BIODIVERSITY RESEARCH AND AWARENESS IN THE LESSER-KNOWN EASTERN ARC MOUNTAINS

VOLUME I

MAHENGE MOUNTAINS ULANGA DISTRICT

Nisha Owen, Victoria Wilkins,
Eibleis Fanning & Kim M. Howell (eds.)

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Biodiversity Research and Awareness in the lesser-known Eastern Arc Mountains

Volume I

Mahenge Mountains
Ulanga District

Owen, N., Wilkins, V.,
Fanning, E. & Howell, K.M. (eds.)

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THE CRITICAL ECOSYSTEM PARTNERSHIP FUND (CEPF)

The Critical Ecosystem Partnership Fund is a joint initiative of Conservation International, the Global Environmental Facility, the Government of Japan, the MacArthur Foundation and the World Bank. The CEPF is designed to safeguard the world's threatened biodiversity hotspