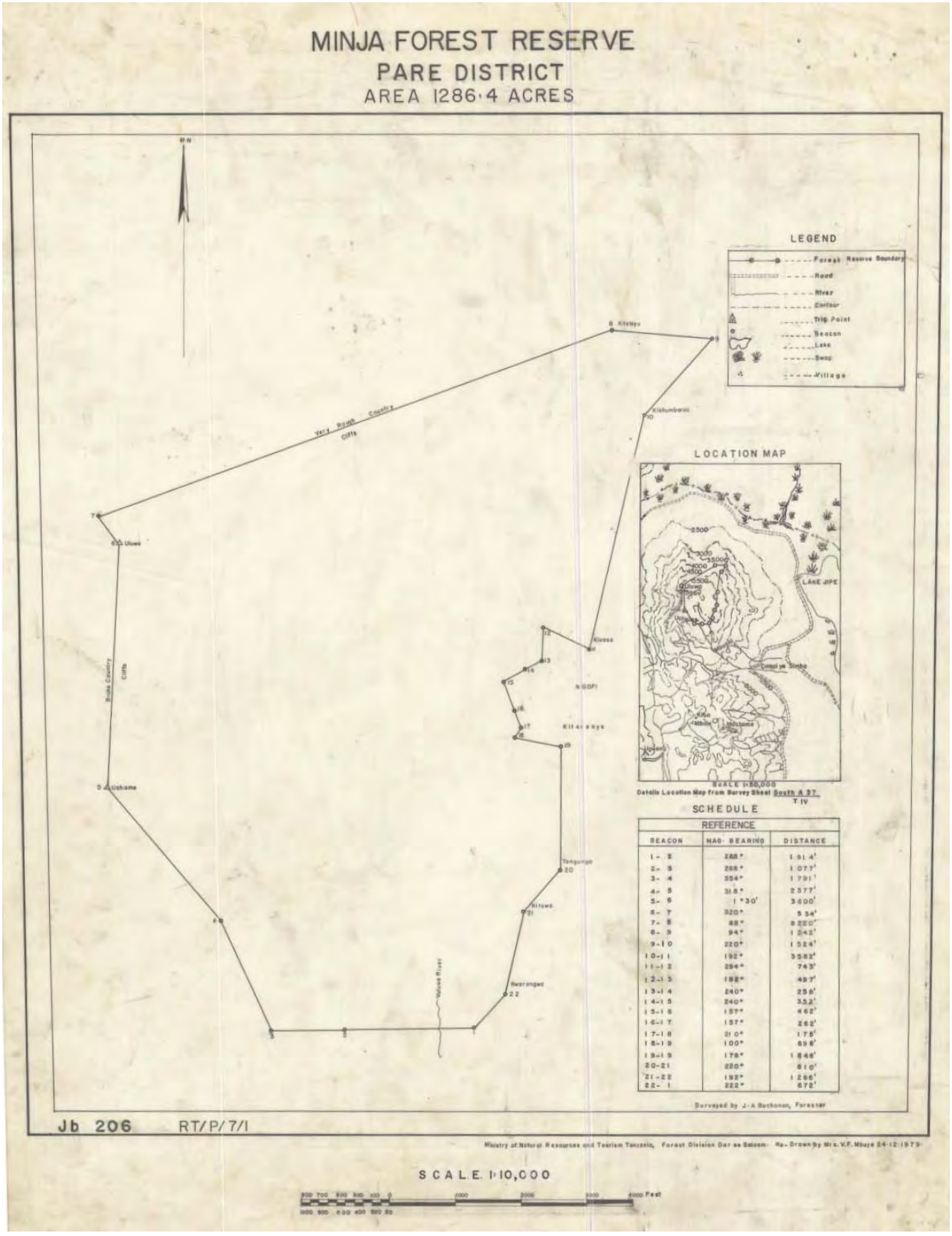
Timber Values
A number of useful timber species occur, including: *Ficalhoa laurifolia* and *Newtonia buchananii*.

2.2 Minja Catchment Forest Reserve

General information
Mwanga District, Kilimanjaro Region

Year of establishment:	1955
Declaration:	GN 197 of 3/6/55
Variation order:	None
Border map:	Jb 206 (1:10 000) redrawn 1979
Topographical maps:	73/1
Gazetted area:	520 ha
Gazetted boundary length:	34 430 ft (10 km)
Location:	3°35' - 3°37' S, 37° 40' - 37°41' E
Altitudinal range:	1500 – 1850m

Map 2. Border map for Minja Forest Reserve



Access

Minja forest is approximately 20 km by road from Mwanga town. From where the Tanga – Moshi road passes through Mwanga Town, turn up towards Kikweni ward. Continue on this road passing the Wara dam towards Kifule ward. In Kifule Ward, turn left up to Moniko-Mcheni village via Ngweni village. From there continue to Vuchama-ngofi village which is adjacent to the forest.

Soils
Shallow acidic lithosols or deeper, red ferralitic latosols have developed under the forested area, with humic ferralitic soils in favourable conditions, over Precambrian gneiss rocks (Lovett and Pócs 1993).

Climate
Oceanic rainfall with oceanic temperatures. Estimated rainfall: 1300 mm / year with wetter eastern and drier western slopes, and a mist effect at higher altitudes. Dry season: June – Sep (Lovett and Pócs 1993).

Vegetation
(This section is based on Lovett and Pócs 1993).

Montane forest covers about 80 % of the area on the summit ridges and higher slopes between 1650 - 1850 m.

Submontane rainforest covers less than 10 % of the area in valley bottoms between 1500 - 1650 m altitude, formerly it would have covered the wetter lower slopes which are now cultivated. Secondary heath occurs at the forest edges where it appears to be the result of burning, and on the shallow soils of the sharp ridge at the western edge of the reserve at 1700 - 1850 m where it appears to be natural.

Montane forest: The low canopy is dominated by *Xymalos monospora* with: *Aphloia theiformis*, *Erica arborea* (especially in patches with degraded, shallow soil), *Manilkara* sp., *Myrica salicifolia*, *Prunus africana, Rapanea melanophloeos*, *Syzygium guineense* subsp. *afromontanum* and *Zanthoxylum* sp.

Submontane forest: Dominated by *Newtonia buchananii*.

Heath: Dominated by *Erica arborea*.

Catchment Values
The reserve is important in the water supply of Vuchama Ngofi and Mcheni villages. One permanent and two seasonal streams flow south-east to Kambi ya Simba near Lake Jipe. Streams support irrigated agriculture in the eastern lowlands. A water intake was constructed in 1975/76 on Vulue stream to pipe water to Vuchama Ngofi.

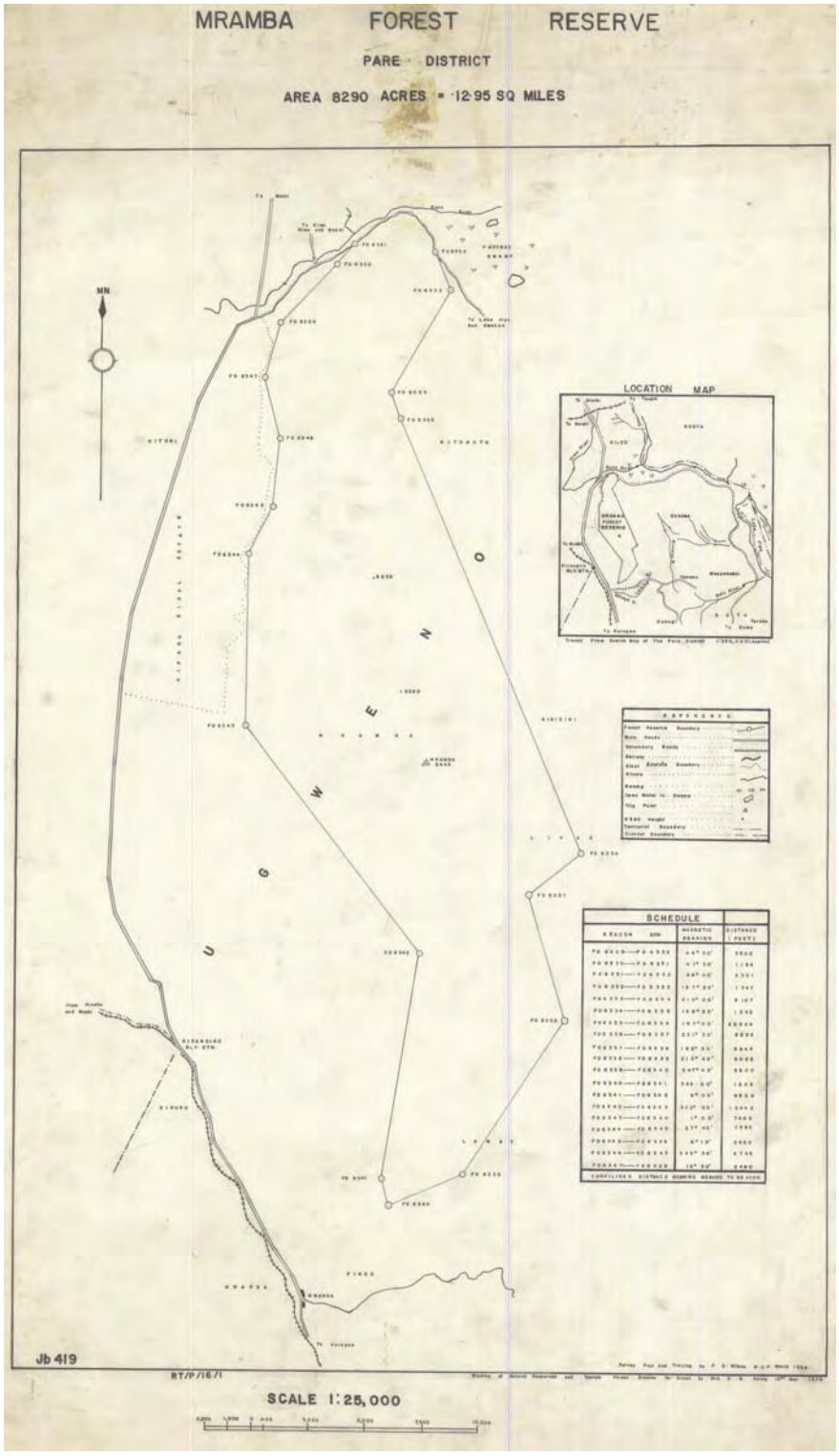
Timber Values
The soft timber tree, Lemonwood (*Xymalos monospora*) dominates the montane forest. The more valuable Satinwood (*Zanthoxylum* sp.) occurs sporadically everywhere in the montane forest. *Newtonia buchananii* is dominant in the submontane rainforest but should not be extracted as it is the most important species in the main catchment area. *Macaranga kilimandscharica* is common in secondary forest.

2.3 Mramba Catchment Forest Reserve

General information
Mwanga District, Kilimanjaro Region

Year of establishment :	1958
Declaration :	GN 352 of 18/7/58
Variation order :	None
Border map :	Jb 419 (1:25 000) 1958
Topographical map :	73/1
Gazetted area :	3355 ha
Gazetted boundary length :	100 172 ft (31 km)
Location:	3° 31' - 3° 39' S 37° 33' - 37° 36' E
Altitude:	760 – 1700 m

Map 3. Border map for Mramba Forest Reserve.



Access

The forest is approximately 20 km from Mwanga by road. From the same road that goes up to Minja, turn left in Lambo Village towards Simbomu Village, which is adjacent to the forest. The reserve covers the steep rocky Mramba – Kifaru ridge on the north-western end of the North Pare mountains.

Soils

Red laterites over gneiss, probably some volcanic input as Kilimanjaro is visible from the reserve (Lovett and Pócs 1993).

Climate
Oceanic rainfall with oceanic/continental temperatures. Estimated rainfall: 1100 mm/year with a mist effect at higher altitudes. Dry season: June - Sep. Estimated temperatures: 22° C max. (Feb.), 17° C min (July) (Lovett and Pócs 1993).

Vegetation
(This section is based on Lovett and Pócs 1993).
The reserve is capped by dry montane forest, but is largely covered by dry woodland and thicket with extensive areas of rock outcrop.

Dry montane forest: *Albizia* sp., *Newtonia buchananii* and *Podocarpus* sp. are reported.

Dry woodland and thicket: Trees to 4 m tall with: *Combretum* spp. and *Commiphora* spp. There are areas of *Dodonea viscosa* scrub.

Catchment Value
Two permanent rivers, the Maruhuri and Mrimwacha, are reported to originate in the reserve. There are many seasonal streams.

Timber Value
Newtonia buchananii and *Podocarpus* sp. are reported to occur in the montane forest.

2.4 Other reserves

Two of the three recently gazetted reserves are Kamwalla II and Kiverenge. Kamwala II (**293 ha**) was declared a territorial Forest reserve through declaration Order of Government Notice No. 232 published on 2/7/2004 and Kivengere FR (**1,758.35 ha**) was gazetted through Government Notice No 41 of 09/02/2007.

3) Mammals

By Francesco Rovero

3.1 Literature review

The only published account of large mammals from the North Pare Mountains is reported in Cordeiro *et al*. (2005). Relevant, previous records from Swynnerton and Hayman's (1951) checklist of Tanzania are also reported in this recent paper. The list of species relevant to this chapter recorded for each of three Forest Reserves visited during the present project is shown in the Table 1.

Table 5. Medium to large mammal species recorded by Cordeiro *et al.* (2005) in North Pare Mountains.

Species	Forest Reserve		
	Minja	Mramba	Kindoroko
Yellow baboon	X	X	-
Sykes's monkey	X	X	X
Black and rufous sengi	X	X	X
Tanganyikan mountain squirrel	X	X	X
Zanji sun squirrel	X	X	X
Palm civet	X	-	-
Leopard	X	-	-
Eastern tree hyrax	X	X	-
Bush pig	X	X	X
Bush buck	X	-	-
Suni	X	X	X
Harvey's duiker	X	-	X

3.2 Objectives

The objectives of the mammal research conducted during this study were:

1. To increase our understanding of the biogeography, taxonomy and ecology of large forest mammals, especially the primates and forest antelopes in selected forest sites.
2. To contribute data and information to the Red List process and to conservation organisations for improved management of study taxa.
3. To provide training in the survey techniques and monitoring of study taxa, especially transect census and camera-trapping techniques.
4. To increase awareness at the local and national level on the conservation of study taxa.

3.3 Methods

We define medium to large mammals as all those mammal species that are usually not recorded using standard, small-mammal trapping methods such as Sherman's and pitfall traps (e.g. Stanley *et al.* 1998) and are instead recorded by the model of camera-traps used in these surveys. Thus, we included mammals from the size of a squirrel genus *Paraxerus* and sengi genus *Petrodromus* and above. Camera trapping is increasingly recognised as an effective way of recording medium to large mammals (Tobler *et al.* 2008).

The following methods were used, reference is made to the methods manual (Doggart 2006) for more details.

3.3.1 Census walks for counting primates and forest antelopes.

Because of the small size of the three Forest Reserves surveyed (in the order of 1 km^2 each) the sampling intensity of census walks was constrained both in length (to a maximum of about 2 km per walk as measured by GPS) and in number. The recommended transect length should normally be of about 3 - 4 km per transect and the number of transect at least 3 per study area. In Kindoroko FR, moreover, the heavy rains imposed a decreased sampling effort.

3.3.2 Camera-trapping to detect presence of medium to large mammals

Camera-traps (Deercam DC 300) were set to take photos 24-h per day and mounted with 36 exposures, Kodak 200 ISO films. The minimum delay between consecutive photos was set at 1 minute. We

retrieved cameras after at least 30 days. For each camera-trapped species, we computed the number of events as the number of photos, not considering photos of the same species or individual taken within the same hour. Trap-rate was computed as the number of events divided by trapping effort (in days) and multiplied by 100. For each species, we pooled data from different cameras by computing total number of events, number of successful cameras and mean trap-rate for successful cameras.

Miscellaneous observations on wildlife presence and human disturbance signs were recorded opportunistically.

3.4 Sampling intensity

We used a total of 20 camera-traps, of which four were stolen while set in the forest. Therefore, only 16 cameras were retrieved (7 in Minja, 3 in Mramba and 6 in Kindoroko FRs). F. Rovero and one assistant conducted 6 census walks (3 in Minja, 1 in Mramba and 2 in Kindoroko FRs), for a mean distance of 1.44 km walked per census, as estimated by GPS. Ground distance is obviously greater, however these walks were kept straight as much as possible and the altitude range covered by each walk was small (mean of 135 m between minimum and maximum altitude covered). Average census duration was 2 hours, beginning at 7:30 h.

Sampling intensity for census walks and camera-trapping is summarized in Table 6, more details on each census walk and camera-trap site are reported in the Tables 7 and 8 respectively.

Table 6. Summary of sampling intensity for camera-trapping and census walks

Forest Reserve	Number of camera-traps (total trap-effort)	Number of census walk (mean distance)	Altitude range (m)	Period
Minja	7 (234 days)	3 (1.07 km)	1570 - 1800	Oct - Nov 2005
Mramba	3 (95 days)	1 (1.36 km)	1630 - 1730	Oct - Nov 2005
Kindoroko	6 (187 days)	2 (1.90 km)	1700 - 2030	Nov - Dec 2005
All sites	16 (516 days)	6 (1.44 km)	1570 - 2030	Oct - Dec 2005

See Tables 7 and 8 for more details, including GPS location of each camera-trap and location and timing of census walk.

Table 7. Details of six mammal census walks in the North Pare Mountains

Num walk	Forest	UTM location at start (bearing)	Date	Forest type	Altitude range
1	Mi	0352990/9604330 (NW)	07-oct-05	Regenerating	1580-1670
2	Mi	0352804/9605036 (NW)	08-oct-05	Closed montane	1720-1800
3	Mi	0352525/9605281 (N)	09-oct-05	Closed and regenerating	1700-1820
4	Mr	0344252/9600660 (N)	12-oct-05	Dry montane	1630-1730
5	Ki	0349463/9586064 (S/SE)	07-nov-05	Closed montane	1700-1900
6	Ki	0349463/9586064 (NW)	08-nov-05	Closed montane and regenerating	1700-1900

Table 8. Details of camera-trap sites in North Pare mountains

Forest reserve	Camera num.	Location (UTM)	Altitude	Trap-effort (dd)	Gross habitat	Canopy cover	Floor cover	Cover density
Mr	17	0344252/9600660	1700	32	Dry montane	Regenerating /Open	Leaf litter	Dense
Mr	15	0344290/9600242	1710	31	Dry montane	Regenerating	Shrub to less than 2m, leaf litter	Moderately dense
Mr	8	0344112/9600902	1715	32	Dry montane	Closed	Leaf litter	Dense
Mi	22	0352863/9604368	1573	34	Submontane, near large swampy valley bottom	Closed	Seedlings	Dense

Forest reserve	Camera num.	Location (UTM)	Altitude	Trap-effort (dd)	Gross habitat	Canopy cover	Floor cover	Cover density
Mi	25	0352804/9605036	1720	33	Montane	Closed	Seedlings and shrub to less than 2m	Open
Mi	16	0352639/9605540	1795	33	Montane	Regenerating	Shrub to more than 2m, leaf litter	Dense
Mi	18	0352323/9605454	1750	34	Montane	Closed	Leaf litter	Open
Mi	19	0352149/9605548	1800	34	Montane	Closed	Seedlings	Dense
Mi	13	0352525/9605281	1720	33	Montane	Closed	Seedlings	Dense
Mi	20	0352804/9605036	1715	33	Montane	Closed	Shrub to more than 2m, grass, leaf litter	Moderately dense
Ki	12	0349785/9585882	2000	39	Montane forest	Closed	Shrub to less than 2 m, seedling and leaf litter	Dense
Ki	3	0349744/9584900	1830	39	Montane forest	Closed	Shrub to less than 2 m, seedling and leaf litter	Dense
Ki	2	0349406/9586480	1880	17	Montane forest	Open	Floor of rock cave	Dense
Ki	10	0349744/9584900	1830	39	Montane forest	Closed	Shrub to less than 2 m, seedling and leaf litter	dense
Ki	6	0349859/9585666	1950	39	Montane forest	Closed	Shrub to less than 2 m, seedling and leaf litter	dense
Ki	5	0349406/9586480	1890	39	Montane forest	Closed	Shrub to less than 2 m, seedling and leaf litter	Dense
Ki	11	0349738/9586208	2030	31	Montane forest	Closed	Mud on stream bed	Dense

3.5 Results

A total of 19 species of medium to large mammals were recorded, 14 in Minja, 14 in Mramba and 11 in Kindoroko, respectively (Table 9). Sixteen species were detected through camera-trapping and sightings or signs, while bush buck, rock hyrax and yellow baboon were detected visually or from signs only.

Table 9. Checklist of medium to large mammals recorded in North Pare

Latin name	Common name	Minja	Mramba	Kindoroko	Abundance	IUCN	Endemism	Habitat	Method
	Carnivores								
Genetta tigrina	Blotched genet	X			U	LC	W	FF	CT
Genetta maculata	Cape's genet		X	X	U	LC	W	FF	CT
Civettictis civetta	African civet	X		X	C	LC	W	F	CT, D
Bdeogale crassicauda	Bushy-tailed mongoose	X		X	C	LC	W	FF	CT

Latin name	Common name	Minja	Mramba	Kindoroko	Abundance	IUCN	Endemism	Habitat	Method
Herpestes ichneumon	Ichneumon mongoose	X			U	LC	W	FF	CT
Nandinia binotata	African palm civet	X	X		U	LC	W	FF	CT, Ob
						LC			
	Primates					LC			
Cercopithecus mitis kibonotensis	Sykes's monkey	X	X	X	C	LC	W	FF	CT, Ob, VH
Papio cynocephalus	Yellow baboon	X			U	LC	W	O	D
Otolemur garnettii	Garnett's galago	X	X	X	C	LC	?		CT, Ob
	Rodents								
Cricetomys gambianus	Giant Pouched rat	X	X	X	C	LC	W	FF	CT, D
Beamys	Lesser pouched rat		X		C	LC	W	F	CT
Paraxerus sp.	Squirrel	X	X	X	C	DD	?	FF	CT, Ob
	Sengi and hyraxes								
Rhynchocyon petersi	Black and rufous sengi	X	X	X	C	EN	NE	FF	CT, ob
Petrodromus tetradactylus	Four-toed sengi		X		C	LC	W	FF	CT, Ob
Procavia johnstoni	Rock hyrax	X	X	X	U	LC	W	O	VH
	Ungulates								
Tragelaphus scriptus	Bush buck		X		U	LC	W	F	Ob
Potamochoerus larvatus	Bush pig	X	X	X	R	LC	W	F	CT, D
Cephalophus harveyi	Harveys' duiker	X	X	X	R	LR/cd	W	FF	CT, Ob, D
Neotragus moschatus	Suni	X	X		R	LR/cd	W	F	CT, D
	Total number of species	**14**	**14**	**11**					

Key to Table 9
Abundance
C = Common, U = Uncommon, R = Rare
IUCN
EN = Endangered, LR/cd = Lower Risk/conservation dependent, DD = Data Deficient, LC = Least Concern
Endemism
W = Widespread, NE = Near-endemic
Habitat
FF = strictly confined to forest, F = mainly forest, but also found outside, O = non-forest species
Detection method
CT = Camera Trap, D = Dung, Ob = Observation, VH = Vocalisation heard
Taxonomy follows Wilson and Reeder (2005)

3.5.1 Census walks for primates and forest antelopes

Sykes' monkey *Cercopithecus mitis* was the only diurnal primate seen during census walks. A maximum of two groups were seen during each walk. The Sykes' monkey appeared to be the subspecies *C. m. kibonotensis*, however this depends on what taxonomy is used as some might consider it *C. m. monoides* (T. Butynski, pers. comm.). Forest antelopes were not seen during systematic walks, however the number of dung piles was scored. Results of sighting rates (number of

groups / dung piles per km) are presented in the table below (Table 10). Primate records have been divided into sightings and the sum of sightings and auditory records. Because male Sykes' monkeys are usually more visible than females and juveniles and often move at the edge of the rest of the social group, sightings of and vocalizations / alarm calls of single individuals were considered as a sighting of a group, for the purpose of computing the encounter rate. Sightings of solitary individuals were however only 1 out of a total of 6 sightings. For the remaining 5 sightings, the group size ranged from 2 - 8 with a mean of 4.8 individuals per group.

Table 10. Summary of primates and forest antelopes census walk results in North Pare surveys

Forest Reserve	Sykes' monkeys seen per km	Sykes' monkeys seen and heard	Harvey's duiker dung	Suni dung
Minja	0.83	1.80	1.46	0
Mramba	0.50	1.00	5.88	0.73
Kindoroko	1.11	1.11	0	0
All forests	0.81	1.30	2.45	0.24

3.5.2. Camera-trapping

Table 11 summarizes the sampling-effort and the overall number of events (independent photographs) obtained. Overall, a total of 156 events were obtained during a total effort of 516 trapping-days. Trapping effort per camera was very consistent across cameras and forest, and varied from 31 to 39 days, with the exception of one camera-trap whose film was full after 16.5 days. A total of 16 species of medium to large mammals (i.e. from the size of a squirrel of the genus *Paraxerus* and above) were camera-trapped, with 10, 8 and 6 species being recorded in Minja, Mramba and Kindoroko FRs, respectively. The different number of species captured per forest could partly reflect differences in the number of cameras used.

Table 11. Summary of camera-trapping sampling effort and results obtained

Forest Reserve	Number of events	Species of mammals
Minja	99	10
Mramba	39	8
Kindoroko	18	6
All sites	156	16

The following tables (Tables 12 - 15) present, for each Forest Reserve as well as for the three reserves combined, the list of species camera-trapped, the number of independent photos (events), the number of cameras that photo-trapped the species and the trap-rate. The trap-rate is the mean value of trap-rates for camera-sites where the species was trapped only. Details of trap-sites are presented in the Appendices.

In Minja Forest Reserve, ten cameras were used, of which three were stolen. The seven cameras recorded 99 events of 10 species of mammals during 234 trap-days.

Table 12. Camera-trapping results for Minja FR.

Species	Events	Successful cameras	Trap-rate
Mammals:			
Blotched genet	2	2	2.99
Ichneumon mongoose	1	1	2.94
Bushy-tailed mongoose	1	1	2.94
African civet	5	4	3.70
Small-eared galago	5	3	5.02
Sykes monkey	2	2	4.46
Giant Pouched rat	69	6	34.45
Harvey's duiker	5	3	4.96
Suni	5	1	14.71
Black and rufous sengi	4	2	6.02

Species	Events	Successful cameras	Trap-rate
Total events	99		
Birds:			
Lemon dove	12	18	17.83

In Mramba Forest Reserve, three cameras were used, of which one was stolen. The three cameras recorded 39 events of 8 species of mammals during 95 trap-days.

Table 13. Camera-trapping results for Mramba FR.

Species	Events	Successful cameras	Trap-rate
Cape genet	7	2	10.99
African palm civet	1	1	3.13
Giant Pouched rat	20	2	31.60
Lesser pouched rat	1	1	3.13
Squirrel (gen. *Paraxerus*)	1	1	3.13
Sykes monkey	4	3	4.23
Black and rufous sengi	1	1	3.23
Four-toed sengi	4	1	12.50
Total events	39		
Birds:			
African crowned eagle	1	1	3.13
Lemon dove	2	1	6.25

In Kindoroko Forest Reserve, seven cameras were used, of which one did not work. The six cameras recorded 18 events of 6 species of mammals during 187 trap-days.

Table 14. Camera-trapping results for Kindoroko FR.

Species	Events	Successful cameras	Trap-rate
Bush pig	5	2	6.41
Harvey's duiker	10	4	7.07
Bushy-tailed mongoose	1	1	2.56
African civet	1	1	2.56
Cape's genet	1	1	3.23
Total events	18		
Birds:			
Lemon dove	2	2	2.9
Olive pigeon	1	1	3.23
Silvery -cheeked hornbill	1	1	3.23

One camera-trap in Kindoroko was placed in front of a rock cave entrance where there were dung of giant-pouched rat and, possibly, of rock hyrax. This camera produced 38 photographs of giant-pouched rat only, during 16.5 trapping-days. Analysis of photographs revealed that at least 3 different individuals were frequenting the cave. Capture times ranged from 18:59 hr to 08:56 hr, with most captures occurring between 19 hr and 5 hr. These data were not used in Table 15 to derive abundance estimation because the camera had a very biased location in comparison to the random locations of other cameras. The camera was placed to assess the presence of hyraxes.

Table 15. Camera-trapping results in the three Forest Reserves combined

Num	Species	Events	Successful cameras	Mean trap-rate	Number of forests
1	Giant-pouched rat	89	8	33.02	2
2	Suni	5	1	14.71	1
3	Four-toed sengi	4	1	12.50	1
4	Cape genet	9	4	7.11	2
5	Bush pig	5	2	6.41	1
6	Harvey's duiker	15	7	6.01	2
7	Bushy-tailed mongoose	1	1	5.50	2
8	Small-eared galago	5	3	5.02	1
9	Black and rufous sengi	5	3	4.62	2
10	Sykes monkey	6	5	4.34	2
11	African civet	6	5	3.13	2
12	Lesser pouched rat	1	1	3.13	1
13	African palm civet	1	1	3.13	1
14	Squirrel	1	1	3.13	1
15	Blotched genet	2	2	2.99	1
16	Ichneumon mongoose	1	1	2.94	1
	All species	156			

Species are ranked by mean trap-rate, which is an index of relative abundance. In addition to the mean trap-rate, the number of events, successful cameras and forests where each species was found are shown.

Although the number of events was usually small (i.e. less than 10), Table 16 shows the number of antelope captures categorized by capture-time, that gives an indication of activity pattern. This shows the diurnal habits of Harvey's duiker and provides evidence for the rather crepuscular activity of suni.

Table 16. Activity pattern of the two antelopes species, as indicated by camera-trapping times.

	Diurnal	Nocturnal	Crepuscular*
Harvey's duiker	8	1	0
Suni	1	1	2

*Between 6:00 and 7:00 h am and pm.

3.5.3 Notes on opportunistic records

The results of other opportunistic sightings are summarised below:

- Young male bush buck seen in Mramba FR, on 11th Nov 2005 at 10:35 hrs, taken by snare and subsequently released. Location: 343700/9601700 (1600 m a.s.l.).
- African palm civet seen in Minja FR at night at two sites of different elevation (1580 and 1720 m a.s.l.), both in evergreen and moist forest near permanent strems.
- Presumed rock hyrax has been heard both in Minja and in Mramba FRs from forest edges by FR and AP.

3.6 Discussion

3.6.1 Species richness, diversity and abundance

Overall, the large mammals' species richness recorded in the North Pare Mountains from our rapid biodiversity survey is high relative to other Eastern Arc Mountains, particularly considering the small size of the three Forest Reserves. For example, a camera-trap survey that deployed comparable sampling effort in Kanga Forest Reserve in the Nguru South Mountains recorded 14 species (12 species by camera-trapping and 2 primate species from census walks) (Rovero *et al.* 2007). Another camera-trap survey conducted in Uluguru North Forest Reserve in the Uluguru Mountains recorded 8 species (7 species by camera-trapping and 1 primate species from census walks) (F. Rovero and A. Bowkett, unpublished data). These results show the potential of camera-trapping for rapid surveys of small to medium mammals.

Differences in species richness and diversity were not marked between the three forests in the North

Pare Mountains. Minja seems to have the highest diversity of small carnivores including the Ichneumon mongoose and the blotched genet. However, some elusive / rare species are difficult to record and therefore differences in survey intensity might also explain the differences in the number of species recorded.

This survey recorded nine species that were not recorded by Cordeiro *et al.* (2005), mainly nocturnal and elusive mammals that were detected through camera-trapping such as the small carnivores. This survey also confirmed the presence of 10 out of 12 of the medium to large mammal species reported in Cordeiro *et al.* (2005), the exceptions being leopard *Panthera pardus* and tree hyrax *Dendrohyrax validus* that were not recorded during our survey. That leopard was not reported is not surprising since they may only occasionally move through these forests from adjacent areas as, given the small areas of the forests, it seems unlikely that leopards live permanently in these forests.

The apparent absence of tree hyrax was of particular interest to the team and so follow up was made with Cordeiro to get details of his records. He noted that he heard tree hyrax calls in Kindoroko and in parts of Minja but not in Mramba. These calls were similar calls to those made by hyrax in the East Usambara Mountains. Unfortunately no recorded calls are available for analysis. Other researchers who have recorded hyrax include Charles Msuya and Kim Howell who noted the possibility that they are present (Cordeiro pers. Comm.). It is also interesting to note that a population of tree hyrax is mentioned in the nearby Mkomazi Reserve including reference to a skull found at Pangaro (Coe *et al.* 1999). A preliminary examination of hyrax skins from rocky areas adjacent to the North Pare forests which were provided to the team by a local hunter as well as individual vocalisations heard by AWP appear to be of rock hyrax. There therefore remains some uncertainty therefore as to whether tree hyrax are present in the North Pare Mountains. Our surveys made no definite records of tree hyrax, although rock hyrax are present in the area. Further research is needed in order to establish conclusively their current status in the North Pare Mountains.

In terms of abundance, among the primates, Sykes' monkey was found to be common throughout the forests, with possible preference for areas with secondary and regenerating vegetation that were more common at lower altitude (1500 - 1600 m a.s.l.) and forest edges. This matches information on habitat preference for the same species in the Udzungwa Mountains (Rovero *et al.* 2006). Among the camera-trapped antelopes (suni and Harvey's duiker), the abundance as derived from camera-trapping rates seems to be quite high. However, careful interpretation of results and sampling effort is needed before making any speculation; thus, suni appears to be the second-most recorded species, but it has been photographed at only one site. This could represent only one or two individuals, while Harvey's duiker has been trapped in seven sites, and although it ranks sixth in abundance there were probably several individuals photo-trapped in 15 photographs, which might indicate a wider distribution and higher abundance. In conclusion, the camera-trapping effort deployed in rapid surveys yields extremely useful data for presence / absence while conclusions on relative abundance need to be treated with caution.

3.6.2. Threatened and endemic species

The only threatened species recorded was the black and rufous sengi *Rhynchocyon petersi*, which has a restricted range and is considered to be Endangered (IUCN 2004). It is also the only near-endemic Eastern Arc, medium sized, mammal species recorded in the North Pares.

It is worth mentioning Harvey's duiker *Cephalophus harveyi*, which is classified as Lower Risk - Conservation Dependent (IUCN 2004). While it is relatively widespread, this duiker is increasingly threatened from hunting and habitat degradation throughout its range (Kingdon and Rovero in press). This work confirms sightings of this species recorded in Cordeiro *et al.* (2005). The same authors noted that 'We also made poorer observations of smaller and duller red duikers moving rapidly through the undergrowth, which may suggest the presence of Natal duiker *C. natalensis* in some of the sites visited.' Our findings stronlgy suggest that the red duikers observed by Cordeiro et al. (2005) were *C. harveyi*, whose pelage can be variable.

The features of the squirrel gen. *Paraxerus* that was both photo-trapped and sighted seems to match the description reported in Cordeiro *et al.* (2005) for an unidentified species resembling the Tanganyika mountain squirrel *P. lucifer lucifer*. This species has a localised range and is Data Deficient (IUCN 2004). However, neither photos nor sightings were clear enough to confirm that identification with certainty. Further work is clearly required on this group.

In terms of diversity and biogeography, the North Pare Mountains lack any Eastern Arc endemic, medium to large mammal species, with the partial exception of the black and rufous sengi which is near-endemic. It should be noted, however, that only the Udzungwa Mountains have strictly endemic large mammals (two monkeys and one giant sengi). Still, in other forest blocks such as Nguru South and Uluguru that were used for species richness comparisons earlier, at least two Eastern Arc endemic species are found, the Lowe's servaline genet (*Genetta servalina lowei*) and the tree hyrax (*Dendrohyrax validus*) (Burgess *et al.* 2007). Also of interest is the apparent absence from North Pare of the Angolan black and white colobus *Colobus angolensis,* the mountain galago *Galagoides orinus* (see Section 4) and Abbott's duiker *Cephalophus spadix*.

3.6.3. Conservation

Our surveys documented heavy human encroachment and disturbance in all of the three Forest Reserves. Hunting through snares and muzzle loaders is probably having the most impact on medium to large mammals. Considering the small size of forest patches, it is surprising that relatively large, normally over-hunted species such as Harvey's duiker, bush buck and bush pig are still present in the abundance indicated by our results. Even if the hunting pressure, as estimated by the number of snares that we recorded, appeared to be high in Mramba Forest Reserve, the above conclusion might indicate that hunting has not been of huge impact so far or that it has not occurred for a very long time. For example, in Uluguru North Forest Reserve, some areas have been completely depleted of large mammals, perhaps indicating that hunting persisted over a great deal of time (F. Rovero unpublished data). Other threats to the forests that raise concern for the persistence of large mammals is habitat degradation as a result of fire, past logging and land encroachment inside the Forest Reserve boundaries.

4) Nocturnal Primates*4.1 Introduction*

The only published records of galagos from the North Pare Mountains are reported in Cordeiro *et al.* (2005). Swynnerton and Hayman's (1951) mammal checklist did not record any galagos from the area although they did note the presence of *Otolemur garnettii* (named as *Galago crassicaudatus panganiensis*) in the "middle Ruvu (or Pangani)" which could refer to the area around the lowland Kileo FR that was surveyed by this team briefly. Cordeiro *et al*'s (2005) paper did not include any records of *Galagoides* species. As such, a key aim of this survey was to determine whether any *Galagoides* species are present in the mountains. Although most Eastern Arc Mountain blocks contain *Galagoides orinus*, it is also possible that the *Galagoides* form recently recorded from the nearby Taita Hills (Perkin *et al.* 2002), is present in the North Pare Mountains. No *Galagoides* have been recorded from the forests of the nearby volcanic massifs such as Mt. Kilimanjaro, Mt. Meru or Kenya highlands.

4.2 Objectives

The objectives of the nocturnal primate surveys were:

1. To increase our understanding of the biogeography, taxonomy and ecology of galagos,.
2. To contribute data and information to the Red List process and to conservation organisations for improved management of study taxa.
3. To increase awareness at the local and national level on the conservation of study taxa.

4.3 Methods

Galagos are mostly or exclusively nocturnal so survey techniques are conducted at night.

4.3.1 Nocturnal transect surveys

Night walks were conducted along pre-existing paths or cut transects to reduce noise and disturbance. Galagos were detected visually by their eyeshine using head torches. Morphological details were noted with the aid of a spotting torch and binoculars. Photographs were also taken where possible. Visual descriptions were compared with published and unpublished descriptions and photographs. During the nocturnal census walks, galago vocalizations were tape-recorded and used for species identification. An analogue Marantz PMD-222 audiocassette recorder and a Sennheiser K6-ME66 directional microphone were used.

Night walks started just before dusk and continued between 18:45 and 22:00, then in the mornings from 05:00 – sunrise. A 15 minute point survey was conducted at 19:00, to estimate relative densities of galagos within a 50 meter radius. During the night, data was also taken advantageously around camp. Walks were conducted slowly at 0.5 km / hr pausing to observe any galagos and other target species when animals were seen and to record vocalizations. Start and finish times were noted as well as time taken to record and / or observe animals. The times at which animals were detected and any behavioural observations were also recorded (Perkin 2006).

4.3.2 Vocalization analysis

Vocalizations were imported into a computer and digitized using Avisoft-Sonapro (R. Spect, Berlin) software to generate sonograms, and spectrograms that graphically illustrate sound patterns. These can then be used to identify calls, make qualitative comparisons and descriptions and quantitative measurements. Galagos are identified mainly from their species specific advertising call and to a lesser extent their alarm calls (due to their complexity and variety).

4.3.2 Trapping

Trapping galagos is difficult and capture rates are highly variable depending on the species, weather and locality. Live box traps of the Chardonneret design were used to attempt to live-trap galagos. Banana and peanut butter bait in varying combinations were used. Galagos once caught are carefully handled with gloves, measured and photographed before release during the night at the point of original capture.

4.4 Sampling intensity

Night walks were conducted in all three sites for a total of 134.5 hours (Table 17). Trapping for galagos was attempted in all reserves for a total of 52 trap nights. A fourth site, Kileo forest which is a lowland ground water forest in between Mt. Kilimanjaro and N Pare was surveyed for two nights for a total of 7.5 hours.

Table 17. Summary of sampling intensity for trapping intensity for galagos.

Forest Reserve	Night walk survey intensity/ hours	Trapping intensity for galagos/trap nights	Altitude range (meters)
Minja	37	16	1570-1800
Mramba	67	24	1630-1730
Kindoroko	30.5	12	1700-2030
All sites	**134.5**	**52**	**1570-2030**

4.5 Results

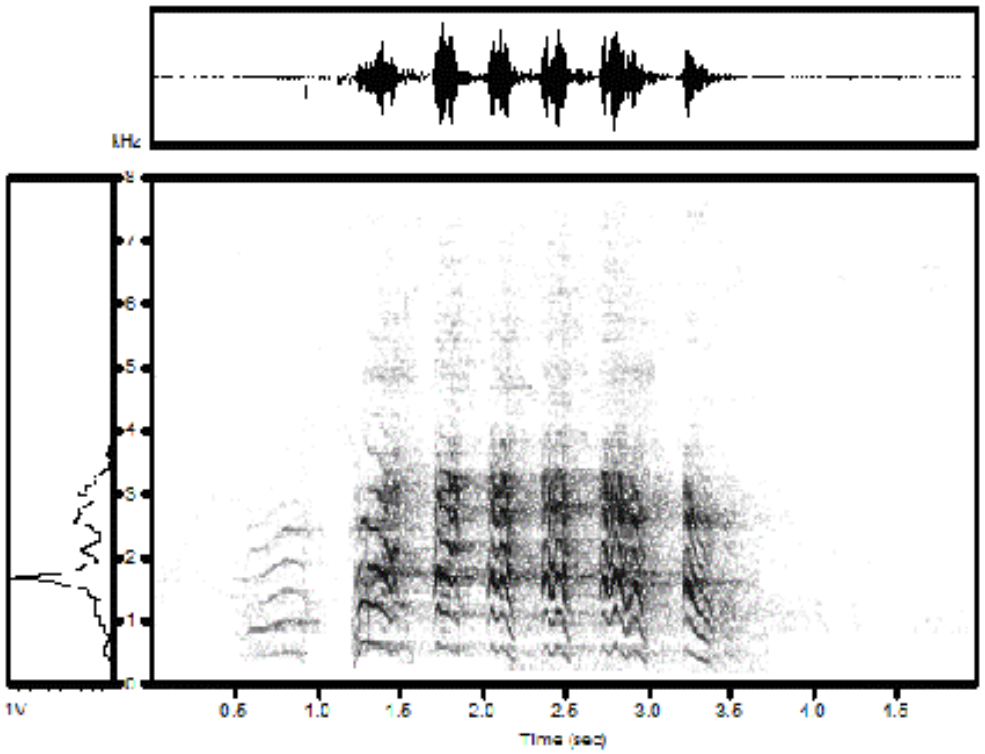
Only one species of galago was recorded in all the three forests surveyed in the North Pares and Kileo forest, the Garnett's greater galago *Otolemur garnettii.* A second species, the Senegal galago *Galago senegalensis*, was recorded on the edge of Kileo forest in *Acacia nilotica* thickets.

Table 18. Galagos found in the North Pare and Kileo forests.

Forest Reserve	Galago species
Minja	*Otolemur garnettii*
Mramba	*Otolemur garnettii*
Kindoroko	*Otolemur garnettii*
Kileo	*Otolemur garnettii and Galago senegalensis*

Figure 2. A typical example of the species specific advertisement call.

'The trailing call' of Garnett's galago recorded in Mramba Forest Reserve, which reliably indicates the presence of this species. There are two introductory cackle notes followed by five trailing (in pitch) units. The number of trailing units varies.



4.6 Discussion

4.6.1 Species richness, diversity and abundance

This survey confirms the earlier finding by Cordeiro *et al.* (2005) that *Otolemur garnettii* is the only

galago living in the North Pare Mountains and that no *Galagoides* species are present. Whilst it is very difficult to determine the absence of taxa, particularly those as cryptic as dwarf galagos, the methodologies employed indicate that this is most likely to be the case. If any dwarf galago species are present then they are unusually difficult to detect, and probably existing at very low densities. Dwarf galagos are known to occur in the nearby South Pare and Taita Hills (Perkin *et. al.* 2002, Cordeiro *et. al.* 2005) which lends support to the possibility that local extinctions have occurred in the North Pare Mountains (see Section 5). The presence of Garnett's galago was expected since this taxa occurs in riverine, coastal and Eastern Arc Mountain forests as well as Mts. Kilimanjaro, Meru and the Kenya highlands. If an extinction event did take place in the North Pares it is likely that Garnett's galago would have been able to re-colonise the area since this species is a habitat generalist and ecologically adaptable.

The indigenous knowledge survey (see Section 8) recorded that local people from each of the villages surveyed reported that they see a dwarf or small galago species almost every day. This either indicates a confusion in the identification of dwarf galagos which could be confused with African dormouse or squirrels or our surveys have failed to locate the dwarf galagos present in the forests. Another possibility is that local people are sometimes seeing the Senegal galago which is a typical acacia woodland species, which may occur at lower altitudes at the drier forest edges such as the east and northern parts of Mramba and Minja but not Kindoroko which is cut off from lowland habitats by human settlement.

4.6.2 Threatened and endemic species

Garnett's galago is not threatened.

4.6.3 Conservation

As mentioned previously there is human encroachment into the forested habitats of the North Pare Mountains, which is reducing the available habitat for Garnett's galago. Although Garnett's galago is not specifically hunted, it is considered an agricultural pest when it comes out to take fruiting crops such as coffee berries from farms. The galagos are easily trapped and killed in such instances but surprisingly they are rarely eaten. However, it does not appear that their populations are seriously affected by hunting.

5) Birds

By Andrew Perkin

5.1 Introduction

The most detailed survey of the birds of the North Pare Mountains was carried out by Cordeiro and Kiure (1995) in Minja, Mramba and Kindoroko. Cordeiro and Kiure (1995) recorded 119 species in the forests and along the forests edge. They used mist nets and conducted observational walks. Cordeiro and Kiure (1995) also visited a fourth site, Kamwala II forest reserve to the North of Kindoroko. Their paper also includes records from other ornithologists and corrects some ID errors of Fjeldsa and Rabol (1995). The North Pares are listed as an Important Bird Area (Baker & Baker 2002) based on the presence of Abbotts' starling *Cinnyricinclus femoralis* which is considered to be 'Vulnerable'; and for the presence of two restricted range species: Kenrick's starling *Poeoptera kenricki* and Abbott's starling as well as 22 'Biome-restricted species'.

5.2 Objectives

The objectives of the current survey were to:

1. To increase our understanding of the biogeography, taxonomy and ecology of birds in selected forest sites.
2. To contribute data and information to the Red List process and to conservation organisations for improved management of study taxa.
3. To increase awareness at the local and national level on the conservation of study taxa.

5.3 Methods

During this survey, day time walks were conducted in the early mornings each day. Mid morning and afternoon walks were conducted on most days. During nocturnal surveys for galagos nocturnal birds e.g. owls (Strigidae) and nightjars (Caprimulgidae) were also recorded. Bird observations were also recorded opportunistically around camp and other times. No mist netting was conducted which means that several shy understorey and low density species were not recorded.

5.4 Sampling intensity

Bird surveys were carried out over 116 hours in four sites (Table 19).

Table 19. Bird observation survey effort in hours per site.

Date	Hours			
	Minja	**Mwanga**	**Kileo**	**Kindoroko**
6/10/2005	6			
7/10/2005	7			
8/10/2005	6			
9/10/2005	7			
10/10/2005	7			
11/10/2005		4		
12/10/2005		6		
13/10/2005		8		
4/11/2005			5	
5/11/2005			2	
5/11/2005				3
6/11/2005				7
7/11/2005				7
8/11/2005				7
10/11/2005		1		
11/11/2005		6		
12/11/2005		6		
13/11/2005		7		
14/11/2005		7		
15/11/2005		7		
Total	**33**	**52**	**7**	**24**

5.5 Results

A total of 56 bird species from 28 families were observed (Table 20).

Table 20. Checklist of bird species recorded in Minja, Mramba and Kindoroko Forest Reserves.

Common name	Latin name	Minja	Mramba	Kindoroko	Abundance	IUCN	Endemism	Habitat	Detection
ACCIPITRIDAE									
Accipiter tachiro	African goshawk	x	x	x	C	LC	W	F	VH
Buteo oreophilus	Mountain buzzard	x	x	x	U	LC	W	F	VH
Stephanoaetus coronatus	African crowned eagle	x	x	x	R	LC	W	F	VH
Polyboroides typus	African harrier hawk	x			R	LC	W	F	Ob
Buteo augur	Augur buzzard	x	x	x	U	LC	W	O	Ob
Circeatus gallicus	Short toed snake eagle		x?		R	LC		O	Ob
NUMIDIDAE									
Guttera pucherani	Crested guineafowl	x	x	x	U	LC	W	F	Ob
COLUMBIDAE									
Columba arquatrix	Olive pigeon	X	X	X	C	LC	W	F	Ob
Columba larvata	Lemon dove	X	X	X	C	LC	W	F	Ob
Turtur chalcospilos	Emerald spotted wood dove	x	x	x	C	LC	W	F	Ob
MUSOPHAGIDAE									
Tauraco hartlaubi	Hartlaub's turaco	x	X	X	C	LC	W	FF	Ob
CUCULIDAE									
Centropus superciliosus	White-browed coucal	x			U	LC	W	O	VH
STRIGIDAE									
Strix woodfordii	African wood owl	x	x	x	C	LC	W	F	VH
CAPRIMULGIDAE									
Caprimulgus poliocephalus	Mountain nightjar	?				LC	W	O	VH
TROGONIDAE									
Apaloderma vittatum	Bar-tailed trogon	x	x	x	C	LC	W	FF	Ob
BUCEROTIDAE									
Tockus alboterminatus	Crowned hornbill	x			C	LC	W	F	Ob
Ceratogymna bucinator	Trumpeter hornbill	x	x	x	C	LC	W	F	Ob
Ceratogymna brevis	Silvery-cheeked hornbill	x	x	x	U	LC	W	FF	Ob
CAPITONIDAE									
Pogoniulus leucomystax	Moustached green tinkerbird	x	x	x	C	LC	W	F	Ob, VH
INDICATORIDAE									
Indicator variegatus	Scaly-throated honeyguide	X			R	LC	W	F	VH
Indicator minor	Lesser honeyguide	X			R	LC	W	F	VH

Common name	Latin name	Minja	Mramba	Kindoroko	Abundance	IUCN	Endemism	Habitat	Detection
PICIDAE									
Dendropicos griseocephalus	Olive woodpecker	x	x	x	U	LC	W	FF	Ob
HIRUNDINIDAE						LC			
Psalidoprocne pristoptera	Black saw-wing	x	X	X	C	LC	W	O	Ob
PYCNONOTIDAE									
Andropadus milanjensis	Striped-cheeked greenbul	x	x	x	C	LC	N	FF	Ob
Phyllastrephus cabanisi	Cabanis's greenbul	x	x	x	C	LC	W	FF	Ob
Pycnonotus barbatus	Common bulbul	x	x	x		LC	W	F	Ob
Chlorocichla flaviventris	Yellow-bellied greenbul	x	x	x	U	LC	W	FF	Ob
TIMALIIDAE									
Alcippe abyssinica	African hill babbler	x	x	x	C	LC	W	F	Ob
TURDIDAE									
Saxicola torquata	Stonechat	x	x	x	C	LC	W	O	Ob
Pogonocichla stellata	White-starred robin	x	x	x	C	LC	W	F	Ob
Cossypha semirufa	Rüppell's robin-chat	x	x	x	C	LC	W	FF	Ob
Zoothera gurneyi	Orange ground thrush	x	x	x	R	LC	W	FF	Ob, VH
Turdus roehli	Usambara thrush			?	R	LC	EA	FF	Ob
SYLVIIDAE									
Phylloscopus umbrovirens	Brown woodland-warbler	x	x	x	R	LC	W	FF	Ob
Bradypterus lopezi	Evergreen forest warbler	x	x	x	C	LC	W	FF	VH
Apalis thoracica	Bar-throated apalis	x	x	x	C	LC	W	FF	Ob, VH
Apalis melanocephala	Black headed Apalis	x	x	x	C	LC	W	FF	Ob
Camaroptera brachyura	Grey back camaroptera	x	x	x	C	LC	W	F	Ob, VH
MUSCICAPIDAE									
Muscicapa adusta	African dusky flycatcher		x		R	LC	W	F	Ob
ZOSTEROPIDAE									
Zosterops senegalensis	Yellow white-eye	x		x	C	LC	W	F	Ob
MONARCHIDAE									
Trochocercus cyanomelas	White-tailed crested flycatcher	x	X	X	C	LC	W	F	Ob
Terpsiphone viridis	Paradise flycatcher	x			C	LC	W	F	Ob
Bradornis microrhynchus	African grey flycatcher		x		R	LC	W	O	Ob
PLATYSTEIRIDAE									
Batis mixta	Forest batis	x			R	LC	N	FF	Ob

Common name	Latin name	Minja	Mramba	Kindoroko	Abundance	IUCN	Endemism	Habitat	Detection
MALACONOTIDAE									
Malaconotus nigrifrons	Black-fronted bush-shrike		x		R	LC	W	F	Ob, VH
Dryoscopus cubla	Black-backed puffback	x	x	x	C	LC	W	F	Ob
Tchagra australis	Brown-headed tchagra		x		CU	LC	W	O	Ob
CAMPEPHAGIDAE									
Coracina caesia	Grey cuckoo-shrike			X	U	LC	W	FF	Ob
STURNIDAE									
Cinnyricinclus femoralis	Abbott's starling	x		x	U	VU	N		
CORVIDAE									
Corvus albicollis	White-naped raven	X			U	LC	W	O	Ob, VH
NECTARINIIDAE		x							
Hedydipna collaris	Collared sunbird	x	x	x	U	LC	W	FF	Ob
Nectarinea mediocris	Eastern double-collared sunbird	x	x	x	U	LC	W	FF	Ob
Cyanomitra olivacea	Olive sunbird	x	x	x	C	LC	W	F	Ob, VH
Cinnyris venustus	Variable sunbird			x	C	LC	W	F	Ob
PLOCEIDAE									
Ploceus ocularis	Spectacled weaver	x	x	x	C	LC	W	O	Ob
ESTRILDIDAE									
Cryptospiza reichenovii	Red-faced crimsonwing	?		X	U	LC	W	F	Ob

KEY TO TABLE 20

Abundance
C = common, U = uncommon, R = rare
Endemism
W = widespread, N = near endemic to the Eastern Arc mountains
Habitat
FF = strictly confined to forest, F = mainly forest, but also found outside, O = non-forest species
IUCN
EN = Endangered, LR/cd = Lower Risk/conservation dependent, DD = Data Deficient, LC = Least Concern
Detection method
CT = Camera Trap, D = Dung, Ob = Observation, VH = Vocalisation heard

5.6 Discussion

A total of 56 bird species were recorded during the current survey. More bird species were recorded in Minja (47) than in Mramba (40) or Kindoroko (40). This total compares with the 166 species listed in Cordeiro and Kiure (1995) which included 119 species recorded during their field survey plus 47 additional species listed by other observers. Only one additional species was recorded during the current survey, the Short toed snake eagle *Circeatus gallicus* which is an uncommon palearctic migrant. This brings the total number of bird species known from the North Pare Mountains to 167 species. The lower count by this author reflects lower survey effort and no mist netting.

The North Pares appear to contain an impoverished avifauna (Baker and Baker 2002, Cordeiro and

Kiure 1995) that lacks some typical Eastern Arc Mountain forest birds such as: Fülleborn's black boubou *Laniarius fuelleborni,* Green barbet *Stactolaema olivacea* and spot-throat *Modulatrix stictigula.* The nearby South Pare Mountains and the Taita Hills contain a richer and more typical Eastern Arc avifauna. The Taita Hills although very small (only 3 km^2 of forest remaining in small patches), contain several endemic bird taxa such as the Taita olive thrush *Turdus hellerii,* Taita apalis *Apalis fuscigularis* and Taita white eye *Zosterops silvanus.* Fjeldså and Rabøl (1995) have speculated that an eruption of the Kibo volcano on Mount Kilimanjaro about 36,000 BP produced an ash fall that may have cause localised extinctions of many sensitive and sessile Eastern Arc fauna.

The North Pares still have affinities with the Eastern Arc avifauna as indicated by the presence of Usambara thrush *Turdus roehli (sensu* Bowie *et al*. 2005), Orange ground thrush *Zoothera gurneyi* and white-chested Alethe *Alethe fuelleborni* (not recorded in this study) which are not present on Mt. Kilimanjaro. However the North Pares share in common with Mt. Kilimanjaro the brown woodland-warbler *Phylloscopus umbrovirens*, Abbott's starling *Cinnyricinclus femoralis* and thick-billed seed eater *Serinus burtoni*. Thus the North Pares appear to be intermediate between the Eastern Arc and Mt. Kilimanjaro.

The North Pares, although relatively depauperate in terms of Eastern Arc avifauna, remain an Important Bird Area and are important for the conservation of the vulnerable and restricted range species found there. If the presence of the recently split double-collared sunbird *Nectarinia usambarica* (Bowie *et. al.* 2004) is confirmed, then the documented importance of the North Pares for conservation will increase.

6) Reptiles and Amphibians

By Michele Menegon

6.1 Literature review

Little has been published on the herpetofauna of the North Pare Mountains. Loader *et al.* (2003) describe the external morphology of a single young caecilian (gymnophiona) from the North Pare Mountains, identified as *Scolecomorphus vittatus*. More recently a paper has been published on *Rhampholeon* taxonomy, describing three new species, including one from the North Pare Mountains, *Rhampholeon viridis* (Mariaux & Tilbury, 2006). Another paper is currently being finalised describing a new species of *Callulina* recorded by Simon Loader from the North Pare Mountains.

6.2 Methods

Three survey methods were used to sample the herpetofauna of the North Pare Mountains. These were:

- Visual encounter surveys (day and night);
- Opportunistic acoustic surveys (day and night) and
- Opportunistic digging to sample cryptic assemblages (day only).

These methods were adopted because they sample the highest number of species in an area in which a preliminary acoustic and visual survey suggested that the forest herpetofauna was extremely scarce relative to other Eastern Arc Mountain forests.

Surveys were conducted in Kindoroko, Minja and Mramba Forest Reserves for 6, 4 and 2 days respectively. On each day, approximately 5 daylight hours and 3 hours at night were spent on opportunistic visual and acoustic surveys. Digging was carried out periodically. For more details on these methods, refer to Menegon (2006).

Additional records of snakes and chameleons were obtained from local people living in the villages at the forest edge. Specimens from the North Pare Mountains held in the herpetological collection of the University of Dar es Salaam were also looked at.

Voucher specimens have been collected and, when possible, frog calls were recorded by means of a Sony TCM directional microphone and a Sony Minidisc.

Specimens, photographs and sound recordings will be deposited in the Museo Tridentino di Scienze Naturali, Trento, Italy.

6.3 Results

During the 12-day survey, 56 amphibians and reptiles were observed or collected (Appendix 3) from 17 species (Table 21). Of these species six are amphibians and 11 are reptiles. No additional records have been found in the material of the University of Dar es Salaam's herpetological collection (a record of *Rieppeleon brachyurus* from Minja FR requires further checking, but it is probably a misidentification of *Rhampholeon viridis*). One species (*Callulina* sp. Nov.) is still awaiting formal description.

Records of other restricted range reptiles and amphibians include a specimen of *Phyrnobatrachus kreffti* from the North Pare Mountains in the collection of the Natural History Museum, London which is included in the species list in Table 21 as is the record of *Scolecomorphus vittatus* from Loader *et al.* (2003).

Burgess *et al.* (2007) cite the presence of *Probreviceps macrodactylus (*also cited by Channing and Howell 2006*)* and *Callulina kreffti* however all these specimens are now referred to a new *Callulina* sp. Nov. Burgess *et al.* (2007) also cite the presence of *Elapsoidea nigra* and *Aparallactus werneri* however upon further investigation we have been unable to identify a confirmed specimen to support these records. As such we have excluded them from the current species list.

The *Callulina* species, the two *Scolecomorphus* species and *Rhampholeon viridis* appear to be the only species present in the North Pares that are 'forest dependent'. Other species from the North Pares, with

some degree of forest dependency are *Hyperolius mitchelli*, *Phrynobatrachus kreffti* and *Cnemaspis africana*; *Leptosiaphos kilimensis* and *Adolfus jacksoni* which are quite widespread species in the northern Eastern Arc and central-southern Kenya Highlands; and *Kinyongia tavetana* which is endemic to the north-western part of the Eastern Arc and Mount Kilimanjaro highlands.

Rieppeleon kerstenii kerstenii has been found at Mramba Village surroundings, a first record for the North Pare Mountains. *R. k. kerstenii* is a coastal chameleon species inhabiting mainly bushlands, dry savanna and semi-desert (Spawls *et al*., 2002).

A single specimen of *Lygodactylus* sp. has been collected in the village belt close to Mramba Forest Reserve, the specimen is currently being investigated as part of a wider molecular study on the genus *Lygodactylus* (Aaron Bauer pers. com.).

Table 21. Check List of Amphibians and Reptiles of North Pare Mountains

Scientific name	Kindoroko	Minja	Mramba	Village land	IUCN status	Endemism	Habitat	Recording method
AMPHIBIANS								
Arthroleptidae								
Leptopelis flavomaculatus	-	+	-	-	LC	W	F	Recording
Brevicipitidae								
Callulina sp. Nov.	+	+	-	-	NL	E	FF	Coll
Hyperolidae								
Hyperolius mitchelli	-	+	-	-	LC	N	F	Coll
Hyperolius glandicolor ssp.	-	-	-	+	LC	W	O	Coll
Phrynobatrachidae								
Phrynobatrachus kreffti					EN	EA	F	Lit.
Phrynobatrachus natalensis	-	+	-	-	LC	W	O	Coll
Scolecomorphidae				-				
Scolecomorphus sp.	+	+	-	-	NL	EA	FF	Coll
Scolecomorphus vittatus					NL	EA	FF	Lit.
REPTILES								
Gekkonidae								
Cnemaspis africana	+	+	-			N	FF	Coll
Lygodactylus sp.	-	-	-	+		?	O	Coll
Chamaeleonidae								
Kinyongia tavetana	+	-	-	+		N	F	Coll
Chamaeleo dilepis	-	-	-	+		W	O	Coll
Rhampholeon viridis	+	+	-			EA	FF	Coll
Rieppeleon kerstenii	-	-	-	+		W	O	Coll
Lacertidae								
Adolfus jacksoni	+	-	-			W	F	Coll
Scincidae								
Leptosiaphos kilimensis	-	+	-			N	F	Coll
Colubridae								
Lamphrophis fuliginosus	-	-	-	+		W	O	Coll
Dispholidus typus			-	+		W	O	Coll
Thelotornis mossambicanus	+	-	+	+		W	F	Coll

Key to Table 21

Threatened status
LC = Least Concern

NL = Not listed

Endemism
E = Endemic to the North Pare Mountains
EA = Endemic to the Eastern Arc Mountains
N = Near-endemic to the Eastern Arc i.e. found in the Eastern Arc and Southern Highlands, Kilimanjaro and / or coastal Forests
W = Widespread

Habitat association
FF = Forest dependent
F = Species that are normally associated with forest but which are also found on forest edge or outside the forest.
O = non-forest species

Recording method
Coll = Collected
Lit. = Record from the literature

6.4 Discussion

In terms of their herpetofauna, the North Pare Mountains have very few forest associated species relative to other Eastern Arc Mountains. For example in a similar study in the South Nguru Mountains Menegon and Doggart (2007) recorded 24 forest dependent reptile and amphibian species compared to the four species recorded in the current study. Furthermore, the area shows only weak zoogeographic affinities to the rest of the Eastern Arc Mountains. The presence of this abrupt zoo-geographic gap between the North Pare Mountains and the more southerly massifs of the Eastern Arc needs to be properly investigated but may reflect past climatic and geologic events, such as eruptions from neighbouring Mount Kilimanjaro.

6.4.1 Species richness

The survey recorded five amphibian and six reptile species within the three forest reserves (Table 21). An additional one amphibian and five reptile species were recorded outside the reserves on village land. These figures are extremely low relative to other Eastern Arc Mountains. For example Menegon and Doggart (2007) recorded a total of 38 amphibians and 43 reptiles in the South Nguru Mountains; while Bracebridge (2005) recorded 13 reptile and 17 amphibian species in Uluguru North Forest Reserve. Species richness was particularly low in Mramba Forest Reserve where only one species was recorded. In terms of species composition, the forests lack some of the herpetological species typical of other Eastern Arc Mountain forests such as *Afrixalus*, *Nectophrynoides* and *Probreviceps* species.

Table 22. Herpetofaunal species richness in North Pare Forest Reserves

Forest reserve	Number of Amphibian species	Number of Reptile species recorded
Kindoroko	2	5
Minja	4	3
Mramba	0	1
Village land	1	7
Total species richness	7*	11

* includes *Phrynobatrachus kreffti* in the collection at NHM, London.

6.4.2 Endemism

The surveys recorded one Pare endemic, four Eastern Arc endemic species (including *Scolecomorphus vittatus* and *Phrynobatrachus kreffti* from the literature) and four Eastern Arc near-endemic reptile and amphibian species. Thus, despite the very low species richness of the North Pare Mountains, two species with very restricted distributions have been recorded: *Rhampholeon viridis* is known to occur in the North and South Pare and West Usambara Mountains only; and an undescribed species of *Callulina* appears to be a North Pare endemic species. The genus *Scolecomorphus* is near-endemic to the Eastern Arc Mountains. Molecular studies currently under way aim to assess whether the specimens from the North Pares are *S. vittatus* (Simon Loader pers. com.). Given the highly conservative morphology of the genus, differences in the colour pattern of the North Pare specimens highlights the need for further taxonomic work at the species level. For this reason the North Pare specimens are preliminarily considered not to be *Scolecomorphus vittatus*.

Table 23. Number of endemic amphibian species recorded in North Pare Forest Reserves.

Forest reserve	Pare endemic	Eastern Arc Endemic	Eastern Arc near-endemic	Widespread
Kindoroko	1	1	0	0
Minja	1	1	1	2
Mramba	0	0	0	0
Village land	0	0	0	1
From literature	0	1	0	0
Total species	**1**	**3***	**1**	**3**

* Includes *P. kreffti* and *S. vittatus* for which precise locality data are not available.

Table 24. Number of endemic reptile species recorded in North Pare Forest Reserves.

Forest reserve	Pare endemic	Eastern Arc Endemic	Eastern Arc near-endemic	Widespread
Kindoroko	0	1	2	2
Minja	0	1	2	0
Mramba	0	0	0	1
Village land	0	0	1	6
Total species richness	0	1	3	7

Of the endemic and near-endemic amphibian genera known for the Eastern Arc Mountains (*Callulina*, *Hoplophryne*, *Parhoplophryne*, *Nectophrynoides* and *Churamiti*) only *Callulina* has been recorded from the North Pare Mountains. The genus *Callulina* includes several species (most of them not yet formally described) having highly conservative morphology. This makes specific identification difficult due to the absence of reliable morphological features. However, call properties and DNA sequences can be used to distinguish the most similar species. The *Callulina* species (undescribed) collected in Kindoroko and Minja Forest Reserves, shows a certain degree of morphological divergence from the typical *Callulina* suggesting that the North Pare Mountains may have been isolated from the rest of the Eastern Arc mountains for a long time. Preliminary molecular analysis supports this theory as it shows that the *Callulina* sp. Nov. from the North Pares belongs to the most basal and divergent subclade within the genus (Simon Loader pers. com.). Cordeiro (pers. Comm.) noted that he collected a specimen of this species in Kindoroko in 1993 which was deposited with Bob Drewes.

Another species of interest in terms of endemism is *Rhampholeon viridis*. This species is known to occur in the North and South Pare Mountains with a single record from West Usambara Mountains. Its occurrence in the West Usambara is based on a single specimen in the British Museum collected in 1980 but its presence in these mountains has not since been reconfirmed (Mariaux and Tilbury 2006) although Cordeiro (pers. comm..) noted that he deposited a specimen of this species with Don Broadley in 1993). According to Matthee *et al.* (2004) and Mariaux & Tilbury (2006) *Rhampholeon viridis* (along with *R. temporalis*) is a sister group of the west african species *R. spectrum* and together belong to a clade basal to the whole *Rhampholeon* genus. Mariaux & Tilbury (2006) argued that the close position between the West African *R. spectrum* and *R. viridis* could be the result of historic climatic changes that resulted in the desiccation of the pan-African forests about 25 million years ago. This would also suggest that this species might be the most ancient sister group to all other *Rhampholeon*, an interesting hypothesis given the wide distribution of this taxon and could also imply that the genus *Rhampholeon* is paraphyletic. Cordeiro (pers. Comm.) has commented that his record of a striped-cheeked greenbul eating a chameleon was probably this species rather than *R. kerstenii* (Cordeiro 1994).

7) Forest Use

By Charles Leonard and Nike Doggart

7.1 Introduction

Deforestation, primarily for agricultural land is a key threat to the Eastern Arc Mountain forests with 6 % of the forest and 43 % of woodland on the Eastern Arc Mountains having been cleared between 1970 and 2000 (Forestry and Beekeeping Division 2006c). There is an urgent need for the problem to be documented if changes are to be made to reverse or slow the degradation process (Madoffe *et al*. 2000). The Eastern Arc Mountain forests have been under continuous, exploitative, human pressure for at least 2,000 years (Schmidt 1989). The growing human population in the area has placed greater demand on the resources of the ecosystem to provide food, fuel wood, hydropower, clean water and other forest products.

As noted earlier, a recent study by the Forestry and Beekeeping Division (FBD 2006c) indicated that the area of forest in the North Pares has declined from 2880 ha in 1975 to 2720 ha by 1999 with most of the forest loss occurring between the 1970s and early 1990s. This represents a decline of 5.6 % over 24 years. Woodland loss over the same time period has been much more dramatic in the North Pare Mountains with a 55 % reduction in the area covered in woodland from 11930 ha to 5350 ha.

Historically, clearance of forest for agricultural land is the major cause of forest loss in the area. This continues to be a threat to the forests as do timber extraction, pole cutting, fire, livestock grazing and firewood collection.

7.2 Objectives

The objectives of the forest disturbance work were:

- To assess the intensity and distribution of human disturbance within North Pare Mountain forests.
- To record the types of human disturbance affecting North Pare Mountain forests.

7.3 Methods

Disturbance transects were used to provide information on rates of timber extraction and pole cutting and other disturbances within the forests. Disturbance was assessed within seven 10 m wide transects in Kindoroko, Minja and Mramba Forest Reserves. Each transect was 1 km in length with the exception of one of the transects in Kindoroko (KI 3) which was only 850 m in length due to the inaccessibility of part of the forest. Transects were placed starting at the forest boundary and following a constant bearing. The bearing depended on the orientation of the forest. The location of the start and end points were recorded using a GPS. The distance between transects varied between forests and depended on the area of the forest. The location of the disturbance transects in each of the three forests is shown in Maps 2, 3 and 4.

Disturbance rates were recorded for each 50 m section along the transect lines. The level of disturbance was assessed in terms of the number of poles and timbers which were cut or left standing in a 10 m strip (5 m either side of the transect line). Poles were defined as those trees with straight stems at least 2 m in length and with 5 - 15 cm dbh. Timber trees were defined as all trees with straight stems at least 3 m in length and exceeding 15 cm dbh.

Every cut tree stump and cut pole was measured within the transect. The diameter at breast height (dbh) was measured at the standard height of 1.3 m above the ground using a calibrated tape. The diameter of cut trees and poles were measured at the point of cut. Fallen tree trunks or branches were not counted, only stumps.

Other forms of human disturbance were also recorded systematically in Mramba, Minja and Kindoroko Forest Reserves. These disturbances include: fire, pit sawing, hunting, cultivation, grazing, paths, roads, charcoal production, settlement and clearance, reservoirs and medicinal plant harvesting.

A more detailed account of the methods used for assessing disturbance is provided in Doggart (2006).

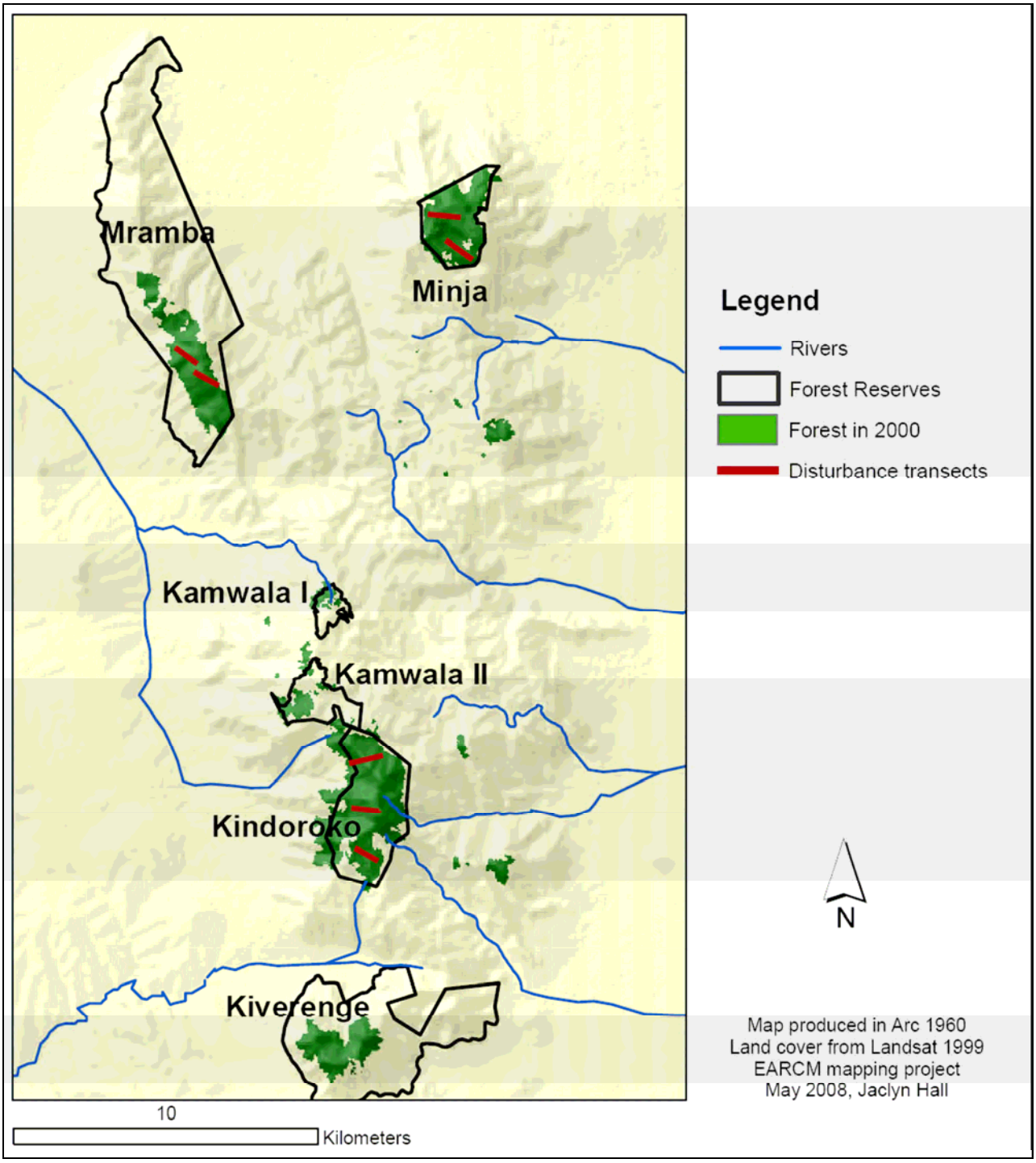
7.4 Results

In Kindoroko Forest Reserve two 10 m wide transects of 1000 m and one transect of 850 m were surveyed, resulting in a total area of 2.85 ha. In Minja and Mramba Forest Reserves two 10 m wide transects were surveyed in each forest. Each of these transects was 1000 m long resulting in a total area of 2 ha in each forest reserve. Thus, for all three forests, a total area of 6.85 ha was assessed for signs of disturbance.

7.4.1 Kindoroko Forest Reserve

The locations of the disturbance transects assessed in each of the reserves including Kindoroko are shown in Map 4.

Map 4. Location of disturbance transects in the North Pare Mountains.



Pole extraction

A total of 1374 poles were recorded in Kindoroko Forest Reserve. Of these 87 % of the poles were alive, 6 % were naturally dead, 7 % were old cut poles and 0.4 % were freshly cut. The number of poles recorded in each transect are summarized in Table 25 below.

Table 25. Numbers of live, dead, and cut poles recorded in Kindoroko FR.

Transect number	Transect area (ha)	Total number poles sampled	Average live poles per ha (% of total)	Average dead poles per ha (% of total)	Average Old cut poles per ha (% of total)	Average Fresh cut poles per ha (% of total)
KI1	1	599	457 (76)	36 (6)	106 (17)	0 (0)
KI2	1	357	342 (96)	13 (4)	2 (0)	0 (0)
KI3	0.85	418	435 (88)	33 (7)	19 (4)	5 (1)
Total	**2.85**	**1374**	**411.3**	**27.3**	**42.3**	**1.7**

Note: Values in brackets are percentages of total poles recorded, to nearest whole number.

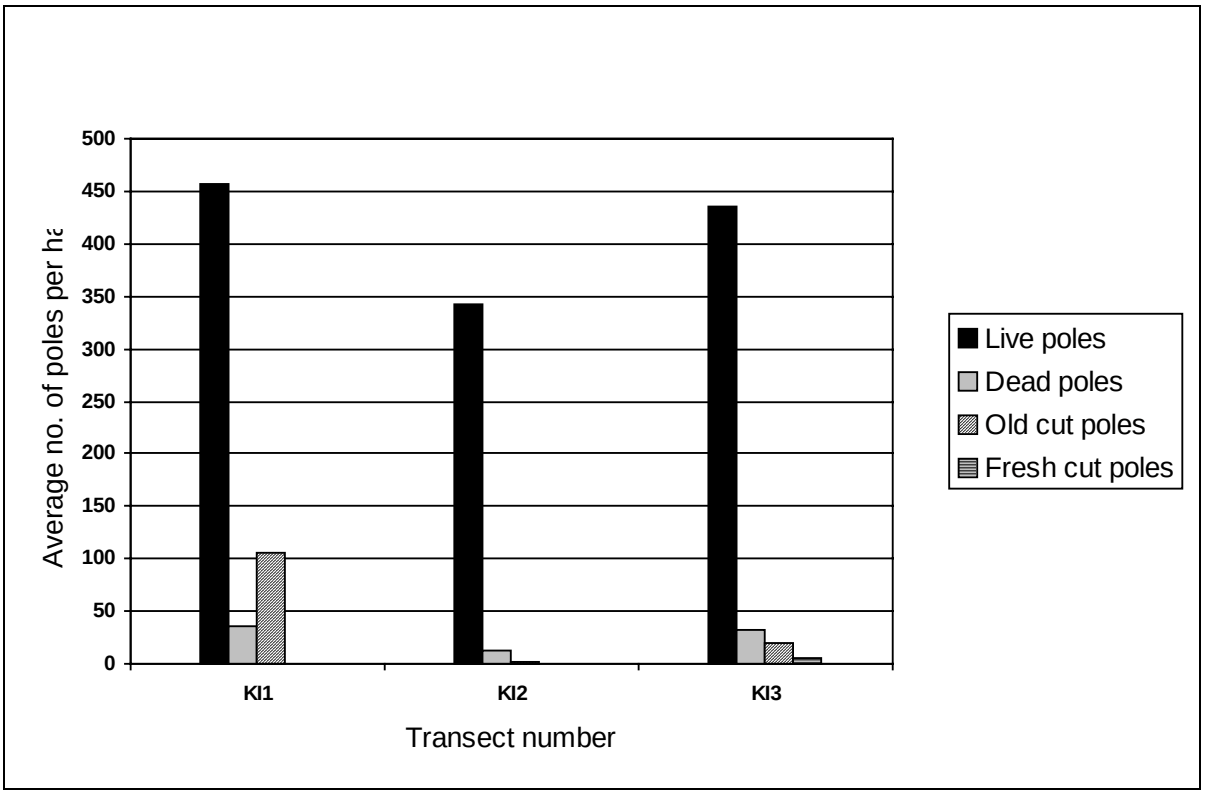


Figure 3. Abundance of live, naturally dead, old and fresh cut poles along disturbance transects, Kindoroko FR

Figure 3 indicates that KI 1 had the most live, naturally dead and old cut poles and KI 3 the least. Fresh cut poles were only recorded on Transect KI 3 where 5 cut poles were recorded.

Timber extraction

A total of 805 timbers were recorded. On average 81% of recorded trees per transect were live, 17 % were naturally dead, 3 % were old cut and 0.4 % were fresh cut. Numbers of timbers are summarized in the Table 26.

Table 26. Numbers of live, dead, old cut and fresh cut timbers recorded in Kindoroko FR

Transect number	Transect area (ha)	Total number timbers sampled	Average live timbers per ha (% of total)	Average dead timbers per ha (% of total)	Average old cut timbers per ha (% of total)	Average fresh cut timbers per ha (% of total)
KI 1	1	250	198 (79)	42 (17)	10 (4)	0 (0)
KI 2	1	318	251 (79)	61 (19)	3 (1)	3 (1)
KI 3	0.85	237	235 (84)	39 (14)	5 (2)	0 (0)
Total	**2.85**	**805**	**228**	**47.3**	**6**	**1**

Note: Values in brackets are percentages of total poles recorded, to nearest whole number.

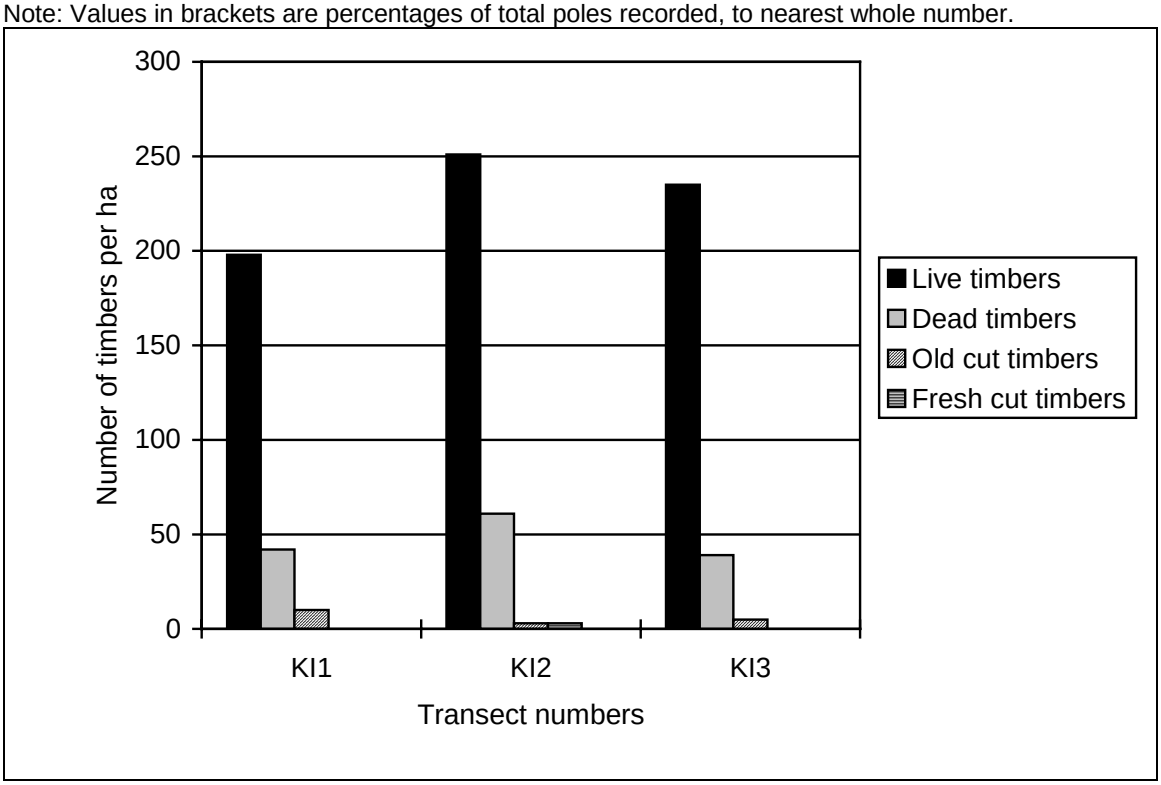


Figure 4. Abundance of live, naturally dead, old and fresh cut timbers along disturbance transects in Kindoroko FR

Figure 4 shows that KI 2 has the most live timbers while transects KI 1 and KI 3 have slightly fewer. The same trend applies to the number of naturally dead timbers in each transect. There are more old cut timbers in transect KI 1 while KI 2 was the only transect on which freshly cut timbers were recorded.

7.4.2 Minja Forest Reserve

The location of the two disturbance transects assessed in Minja Forest Reserves are shown in Map 4.

Pole extraction

A total of 892 poles were recorded along transects in Minja Forest Reserve. On average, 89 % poles per transect were alive, 9 % were naturally dead, 2 % were old cut and 0.2 % were fresh cut. Table 27 below summarizes the number of poles recorded in each category in Minja forest.

Table 27. Number of live, dead, old and fresh cut poles recorded in Minja FR

Transect number	Transect area (ha)	Total number poles sampled	Average live poles per ha (% of total)	Average dead poles per ha (% of total)	Average old cut poles per ha (% of total)	Average fresh cut poles per ha (% of total)
MI1	1	425	373 (88)	38 (9)	12 (3)	2 (0)
MI2	1	467	425 (91)	41 (9)	1 (0)	0 (0)
Total	**2**	**892**	**399**	**39.5**	**6.5**	**1**

Note: Values in brackets are percentages of total poles recorded, to nearest whole number.

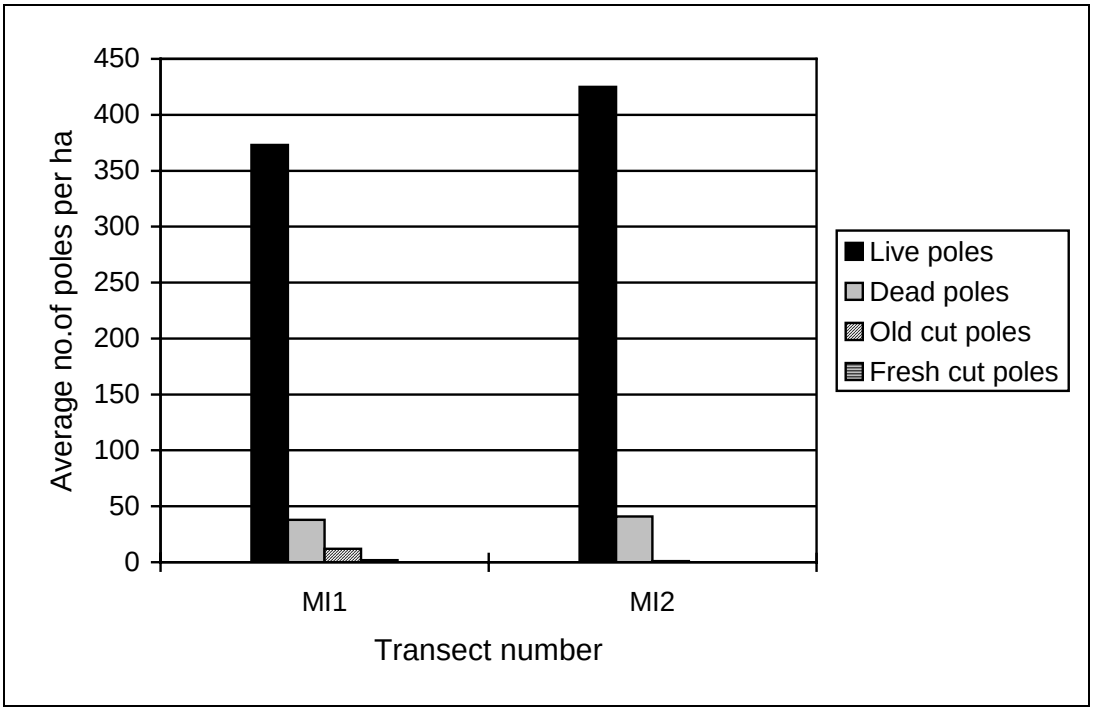


Figure 5. Abundance of live, naturally dead, old and fresh cut poles in Minja FR.

In Minja Forest Reserve, Transect MI 2 had the most live poles. Number of naturally dead poles was more-or-less equal in both transects (Figure 5). Transect MI 1 had the most new and old cut poles.

Timber extraction

A total of 609 trees with a diameter breast height exceeding 15 cm were recorded. On average, 79 % timbers were live, 19 % naturally dead, 1 % old cut and 1 % freshly cut timber tree species. Number of timber trees recorded is summarized in Table 28 below.

Table 28. Numbers of live, dead, fresh and old cut timbers recorded in Minja FR

Transect number	Transect area (ha)	Total number timbers sampled	Average live timbers per ha (% of total)	Average dead timbers per ha (% of total)	Average old cut timbers per ha (% of total)	Average fresh cut timbers per ha (% of total)
MI1	1	258	220 (85)	34 (13)	4 (2)	0 (0)
MI2	1	351	259 (74)	81 (23)	3 (1)	8 (2)
Total	**2**	**609**	**239.5**	**57.5**	**3.5**	**4**

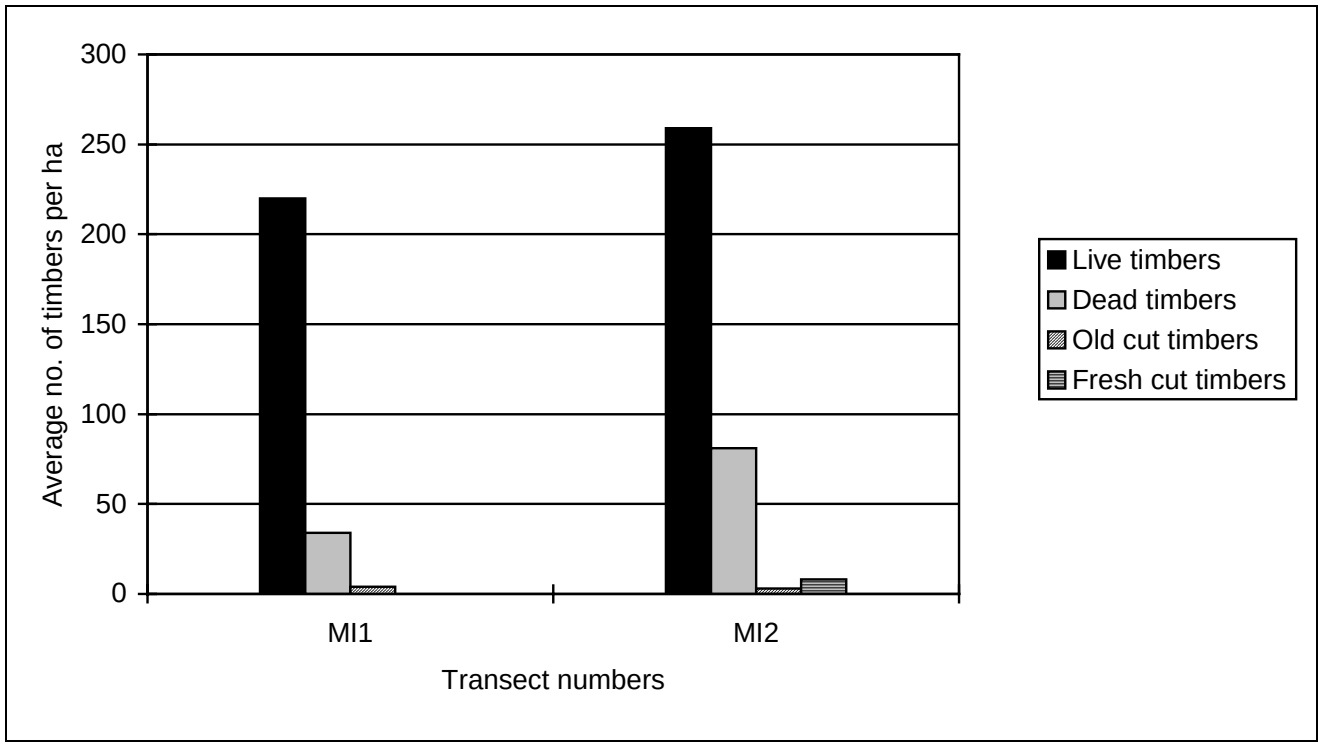


Figure 6. Abundance of live, naturally dead, old and fresh cut timbers along disturbance transects, Minja FR

In Minja FR, transect MI 2 had the most live, naturally dead and fresh cut timbers. More old cut timbers were recorded in Transect MI 1.

7.4.3 Mramba Forest Reserve

The location of the two disturbance transects assessed in Mramba Forest Reserve are shown in Map 4.

Pole extraction

A total of 1693 poles were recorded in the Mramba Forest. On average, 90 % poles were live, 8 % were naturally dead, 2 % were old cut and 0.3 % were freshly cut poles. Table 29 below summarizes numbers of poles recorded in each transect line

Table 29. Numbers of live, dead, fresh and old cut poles recorded in Mramba Forest

Transect number	Transect area (ha)	Total number poles sampled	Average live poles per ha (% of total)	Average dead poles per ha (% of total)	Average old cut poles per ha (% of total)	Average fresh cut poles per ha (% of total)
MR1	1	1026	949 (92)	68 (7)	8 (1)	1 (0)
MR2	1	667	573 (86)	62 (9)	28 (4)	4 (1)
Total	**2**	**1693**	**761**	**65**	**18**	**2.5**

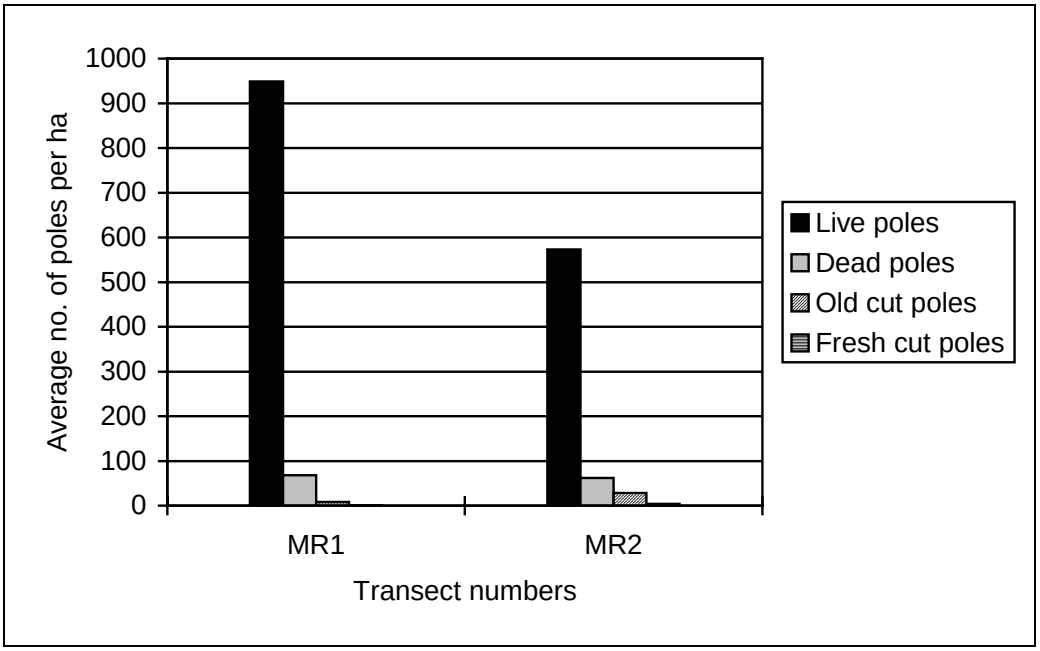


Figure 7. Abundance of live, naturally dead, cut and fresh poles in Mramba

From Figure 7 above, transect MR 1 has the most live poles but the least old and fresh cut poles. On average, the number of dead poles is roughly equal between transects MR 1 which had 68 and Transect MR 2 which had 62 (Table 29).

Timber extraction

A total of 419 timber-sized trees were recorded in Mramba FR. On average, 87% were live, 10% were naturally dead, 3% were old cut and 0% were freshly cut timber trees. Table 6 below summarizes numbers of timbers recorded in each transect.

Table 30. Numbers of live, dead, fresh and old cut timbers recorded in Mramba FR

Transect number	Transect area (ha)	Total number timbers sampled	Average live timbers per ha (% of total)	Average dead timbers per ha (% of total)	Average old cut timbers per ha (% of total)	Average fresh cut timbers per ha (% of total)
MR1	1	235	205 (87)	29 (12)	1 (1)	0 (0)
MR2	1	184	159 (86)	13 (7)	12 (7)	0 (0)
Total	**2**	**419**	**182**	**21**	**6.5**	**0**

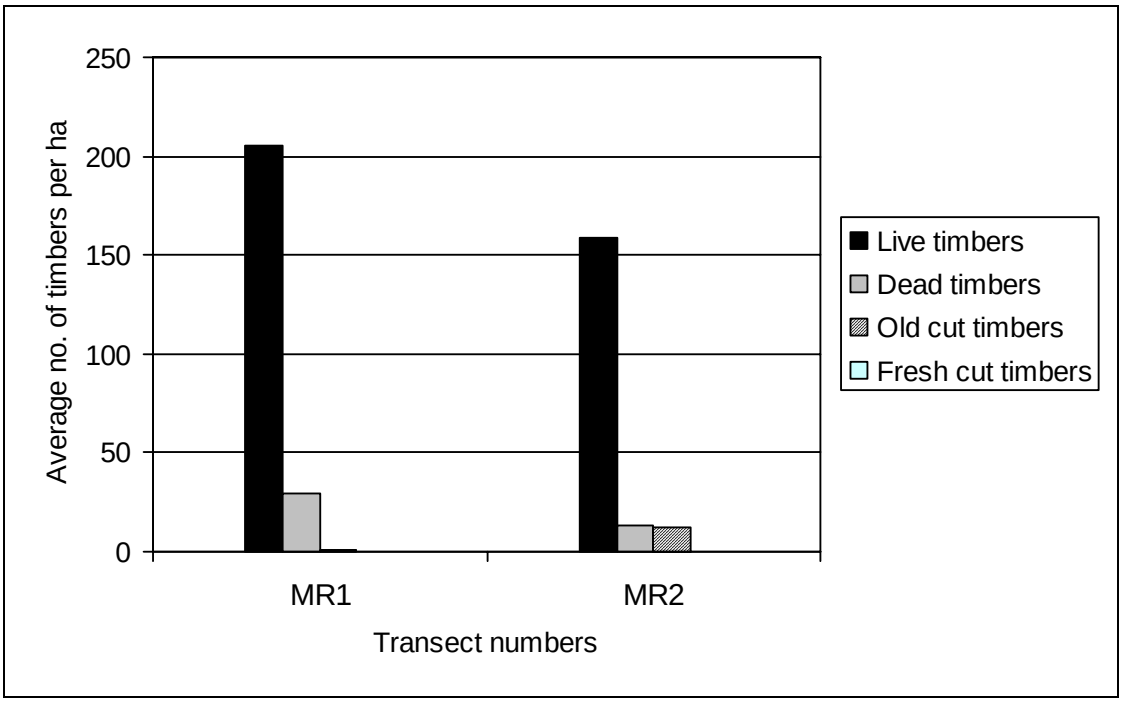


Figure 8. Abundance of live, naturally dead, old cut and fresh cut timbers in Mramba FR.

Transect MR1 has the most live and naturally dead timbers while Transect MR2 had the most old cut timbers. Fresh cut timbers were not recorded on either transect (Figure 8).

7.4.5 Other human disturbances

Mramba Forest Reserve

Fire, paths and bee hives were recorded along both transects in Mramba Forest Reserve. In transect MR 1 a fire, path and beehive were recorded once while in transect MR 2 fire was recorded four times along the transect. Paths and beehives were both recorded twice along transect MR 2. Other disturbances in Mramba FR include the collection of sandalwood (*Osyris lanceolata*) (DNRO pers comm.). This has a lucrative international market.

During our surveys in Mramba we recorded about 41 snares during the two days that we were there.

Cultivation and grazing were observed outside the forest. Maize, beans and cassava were the major crops cultivated. Many livestock tracks were observed in the forest. Thus, the total number of events of other human disturbances in Mramba forest is as follows: snares (41), fire (5), beehives (3), paths (3) and snared bushbuck (1). This is summarized in Table 31 below.

Minja Forest Reserve

On both transects in Minja Forest Reserve, fire, pitsawing and paths were recorded. In transect MI 1 fire was recorded twice while paths were recorded only once. Along transect MI 2, pitsawing was recorded twice while paths and fire were recorded once each. We also recorded six snares for forest antelopes during the two days that we were in Minja. Thus, the total number of events of other human disturbances in Minja forest is as follows: traps (6), fire (3), path (2) and pitsawing (2). This is summarized in Table 31 below.

Kindoroko Forest Reserve

Fire, pitsawing, paths, planks and hunting were the main disturbances observed in this forest. Along Transect KI1 fire was recorded four times, paths three times, planks three times, pitsawing twice and an old reservoir was recorded once. On Transect KI 2 paths were recorded six times, fire twice, pitsawing three times and hunting once. In transect KI3 paths were recorded five times, fire and traditional healer sites were recorded once each. Thus, the total number of events on other human disturbances in Kindoroko forest is as follows: paths (14), fire (7), pitsawing (5), planks (3), trap (1), old reservoir (1), and traditional healer site (1). Camera-trapping photographed one hunter with a panga, muzzle-loader gun and two dogs. These results are summarized in Table 31 below.

Table 31. Summary of events on other human disturbances in North Pare Mountain forests

Forest Reserve	Number of events						Opportunistically found events	Total
	F	P	R	T	W	Other		
Mramba	5		3			3*	41 snares and one snared bushbuck	52
Kindoroko	7	5	14	1	3	2**	Hunter	33
Minja	3	2	2				Six snares	13

Key:

*Beehives **1 old reservoir, 1 traditional healer site

F=Fire, P=Pitsawing R=Path, T=Traps, W=Planks

7.5 Discussion

Human disturbances were recorded in all three forest reserves. The most frequently recorded type of disturbance was pole cutting followed by timber cutting, paths and fire. The highest rates of pole cutting were in Kindoroko Forest Reserve where there was more than twice as much cutting as in the other two reserves. The rate of pole cutting was lowest in Minja. Rates of timber cutting were similar in all three reserves although there appears to be more recent timber cutting in Minja. High rates of pole cutting in Kindoroko correspond with the presence of many paths in this forest (14 recorded during the survey). People use the paths to harvest poles as well as travelling to other villages, collecting firewood and fodder. Hunting appears to be most intensive in Mramba Forest Reserve where the team recorded 41 snares.

Based on the results from the transects, Kindoroko has the most disturbance events per hectare while Minja has the least. Interestingly Kindoroko is the only one of the three villages in which participatory forest management has been initiated. Low rates of disturbance in Minja forest may reflect the spiritual value that this forest has for some local people. According to the indigenous knowledge interviews (see section 8) which were done in this area, there are several sites within Minja which are used by some clans in the Wagweno tribe (indigenous tribe in this area) for spiritual activities like worshipping, making sacrifices to pray for rain and other cultural events like initiation ceremonies.

The distribution of disturbances within the three reserves was similar. Most fire, paths and grazing areas were recorded within 450 m of the reserve boundary. In contrast, snares and pit sawing sites were most frequently recorded further from the reserve boundary. The proximity of fire to the forest edge reflects the use of fire in clearing shambas close to the reserve boundary. When these shamba fires get out of control they can quickly spread into the edges of the forest reserves. Similarly wild fires may result from honey harvesting close to the forest edge. Accessibility also explains the concentration of paths and livestock grazing areas close to the forest edge.

A similar study was conducted by the Conservation and Management of the Eastern Arc Mountain Forests Project (CMEAMF) in 2004 in Mramba Forest Reserves. For comparative purposes, the results of their transects are provided in Table 32. For all categories the CMEAMF team recorded more trees and saplings than were recorded during the current survey. This may reflect differences between the two teams estimation of the 10 m width of the transect or of the size categories of saplings / poles and trees / timbers. There may also have been differences in how stumps were classified as new or old cut. A more similar pattern emerges if we compare percentages (Table 33).

Table 32. Number of poles and timbers evaluated by CMEAMF project in Mramba forest reserve with figures from the current study provided in brackets for comparison

Trees/poles	Total area of transect (ha)	Total no.	Average live per ha	Average dead per ha	Average old cut per ha	Average new cut per ha
Poles	2.45 (3)	2362 (1693)	849 (761)	69 (65)	39 (18)	7 (2.5)
Trees	2.45 (3)	1195 (419)	425 (182)	52 (21)	9 (6.5)	2 (0)

Table 33. Percentage of poles and timbers evaluated by CMEAMF project in Mramba forest reserve with figures from the current study provided in brackets for comparison.

	Percentage of live stems	Percentage of naturally dead stems	Percentage of new cut stems	Percentage of old cut stems
Timber	87.0 (87)	10.7 (10)	0.5 (0)	1.8 (3)
Poles	88.0 (90)	7.2 (7.7)	0.7 (0.3)	4.0 (2.1)

Relative to other sites in the Eastern Arc where similar analyses of disturbance have been carried out, CMEAMF concluded that levels of disturbance are quite low in Mramba. Out of the 26 forests analysed by CMEAMF, Mramba had the fourth lowest rates of timber cutting and the 11th lowest rates of pole cutting.

8) Indigenous knowledge survey

By Charles Leonard

8.1 Introduction

People living close to forests often have an extensive knowledge of the wildlife found within the forests. Levels of knowledge are likely to vary depending on the frequency with which a person visits the forest, the activities that they are conducting in the forest and the degree to which they have received information on the forest from their parents and other elders. Such information can be valuable in detecting cryptic species that might otherwise be missed during a biodiversity survey as well as providing information relevant to the design of conservation initiatives.

Research on indigenous knowledge in the North Pare Mountains has focused on the sacred forests that are dotted across the mountain landscape. Mwihomeki *et al*. (1998) recorded 230 sacred forests in the North Pare Mountains covering a total area of 370 ha. The forests range in size from 0.125 ha to 50 ha with 75 % of them being under 2 ha in size. They recorded two types of sacred forest, *mshitu wa ngasu* which are forests used as cultural training spaces for men and *mpungi* which are burial groves. Mwihomeki *et al*. (1998) noted that these forests are one of the few areas of uncultivated land left in the North Pare Mountains and that the pressure is therefore increasing significantly on these forests. It is not known how important the role of these forests is in maintaining sufficient habitat for threatened species in the North Pare Mountains.

Ylhaisi (2006) in his study on the traditionally protected forests in the Gweno and Zigua ethnic groups defined a 'traditionally protected forest' as a forest which has been conserved from open access situations in different ways depending on its type. The paper distinguishes two types of Traditionally Protected Forest based on the purpose for which it is used: sacred forests and profane forests, although the profane forests were mentioned to have minor sacred sites. According to Yhlaisi, the sacred forests have the strictest prohibition on access and secular utility and were also the most important forests of precolonial societies. Yhlaisi (2006) mentioned that the size of these forests vary with some being as small as one remaining sacred tree whilst others are over 100 ha.

In another paper by the same author (Ylhaisi 2004), it was mentioned that about 77 % of the area of traditionally protected forests in the North Pare Mountains are located on land at the most fertile altitudes (1200 – 1400).

According to Ylhaisi (2000), in a study on the values of local people in relation to traditionally protected forests and rituals, it was found that the local people still value the traditionally protected forests and traditional rituals even in villages where Christian and Islamic religions have gained a stronghold. It was also found that the way that local people of different age groups value the traditionally protected forests did not differ significantly.

Wildlife-induced damages in the montane forests of North Pare are discussed in section 8.6 of this report. Most of the damages experience by local people in the North Pares relate to crop destruction.

8.2 Methods

Semi-structured interviews were conducted with a fairly open framework that allowed for focused, conversational and two way communication. At the start of the interview, the facilitator explained the purpose of the interview, which was to understand better the relationship between people in the local area and the animals of interest. The interviewees included at least three people per group. Groups were separated according to gender and age categories.

The facilitator recorded names, gender, tribe, profession, length of residency in the area and age group of the person(s) interviewed. Then questions about animal groups were asked based on the following groups: forest duikers, diurnal primates, galagos, hyraxes and sengis. The discussion focused on:

- Uses e.g. hunting for meat, skins;
- Local names
- Trapping methods;
- Any stories of traditions about the animals;
- Perceptions of changing populations / status;
- Behavioural or ecological observations e.g. feeding, predation, breeding.

The process was repeated for each taxon.

During the interview, a few notes were made and immediately after the interview, detailed notes were recorded into data sheets.

A detailed description of the methods and sample data sheets are provided in Doggart (2006).

8.3 Sampling intensity

In the North Pare Mountains, interviews were conducted with nine groups from three villages between 9th - 16th November 2005. Details of these groups are outlined in Table 34.

Table 34. Sampling intensity for indigenous knowledge survey

Village	Number of interviewees / age group		Length of residency		Educational level		Economic activity	Gender	Tribe	Adjacent forest
	20-40	> 40	Whole life	> 5	< / = Std7	=/< Form 4 and > Std 7				
Chanjale		3	2	1		3	Agric	F	2 Pare, 1 Hiyao	Kindoroko
Chanjale		3	3		1	2	Agric	M	Pare	
Chanjale	3		3		2	1	Agric	M	Pare	
Chanjale	3		3		1	2	Agric	F	Pare	
Vuchama		5	5		2	3	Agric	M	Pare	Minja
Simbomu		3		3	3		Agric & Husb	F	Chagga	Mramba
Simbomu	1	2	1	2	3		Agric & Husb	M	Chagga	
Simbomu		3	1	2	3		Agric	M	Chagga	
Simbomu		3	3		3		Agric	M	Chagga	

8.4 Results

8.4.1 Sacred forests

Some sites in Mramba, Minja and Kindoroko forest reserves and in the clan forests known as '*Mpungis*' were mentioned as having sacred values. Some of the activities carried out in these sites include: training youths about tribal traditions; making offerings and conducting rituals to please gods so that the rains come; storing skeletons and other remains of ancestors; and for other ritual ceremonies.

The size of these sacred sites varies depending on its location and purpose of use. Generally, sacred sites within the forest reserves are bigger than sacred sites on public and village land. They further reported that sites for worshipping are bigger than burial sites. The team was shown a worshipping sacred site of more than 10 acres known as *Kwa Kivia* in Minja forest. The forest in the sacred area is in good condition. People are not allowed to enter the sacred site without making a sacrifice, usually a black cow. The site is supervised by a caretaker who is also a traditional healer.

As noted above, Mwihomeki *et al.*, (1998), recorded two types of sacred forests: *mpungi* and *mshitu wa ngasu*. *Mpungi* is a burial grove and reserved for communication with ancestral spirits while *mshitu wa ngasu* is used for teaching young men about traditional culture and nature. *Mshitus* are bigger than *mpungis* but there are fewer mshitus than mpungis.

Contrary to Mwihomeki's study, we found that respondents only mentioned *mpungi* and not *mshitu*, although they indicated that these areas were used both for burial and cultural learning purposes. This apparent, lack of distinction between *mpungi* and *mshitu* may be because there are so few *mshitu* and so most people are only familiar with *mpungi* although further research is needed to determine this conclusively.

8.4.2 Mramba Forest Reserve.

Adjacent village: Simbomu

Introduction

Of the 12 people from Simbomu who were interviewed, nine were men and three were women. Of these 42 % had lived in the area for their whole lives and 58 % had immigrated to the area between 50 and 60 years ago.

How frequently do people see the focal taxa

In Simbomu, all of the men stated that they were familiar with all but four of the species and that they saw them either daily or monthly (Table 35). Women were familiar with dwarf and greater galagos, chequered sengi, black and rufous sengi and the Sykes monkey but were not familiar with red duiker, bushbuck and rock hyrax. Neither the men nor the women said that they had observed Abbott's duiker, black and white colobus, red colobus or tree hyrax in the forest suggesting that none of these species are present in the reserve.

Table 35. Frequency with which focal taxa were sighted by villagers in Simbomu Village.

Species' name	**Percentage of men and women who stated that they have ever seen the species**		**Most frequently stated frequency of sighting**
	Men	*Women*	
Red duiker	100	0	Once per month
Abbott's duiker	0	0	Never
Black and rufous sengi	100	100	Once per month
Chequered sengi	100	100	Once per month
Dwarf galago	100	100	Once per day
Greater galago	100	100	Once per day
Bushbuck	100	0	Once per month
Tree hyrax	0	0	Never
Rock hyrax	100	0	Once per day
Sykes monkey	100	100	Once per day
Black and white colobus	0	0	Never
Red colobus	0	0	Never

In Simbomu Village most species were cited as being seen both inside and outside of the forest by one or more respondents with the exception of the rock hyrax which was only observed outside of the forest (Table 36).

Table 36. Location of sightings in Simbomu Village.

Species	**Site where seen**		
	Inside the forest	**Outside the forest**	**Both**
Red duiker	√ (50%)	√ (25%)	
Black and rufous sengi	√ (50%)	√ (50%)	
Chequered sengi	√ (50%)	√ (50%)	
Dwarf galago	√ (25%)	√ (50%)	√ (25%)
Greater galago		√ (75%)	√ (25%)
Bushbuck	√ (25%)	√ (50%)	
Rock hyrax		√ (75%)	
Sykes monkey		√ (50%)	√ (25%)

In Simbomu Village, there was little consistency with regard to the trends in the abundance of the focal taxa, with the exception of the duiker, which all respondents who were aware of its presence, noted was declining (Table 37).

Table 37. Interviewee responses on abundance of focal taxa in Simbomu Village.

Species	% of interviewees responded on abundance (in brackets, their number out of total ie 12)		
	Increasing	Decreasing	Don't know
Red duiker		75 (9)	
Black and rufous sengi	75 (9)		25 (3)
Chequered sengi	75 (9)		25 (3)
Dwarf galago	75 (9)	25 (3)	
Greater galago	75 (9)	25 (3)	
Bushbuck	50 (6)		25 (3)
Rock hyrax		50 (6)	25 (3)
Sykes monkey		25 (3)	75 (9)

Reasons for changes in the abundance of focal taxa

Respondents stated that red duiker populations were declining because of food scarcity due to prolonged droughts in the area. Populations of Sykes monkeys and rock hyraxes were reported to be decreasing due to hunting. Sykes monkeys are hunted for medicine while hyraxes are hunted for their skin and meat. The abundance of sengis and galagos was reported to be increasing due to reduced predation and abundance of their preferred food.

Hunting of animals:

In Simbomu Village, animals such as antelopes and hyrax are hunted using guns (muzzle loaders), dogs or snares. Dogs are often used to flush the animals from their hiding places after which they can easily be shot or snared. For those animals that are hunted, uses include meat, medicines and skins (Table 38). No animals were reported to be traded live.

Table 38. Traditional uses for focal taxa in Simbomu Village.

Species	Use				% of interviewees mentioned (in brackets, their number out of total ie 12)
	Meat	Medicine	Skin	Trade	
Red duiker	√	√			75% (9) meat, 25% (3) medicine
Black and rufous sengi					
Chequered sengi					
Dwarf galago					
Greater galago					
Bushbuck	√		√		75% (9)
Rock hyrax	√		√		75% (9)
Sykes monkey		√	√		100% (12)

Local names for eight focal taxa were recorded (Table 39).

Table 39. Local names of focal taxa in Simbomu Village.

Species	Language	Name
Red duiker	Chagga	Kitaria
	Pare	Mbuno
Black and rufous sengi	Chagga	Kitembo
Dwarf galago	Chagga	Ngagha
Greater galago	Chagga	Ngagha
Bushbuck	Chagga	Mbala/Sarigha
	Swahili	Pongo
Rock hyrax	Chagga	Mbelele
	Pare	Mbe
Sykes	Chagga	Ngima

Traditions and stories:

Red duiker: It is believed that if a person hears the 'bark' of a red duiker and if he has a sick relative, they will die.

Galago: It is believed that if a dog eats a galago, it will die.

Behavioural observations:
Respondents described the following ecological observations:
*Red duiker*s eat forest grass and some crops such as beans. Pythons, caracals, baboons and eagles prey on red duiker. They give birth to one young between August and November.
Bushbuck is a herbivore. Young ones may be preyed on by medium-sized carnivores such as caracals.
Sengis are eaten by eagles.
Sykes monkeys eat fruits, bananas, maize and beans and are preyed on by crowned eagles. They breed between January and March.
Galagos drink '*mnazi*' and eat coffee berries. They are eaten by owls.
Rock hyrax eat grass and tree leaves and are eaten by pythons and eagles. They can give birth to more than four young.

8.4.3 Kindoroko Forest Reserve.

Adjacent village: Chanjale
Of the 12 people from Chanjale who were interviewed, six were men and six were women. Of these 92 % had lived in the area for their whole lives and 8 % had immigrated to the area between 40 and 50 years ago.

How frequently do people see the animals
In Chanjale, all of the women stated that they were familiar with all but four of the species and that they saw them either daily, monthly or once per year (Table 40). Six men were familiar with red duiker, greater galago, black and rufous sengi, chequered sengi, rock hyrax and the Sykes monkey. Out of these six men, only three were familiar with dwarf galago and bushbuck. Neither the men nor the women said that they had observed Abbott's duiker, black and white colobus, red colobus or tree hyrax in the forest suggesting that none of these species are present in the reserve.

Table 40. Frequency with which focal taxa were sighted by villagers in Chanjale Village.

Species' name	**Percentage of men and women who stated that they have ever seen the species**		**Most frequently stated frequency of sighting**
	Men	*Women*	
Red duiker	100	100	50% once per month, 50% once per year
Abbott's duiker	0	0	Never
Black and rufous sengi	100	100	Once per month
Chequered sengi	100	100	Once per month
Dwarf galago	50	100	Once per day
Greater galago	100	100	Once per day
Bushbuck	50	100	Once per month
Tree hyrax	0	0	Never
Rock hyrax	100	100	Once per day
Sykes monkey	100	100	Once per day
Black and white colobus	0	0	Never
Red colobus	0	0	Never

In Chanjale Village, most species were cited as being seen both inside and outside of the forest by one or more respondents with the exception of the Greater galago which was only observed outside of the forest (Table 41).

Table 41. Location of sightings in Chanjale Village.

Species	**Site seen***		
	Inside the forest	**Outside the forest**	**Both**
Red duiker	√ (50%)	√ (50%)	
Black and rufous sengi	√ (50%)	√ (50%)	
Chequered sengi	√ (50%)	√ (50%)	
Dwarf galago	√ (25%)		√ (50%)
Greater galago		√ (100%)	
Bushbuck	√ (50%)	√ (25%)	
Rock hyrax		√ (50%)	√ (50%)

Sykes monkey	√ (75%)	√ (25%)	

*Percentage of respondents in brackets.

In Chanjale Village, there was little consistency with regard to the trends in the abundance of the focal taxa, with the exception of the bush buck, which all respondents noted was declining (Table 42).

Table 42. Interviewee responses on abundance of focal taxa in Chanjale Village.

Species	% of interviewees responded on abundance (in brackets, their number out of total i.e. 12)		
	Increasing	Decreasing	Don't know
Red duiker		50 (6)	50 (6)
Black and rufous sengi			100 (12)
Chequered sengi			100 (12)
Dwarf galago	50 (6)		50 (6)
Greater galago	50 (6)		50 (6)
Bushbuck		100 (12)	
Rock hyrax		25 (3)	75 (9)
Sykes	50 (6)	25 (3)	25 (3)

Reasons for the abundance:

Red duiker populations were cited as being on the decline because of illegal subsistence hunting and habitat loss due to encroachment for agriculture. The respondents had little knowledge of the abundance of sengis although they mentioned that they are also found in their areas. Increased availability of food and less predation were the main factors for the increase in the abundance of galagos. Bushbuck was mentioned as decreasing because they are hunted illegally for meat. The decrease of rock hyrax was mentioned by some to be caused by subsistence hunting for meat and skin. Although the abundance of Sykes monkeys was mentioned to be increasing because of high fecundity and availability of food e.g. wild fruits, illegal hunting for skin and meat was mentioned by the interviewees to be a potential threat (Table 42). For those species that are hunted, uses included meat, medicines and skins (Table 43).

Table 43. Traditional uses for focal taxa in Chanjale Village.

Species	Use				% of respondents mentioned(in brackets, their number out of total i.e. 12)
	Meat	Medicine	Skin	Trade	
Red duiker	√				100% (12)
Black and rufous					
Chequered					
Dwarf galago					
Greater galago					
Bushbuck	√		√		75% (9)
Rock hyrax	√		√		100% (12)
Sykes		√			100% (12)

Local names for eight focal taxa were recorded (Table 44).

Table 44. Local names of focal taxa in Chanjale Village.

Species	**Language**	**Name**
Red duiker	Pare	Mbuno
Black and rufous	Pare	Ijonge
Chequered sengi	Pare	Ijonge
Dwarf galago	Pare	Mkeghe
Greater galago	Pare	Mkeghe
Bushbuck	Pare	Mbala
Rock hyrax	Pare	Mbe
Sykes monkey	Pare	Ngima

Traditions and stories:

Greater galago: It is believed that faecal materials of Greater galago are harmful to people.

Behavioural observations:

The respondents described the following ecological observations**:**

Red duiker eats grass and sometimes crops e.g. beans and legumes. It is eaten by leopard. Red duiker give birth to one young at a time.

Sengis eat insects.

Galagos eat fruits e.g. ripe bananas and they are eaten by dogs although dogs die soon after eating them.

Sykes monkeys eat wild fruits and wattle tree flowers, bananas, beans sugarcanes and maize. They give birth to one young at a time and have no specific breeding season. They are preyed upon by dogs and eagles.
Rock hyrax eats grasses and is eaten by pythons.
Bushbuck eats grasses and crops e.g. beans. They are preyed upon by leopards.

8.4.4 Minja Forest Reserve

Adjacent village: Vuchama

Five people from Vuchama were interviewed, all of them were men. They had lived in the area for their whole lives. It was difficult to get the women as the time for the survey was not convenient for them and unfortunately the survey team were unable to return at a more convenient time.

How frequently do people see the animals

In Vuchama, all of the respondents stated that they were familiar with all but of three of the species and that they saw them either daily, monthly or annually (Table 45). They were familiar with red duiker, greater galagos, dwarf galagos, black and rufous sengi, chequered sengi, rock hyrax, bushbuck, Abbott's duiker and the Sykes monkey. They did not mention black and white colobus, red colobus or tree hyrax in the forest suggesting that none of these species are present in the reserve.

Table 45. Frequency with which focal taxa were sighted by villagers in Vuchama Village.

Species' name	Percentage of men who stated that they have ever seen the species	Most frequently stated frequency of sighting
Red duiker	100	Once per month
Abbott's duiker	100.	Once per year
Black and rufous sengi	100	Once per month
Chequered sengi	100	Once per month
Dwarf galago	100	Once per day
Greater galago	100	Once per day
Bushbuck	100	Once per month
Tree hyrax	0	Never
Rock hyrax	100	Once per day
Sykes monkey	100	Once per day
Black and white colobus	0	Never
Red colobus	0	Never

In Vuchama Village, most species were cited as being seen only inside the forest with the exception of the Greater galago and Sykes Monkey which were observed both inside and outside of the forest and the rock hyrax which was only observed outside of the forest (Table 46).

Table 46. Location of sightings in Vuchama Village.

Species	Site of seen*		
	Inside the forest	Outside the forest	Both
Abbott's duiker	√ (100%)		
Red duiker	√ (100%)		
Black and rufous sengi	√ (100%)		
Chequered sengi	√ (100%)		
Dwarf galago	√ (100%)		
Greater galago	√ (50%)	√ (50%)	
Bushbuck	√ (100%)		
Rock hyrax		√ (100%)	
Sykes monkey	√ (50%)	√ (50%)	

*Percentage of respondents in brackets.

In Vuchama Village, populations of most species were reported to be declining (Table 47) with the exception of rock hyrax which were reported to be increasing in number.

Table 47. Interviewee responses on abundance of focal taxa in Chanjale Village.

Species	% of interviewees responded on abundance (Number of interviewees = 5)		
	Increasing	Decreasing	Don't know
Abbott's duiker		100	
Red duiker		100	

Species	% of interviewees responded on abundance (Number of interviewees = 5)		
	Increasing	Decreasing	Don't know
Black and rufous sengi			100
Chequered sengi			100
Dwarf galago		100	
Greater galago		100	
Bushbuck		100	
Rock hyrax	100		
Sykes		100	

Reasons changes in the abundance of focal taxa

Excessive illegal hunting and habitat loss due to human expansion were the reasons pointed out to support their comments that the abundance of Abbott's duiker is decreasing. It was also added that, nowdays it is rarely seen during the night. The major reason for decrease in abundance of red duiker and galagos was habitat loss caused mainly by human expansion while for bushbuck, illegal subsistence hunting was the major reason. Sykes are hunted illegally for medicine and are also killed as pests, thus their decrease in abundance (Table 48).

Table 48. Traditional uses for focal taxa in Vuchama Village.

Species	Use			
	Meat	Medicine	Skin	Trade
Abbots duiker	√		√	
Red duiker	√			
Black and rufous				
Chequered				
Dwarf galago				
Greater galago				
Bushbuck	√	√	√	
Rock hyrax	√			
Sykes		√		

Note: Uses were mentioned by all the interviewees i.e. 100%

Local names for eight focal taxa were recorded (Table 49).

Table 49. Local names of focal taxa in Vuchama Village.

Species	Language	Name
Abbots duiker	Pare	Sha
Red duiker	Pare	Mbuno
Black and rufous	Pare	Shange
Chequered	Pare	Nyunyunga
Dwarf galago	Pare	Mkeghe
Greater galago	Pare	Mkeghe
Bushbuck	Pare	Mbala
Rock hyrax	Pare	Mbelele
Sykes	Pare	Ngima

Traditions and stories:

Bushbuck: Skins of bushbuck were used to protect village farms against livestock herders who were regarded as intruders. Also, horns were used to divert rivers.

Galago: It was believed that when galago calls on a roof of someones's house, one family member will die.

Rock hyrax: Dungs of rock hyrax when mixed with herbs are used to prevent a person ("the devil eye person") from 'cursing' someone's properties e.g. a healthy cow.

Behavioural observations:

The respondents described the following ecological observations:

Rock hyrax is mainly a herbivore and is eaten by pythons, eagles and leopard. They breed normally after rainy period. They give birth to only one young.

Galagos eat ripe bananas, wild fruits and '*mnazi*' and are preyed by owls.

Sykes monkeys eat wild fruits, cultivated crops e.g. beans, banana and maize and calves of goats. They give birth to one after ripening of crops.

Bushbuck eats grasses and is eaten by leopards and lions (from Tsavo National Park in Kenya). They breed during the rainy season and give birth to one only.
Red duiker is a herbivore feeds on forest grasses and herbs. It is preyed by medium-sized carnivores including leopard. They give birth after rains, with one young.
Abbott's duiker eats mainly forest grasses and is eaten by leopard.

8.5 Discussion

8.5.1 Species

Overall, local people mentioned the presence of nine primate, ungulate and sengi species (Table 50). The results were the same across each of the three forests with the exception of Abbott's duiker which was only mentioned in Minja. Respondents were also consistent in not mentioning red colobus, black and white colobus and tree hyrax suggesting that these species are not present in the North Pare Mountains. With the exception of the citing of Abbott's duiker in Minja, these findings correspond with the findings of the mammal surveys described in Section 3. Whilst the mention of Abbott's duiker in Minja is interesting, the sighting of this rare antelope would need to be verified using more intensive sampling in order to confirm its presence. However, the camera-trapping effort in Minja was quite intense relative to forest size and it seems therefore unlikely that Abbott's duiker is still present in this forest. Further research is needed to find out whether these records reflect confusion between duiker species; the recent extinction of Abbott's duiker in the North Pare Mountains; or its presence at very low densities.

Table 50. Summary of species mentioned during the indigenous knowledge surveys.

Species	**Forest**
Red duiker	Mramba, Minja and Kindoroko
Abbot's duiker	Minja
Black and rufous sengi	Mramba, Minja and Kindoroko
Chequered sengi	Mramba, Minja and Kindoroko
Dwarf Galago	Mramba, Minja and Kindoroko
Greater Galago	Mramba, Minja and Kindoroko
Bushbuck	Mramba, Minja and Kindoroko
Sykes monkey	Mramba, Minja and Kindoroko
Rock hyrax	Mramba, Minja and Kindoroko
Black and white colobus monkey	None
Tree hyrax	None
Red Colobus	None

There is more variability with regard to whether animals are seen only inside or outside of the forest, or in both areas. No species was said to only be seen in one or other habitat suggesting that all species mentioned spend some time in either habitat. The variability in responses may reflect difference in how much time respondents spend in the forest (Table 51).

Table 51. Summary of whether animals were seen only inside or outside of forests or both

	% of respondents in all villages		
Species	**Inside forest only**	**Outside forest only**	**Both inside and outside the forest**
Red duiker	67%	25%	0%
Abbotts duiker	33%	0%	0%
Black and rufous sengi	67%	33%	0%
Chequered sengi	67%	33%	0%
Dwarf galago	50%	17%	25%
Greater galago	0%	58%	42%
Bushbuck	58%	25%	0%
Sykes monkey	25%	25%	50%
Rock hyrax	0%	75%	17%

In some cases, interviewees found it difficult to clearly distinguish between some of the animal species. For example, some of the respondents confused sengis with giant-pouched rats (a species not included in the study) and were also confused on the differences between the black and rufous and the chequered sengis. These two species of sengi are not found together which supports the evidence that they are confused, or not clearly observed. There was also some confusion over different galago species. Some of the respondents confused the Greater and Dwarf galagos, with most respondents

being more familiar with the Greater galago as this appears to be the only species present in the North Pare Mountains. Similarly, it is possible that respondents might have confused rock and tree hyrax. Comparing awareness of forest species between those people who regularly enter the forest and those who do not, the answer is predictably that those who spend more time in the forest are more familiar with the forest species.

8.5.2 Threats to forest wildlife and traditional uses

Food scarcity, illegal subsistence hunting for meat and habitat loss due to encroachment for agriculture were the main reasons given for the decrease in abundance of duikers in this mountain block. For Sykes, bushbuck and hyraxes, hunting for meat and skin were the major reasons. A summary of the motivation for hunting are provided in Table 52. Sykes monkey were hunted mainly for medicinal purposes whereby either the skin or meat was taken, but mostly it was reported that it is the skins which are used. Less predation and high availability of food were the main reasons mentioned for changes in abundance of galagos and sengis.

Table 52. Uses of mammals hunted in the North Pares

	Use			
Species	**Meat**	**Medicine**	**Skin**	**Trade**
Red duiker	92%	8%	0%	0%
Abbott's duiker	33%	0	33%	0%
Black and rufous sengi	0%	0%	0%	0%
Chequered sengi	0%	0%	0%	0%
Dwarf galago	0%	0%	0%	0%
Greater galago	0%	0%	0%	0%
Bushbuck	83%	33%	83%	0%
Sykes monkey	0%	100%	33%	0%
Rock hyrax	92%	0%	58%	0%

Sykes monkeys were reported to be sold to the local people by hunters. Meat and skins of these animals are used as treatment for skin cancer *'kiguma'* whereby the monkey's skin is burnt into ashes and then mixed with some herbs to form a paste which is used to treat the affected human skin. Also soup is made from the meat and is taken by the affected person to treat the disease.

The meat was either sold as the whole animal or in pieces. Prices varied according to the size of the animal. Prices ranged from Tshs. 2000 - 5000/= (US$ 1.50 – US$ 4.00) for the whole animal.

Of all the species, Sykes monkeys was mentioned the most frequently as having a medicinal value in this mountain block. Bushbuck was also mentioned as having medicinal value. The respondents reported that small intestines of bushbuck, when mixed with shrubs such as *Solanum incanum*, are used to treat chronic malaria.

According to the forest use information recorded by this study (Section 7 of this report), Minja forest is the least disturbed forest in the North Pare Mountains. This corresponds with the findings of the indigenous knowledge study which indicated that Minja forest has more spiritual values than any other forest in the North Pares, thus the locals protect it well.

8.6 Wildlife conflicts

Local people in Tanzania who live adjacent to boundaries of protected areas often experience problems from wildlife. Wildlife knows no boundaries and roams freely in and out of the protected areas. When outside a protected area, wildlife can compete with crops and livestock for land and water. The wild animals can cause damage to crops, livestock and poultry or inflict injuries to people. Normally, the animals concerned are large animals such as elephants, buffalo, lions and crocodiles. However even animals such as baboons, bush pigs and monkeys can cause significant damage. Small animals such as some rodents and small carnivores such as mongooses can also cause damage. These are regarded as pests. This causes conflicts between the people, the wild animals and the wildlife departments.

In the forests of the North Pare Mountains, there are some wildlife conflicts. Medium-sized wild animals such as baboons, vervet monkeys, Sykes monkeys, bushpigs, bushbuck and red duiker were mentioned as causing damage to crops. In addition, small animals such as galagos, rock hyrax and sengis were also mentioned as causing damage to crops.

The results of the interviews around Mramba, Minja and Kindoroko are summarised in Tables 53, 54 and 55 respectively.

Table 53. Crop damage caused by different animals as reported by respondents in Mramba Village.

Animal	Crop said to be targeted	% of respondents mentioning the animal as a pest
Baboons	Maize, banana, cassava, beans, avocadoes and mangoes.	100
Vervet monkeys	Maize, banana, cassava, beans, avocadoes and mangoes.	100
Sykes monkeys	Maize, banana, cassava, beans, avocadoes and mangoes.	100
Bush pigs	Maize and cassava	100
Galagos	Banana, avocadoes, pawpaw, coffee berries and mnazi	100
Rock hyrax	Bean seedlings	25
Red duiker	Bean seedlings	50
Bush buck	Bean seedlings	25
Sengis*	Maize seedlings and cassava plants	25

* Kingdon (1997) reported that the invertebrate diet of the sengis is occasionally supplemented by seeds or fruits

Table 54. Crop damage caused by different animals as reported by respondents in Minja Village.

Animal	Crop said to be targeted	% of respondents mentioning the animal as a pest
Baboons	Maize and bananas	100
Vervet monkeys	Maize and bananas	100
Sykes monkeys	Maize, banana, beans and kids (i.e. young goats).	100
Bush pigs	Maize	100
Galagos	Banana and mnazi	100

Table 55. Crop damage caused by different animals as reported by respondents near Kindoroko Forest.

Animal	Crop said to be targeted	% of respondents mentioning the animal as a pest
Baboons	Maize, banana, cassava, beans, avocadoes and mangoes.	100
Vervet monkeys	Maize, banana, cassava, beans, avocadoes and mangoes.	100
Sykes monkeys	Maize, banana, sugarcane, cassava, beans, avocadoes and mangoes.	100
Bush pigs	Maize and cassava	100
Galagos	Banana, avocadoes and pawpaw	75
Rock hyrax	Bean seedlings	75
Red duiker	Bean seedlings	50
Bush buck	Bean seedlings	25

The results of the interviews about wildlife conflicts shows broad similarities across the three reserves. Baboons, vervet monkeys, Sykes monkeys, bush pigs and galagos were mentioned in all three sites. In contrast rock hyrax, red duiker and bush buck were not mentioned in Minja and sengis were only mentioned as being a pest in Mramba. Rock hyrax were abundant in the rocky outcrops close to Mramba which would explain why they might be more of a pest to famers living close to the Mramba forest than elsewhere. Similarly the four-toed sengi, *Petrodromus tetradactylus* was only recorded by the survey team in Mramba suggesting that it is most abundant there which might also explain why it was cited as being a pest more frequently. Overall however, more research is needed to explain the differences in perceived rates of wildlife conflict between the reserves.

9) Conclusions

9.1 Species richness

The surveys recorded a total of 92 vertebrate species in Minja, Mramba and Kindoroko Forest Reserves and adjacent village land (Table 56).

Table 56. Summary of species richness recorded by the current surveys in all reserves.

Taxon	Minja	Mramba	Kindoroko	Village land	Total
Birds	48	41	42	N / A	56
Mammals	15	14	11	N / A	19
Amphibians	5	0	2	1	6
Reptiles	3	1	5	7	11
Total	**70**	**56**	**60**	**8**	**92**

N/A = Not Assessed

If we include other published records the total number of vertebrates known from the North Pares increases to 220 species with 167 bird species, 32 mammals, 8 amphibians and 11 reptiles. As these results include only three bat species and no fish species, it is likely that additional vertebrate species will be recorded in the area.

This means that, overall, the North Pare Mountains are quite diverse relative to other Eastern Arc Mountain blocks. For example in Uluguru North Forest Reserve which is twice as large as the three reserves included in this survey, Bracebridge (2005) recorded 209 vertebrate species. And in the South Ngurus, Doggart and Loserian (2007) recorded 319 vertebrate species in an area seven times the size of the North Pare forests.

Of the three reserves that the team visited, Minja appears to be the most diverse with 70 species, whilst Mramba appears to have the least species. This corresponds with the findings of Stanley *et al.* (2007) in terms of small mammal species richness. Although Minja is the smallest reserve and Mramba is the largest reserve, this probably reflects the extent of forest within these reserves rather than the reserve size. For example, much of Mramba is covered in woodland or thicket rather than forest.

9.2 Endemism

The surveys recorded a total of 11 restricted range species. Of these one is endemic to the North Pare Mountains, two are Eastern Arc endemics and eight are Eastern Arc near-endemics. A further three Eastern Arc endemic species have been recorded from the literature as being present in the North Pares which brings the total number of restricted range species to 14.

Table 57. Numbers of endemic, Eastern Arc endemic and Eastern Arc near-endemic vertebrates species.

Endemism	Minja	Mramba	Kindoroko	Village land	Total
Endemic	1	0	1	0	1
Eastern Arc endemic	2	0	2	0	5
Eastern Arc near-endemic	7	2	5	1	8
TOTAL	**10**	**2**	**8**	**1**	**14**

The endemic species are:

North Pare endemic species

Our surveys recorded one North Pare endemic vertebrates species:

Callulina sp. Nov.: this frog species was found in Minja and Kindoroko reserves. Although the species has not been fully described, molecular analysis indicates that it is significantly distinct from other Callulina to merit species status.

Eastern Arc endemic species found in the North Pare Mountains

Eastern Arc Endemics

Our surveys recorded three Eastern Arc endemic species:

Amphibians
Scolecomorphus sp. Nov.

Reptiles
Rhampholeon viridis

Birds
Turdus roehli

Two other species are recorded in the literature.

Scolecomorphus vittatus (Loader 2003)
Phyrnobatrachus kreffti (this is based on a specimen held at the Natural History Museum, London)

This brings the total number of Eastern Arc endemic vertebrates recorded from the Eastern Arc Mountains to five.

Eastern Arc Near endemics
Our surveys recorded eight Eastern Arc near-endemic species:

Birds
Andropadus milanjensis Striped-cheeked greenbul
Batis mixta Forest batis
Cinnyricinclus femoralis Abbott's starling

Mammals
Rhynchocyon petersi Black and rufous sengi

Amphibians
Hyperolius mitchelli

Reptiles
Cnemaspis africana
Kinyongia tavetana
Leptosiaphos kilimensis

9.3 Threatened species

There are five threatened species in the North Pare Mountains of which two are considered to be endangered, one is vulnerable and two are lower risk / conservation dependent.

Table 58. Numbers of threatened species in each reserve.

Threatened status	Minja	Mramba	Kindoroko	Village land	Total
Endangered	1	1	1	0	2
Vulnerable	1	0	1	0	1
Lower risk / conservation dependent	2	2	1	0	2
TOTAL	**4**	**3**	**3**	**0**	**4**

The threatened species are:

Endangered
Rhynchocyon petersi Black and rufous sengi
Phyrnobatrachus kreffti

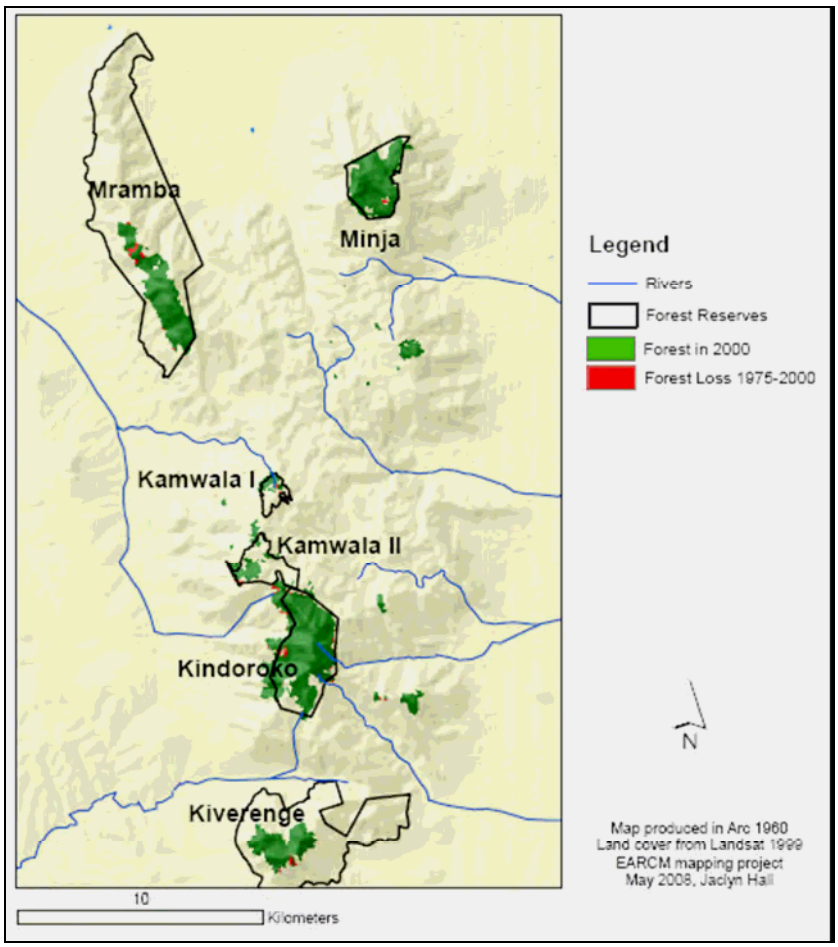
Vulnerable
Cinnyricinclus femoralis Abbott's starling

Lower risk / conservation dependent

Cephalophus harveyi	Harveys' duiker
Neotragus moschatus	Suni

9.4 Conservation

The three largest areas of forest in the North Pare Mountains are Mramba, Minja and Kindoroko Forest Reserves. The three forests are gazetted as protective forest reserves. In addition, Kileo Forest Reserve, in the lowlands is a Local Authority Forest Reserve. Three other areas of forest: Kiverenge, Kamwalla I and Kamwalla I have recently been gazetted as Central Government forest reserves.



Map 5. Forest change in the North Pare Mountains. (FBD 2006 c).

In a recent initiative to code Tanzania's Eastern Arc forest reserves according to IUCN protected area categories (Forestry and Beekeeping Division 2006 b), the six Central Government Forest Reserves of the North Pare Mountains were all recommended to be classified as Category IV Protected Areas. Category IV Protected areas are protected areas managed mainly for conservation through management intervention. Kileo Forest Reserve was recommended to be classified as Category III which means that it is managed mainly for conservation of specific natural features. These recommendations have been accepted by IUCN and WCMC and the reserves are now included in the World Database on Protected Areas.

Many of the clan forests do not yet have legal protection although some work has gone into gazetting a few of these as Village Forest Reserves.

Joint forest management has been promoted in Mramba and Kindoroko Forest Reserves according to Forestry and Beekeeping Division (2006 a) where as Minja Forest Reserve does not yet have a General Management Plan.

Despite their spiritual importance, forest loss and degradation are occurring in all of the North Pare Forests. According to Forestry and Beekeeping Division (2006 c), forest loss could be detected in each

of the three main forests between 1975 and 1999 (Map 5) with the highest rates occurring in Kindoroko and Kiverenge forests. Evidence of current pole and tree cutting was also recorded during the current survey with the highest rates of pole cutting occurring in Kindoroko Forest Reserves. Fire also appears to be contributing to forest loss, particularly along the forest boundaries.

10) Recommendations

10.1 Research recommendations

The 'Filling the Knowledge Gap' project has provided significantly more information on the mammal, reptile and amphibian fauna of the North Pare Mountains, however there remain a few significant gaps in our knowledge of the vertebrate fauna. The rodents, shrews and bats are the most obvious gap. This should be filled by parrallel research being carried out by Bill Stanley of the Field Museum, Chicago. As with other Eastern Arc Mountains, little is known about the fish. There is also much to find out about the invertebrate fauna of the mountains.

Recent work on the phylogenetics of amphibians and birds is relevaling significant genetic differences between populations of animals previously thought to belong to one species. Inclusion of samples from the North Pare Mountains would also help to determine how distinct the species are in this block.

The paucity of the North Pare Mountains in terms of endemic species is curious and deserves further research. There has been speculation that this was caused by eruptions of Mount Kilimanjaro or Mount Meru. Another possibility is that the North Pares experienced more extreme drying events than other Eastern Arc Mountains and that this resulted in local extinctions. Such research might also help to fine tune models attempting to predict the impact of climate change on other Eastern Arc mountains.

Further research on the biological values and roles of the sacred forests in the North Pare Mountains would be useful in assessing their role in the landscape mosaic.

10.2 Management recommendations

Kindoroko Forest Reserve

- Resurvey and demarcate the boundary with a non-invasive exotic such as *Grevillea robusta*.
- Ensure that the corridor to the Kamwalla II proposed reserve is included in the gazettement process.
- Evaluate the success of the joint forest management and provide support where necessary.
- District Authorities should provide ongoing technical support to the communities to fulfil their obligations under the joint forest management.
- Raise awareness on the status and importance of the reserve.
- Support improved community fire management and prevention.
- Support the establishment of village forest reserves to include the forest contiguous with Kindoroko Forest Reserve.

Minja Reserve

- Resurvey and demarcate the boundary with a non-invasive exotic such as *Grevillea robusta*.
- Prepare a General Management Plan and recruit a forest officer to implement the plan.
- Raise awareness on the status and importance of the reserve.
- Support improved community fire management and prevention.

Mramba Forest Reserve

- Resurvey and demarcate the boundary with a non-invasive exotic such as *Grevillea robusta*.
- Raise awareness on the status and importance of the reserve.
- Support improved community fire management and prevention.

Sacred forests

- Support the legal protection of sacred forests as community or village forest reserves in order to strengthen their protection and clarify their management.

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APPENDICES

Appendix 1. Coordinates recorded at forest edge.

Minja FR:

- 353315/9605730, 1795 m asl, SE edge
- 352398/9606133, 1800 m asl, NE edge
- 352287/9605794, 1818 m asl, N edge

Mramba FR:

- 343766/9602022, 1550 m asl, W/NW edge
- 344552/9600054, 1670 m asl, S edge
- 344081/9601996, 1630 m asl, N edge

Kindoroko FR:

- 349461/9585316, 1900 m asl, S edge
- 350223/584144, 1670 m asl, N edge

Appendix 2. Visit to Kileo Forest Reserve.

The survey team visited Kileo Forest Reserve on the 4th November 2005. This is a ground-water forest patch located on the plain north of the North Pare Mountains, near the Kenyan border. A key aim of this visit was to assess the presence of the Black and White colobus species reported by the District Forest Officer, especially since this monkey was not found in the mountain forests that we had surveyed. It was also not clear whether this colobus was reported as the Angolan or the guereza (highland form) colobus.

The team camped for one night near the forest edge close to a large pond that is used as a source of pumped water for the village. Two random, daily and nocturnal walks of about 2 h each were conducted to assess wildlife presence. The forest is about 1 sq km in size and is centred on 37M 341154 E and 9617382 S (altitude 730 m asl). It presents closed canopy, moist trees in its interior with savannah trees (*Acacia* spp) and more fragmented canopy towards its edge.

Among the large mammals, the most interesting sighting was of the black and white guereza colobus, East African highland form (*Colobus guereza caudatus*), in proximity of 37M 341154 E and 9617382 S. This is the southeastern-most record for this species (T. Butynski, pers. comm.) that occurs in the slopes of Mount Kilimanjaro and Mount Meru. There might be only a maximum of 5 - 8 groups in this isolated forest.

Other mammals recorded were the crested porcupine (seen at night), the African civet (scat), the Sykes's monkey (seen) and the vervet monkey (*Cercopithecus aethiops pygerythrus*).

We recommend that Kileo forest patch- probably a remnant of once a larger lowland forest - be given protection from tree cutting and encroachment, because of the presence of the guereza colobus and because the forest protects the water source.

Appendix 3. List of reptile and amphibian specimens recorded (collected and observed).

Specimen number	Species	Order	Family	Location
Obs.	*Adolfus jacksoni*	Reptilia	Lacertidae	Kindoroko FR. Pare Mts.
MTSN 8604	*Cnemaspis cf. africana*	Reptilia	Gekkonidae	Kindoroko FR. Pare Mts.
MTSN 8605	*Cnemaspis cf. africana*	Reptilia	Gekkonidae	Kindoroko FR. Pare Mts.
MTSN 8606	*Cnemaspis cf. africana*	Reptilia	Gekkonidae	Kindoroko FR. Pare Mts.
MTSN 8609	*Callulina sp.*	Amphibia	Microhylidae	Kindoroko FR. Pare Mts.
MTSN 8610	*Callulina sp.*	Amphibia	Microhylidae	Kindoroko FR. Pare Mts.
MTSN 8611	*Callulina sp.*	Amphibia	Microhylidae	Kindoroko FR. Pare Mts.
MTSN 8612	*Callulina sp.*	Amphibia	Microhylidae	Kindoroko FR. Pare Mts.
MTSN 8613	*Callulina sp.*	Amphibia	Microhylidae	Kindoroko FR. Pare Mts.
MTSN 8614	*Callulina sp.*	Amphibia	Microhylidae	Kindoroko FR. Pare Mts.
MTSN 8615	*Callulina sp.*	Amphibia	Microhylidae	Kindoroko FR. Pare Mts.
MTSN 8617	*Callulina sp.*	Amphibia	Microhylidae	Kindoroko FR. Pare Mts.
MTSN 8618	*Callulina sp.*	Amphibia	Microhylidae	Kindoroko FR. Pare Mts.
MTSN 8619	*Scolecomorphus sp.*	Amphibia	Scolecomorphidae	Kindoroko FR. Pare Mts.
MTSN 8620	*Scolecomorphus sp.*	Amphibia	Scolecomorphidae	Kindoroko FR. Pare Mts.
MTSN 8621	*Callulina sp.*	Amphibia	Microhylidae	Kindoroko FR. Pare Mts.
MTSN 8622	*Callulina sp.*	Amphibia	Microhylidae	Kindoroko FR. Pare Mts.
MTSN 8624	*Rhampholeon sp. (viridis)*	Reptilia	Chamaeleonidae	Kindoroko FR. Pare Mts.
MTSN 8625	*Rhampholeon sp. (viridis)*	Reptilia	Chamaeleonidae	Kindoroko FR. Pare Mts.
MTSN 8626	*Rhampholeon sp. (viridis)*	Reptilia	Chamaeleonidae	Kindoroko FR. Pare Mts.
MTSN 8627	*Rhampholeon sp. (viridis)*	Reptilia	Chamaeleonidae	Kindoroko FR. Pare Mts.
MTSN 8629	*Rhampholeon sp. (viridis)*	Reptilia	Chamaeleonidae	Kindoroko FR. Pare Mts.
MTSN 8630	*Rhampholeon sp. (viridis)*	Reptilia	Chamaeleonidae	Kindoroko FR. Pare Mts.
MTSN 8631	*Scolecomorphus sp.*	Amphibia	Scolecomorphidae	Kindoroko FR. Pare Mts.
MTSN 8632	*Callulina sp.*	Amphibia	Microhylidae	Kindoroko FR. Pare Mts.
MTSN 8633	*Scolecomorphus sp.*	Amphibia	Scolecomorphidae	Kindoroko FR. Pare Mts.
MTSN 8634	*Scolecomorphus sp.*	Amphibia	Scolecomorphidae	Kindoroko FR. Pare Mts.
MTSN 8637	*Scolecomorphus sp.*	Amphibia	Scolecomorphidae	Kindoroko FR. Pare Mts.
MTSN 8638	*Scolecomorphus sp.*	Amphibia	Scolecomorphidae	Kindoroko FR. Pare Mts.
MTSN 8639	*Scolecomorphus sp.*	Amphibia	Scolecomorphidae	Kindoroko FR. Pare Mts.
MTSN 8658	*Chamaeleo tavetanus*	Reptilia	Chamaeleonidae	Kindoroko FR. Pare Mts.
MTSN 8661	*Chamaeleo tavetanus*	Reptilia	Chamaeleonidae	Kindoroko FR. Pare Mts.
MTSN 8640	*Callulina sp.*	Amphibia	Microhylidae	Minja FR. Pare Mts.
MTSN 8641	*Callulina sp.*	Amphibia	Microhylidae	Minja FR. Pare Mts.
MTSN 8642	*Scolecomorphus sp.*	Amphibia	Scolecomorphidae	Minja FR. Pare Mts.
MTSN 8643	*Hyperolius mitchelli*	Amphibia	Hyperolidae	Minja FR. Pare Mts.
MTSN 8644	*Scolecomorphus sp.*	Amphibia	Scolecomorphidae	Minja FR. Pare Mts.
MTSN 8645	*Scolecomorphus sp.*	Amphibia	Scolecomorphidae	Minja FR. Pare Mts.
MTSN 8647	*Scolecomorphus sp.*	Amphibia	Scolecomorphidae	Minja FR. Pare Mts.
MTSN 8648	*Callulina sp.*	Amphibia	Microhylidae	Minja FR. Pare Mts.
MTSN 8649	*Scolecomorphus sp.*	Amphibia	Scolecomorphidae	Minja FR. Pare Mts.
MTSN 8650	*Leptosiaphos kilimensis*	Reptilia	Scincidae	Minja FR. Pare Mts.
MTSN 8651	*Leptosiaphos kilimensis*	Reptilia	Scincidae	Minja FR. Pare Mts.
MTSN 8652	*Leptosiaphos kilimensis*	Reptilia	Scincidae	Minja FR. Pare Mts.
MTSN 8653	*Rhampholeon sp. (viridis)*	Reptilia	Chamaeleonidae	Minja FR. Pare Mts.
MTSN 8654	*Cnemaspis cf. africana*	Reptilia	Gekkonidae	Minja FR. Pare Mts.
MTSN 8655	*Thelotornis mossambicanus*	Reptilia	Colubridae	Minja FR. Pare Mts.
MTSN 8656	*Hemidactylus cf. mabouia*	Reptilia	Gekkonidae	Minja FR. Pare Mts.
MTSN 8657	*Rhampholeon sp. (viridis)*	Reptilia	Chamaeleonidae	Minja FR. Pare Mts.
MTSN 8635	*Hyperolius glandicolor*	Amphibia	Hyperolidae	Mission, Kindoroko
MTSN 8636	*Hyperolius glandicolor*	Amphibia	Hyperolidae	Mission, Kindoroko
Obs	*Chamaeleo dilepis*	Reptilia	Chamaeleonidae	Mramba, Pare Mts.

Specimen number	Species	Order	Family	Location
Obs	*Dispholidus typus*	Reptilia	Colubridae	Mramba, Pare Mts.
Obs	*Lamprophis fuliginosus*	Reptilia	Colubridae	Mramba, Pare Mts.
Obs	*Rhampholeon kerstenii*	Reptilia	Chamaeleonidae	Mramba, Pare Mts.
Obs	*Rhampholeon kerstenii*	Reptilia	Chamaeleonidae	Mramba, Pare Mts.

Obs = Observation
MTSN = Museo Tridentino di Scienze Naturali, Italy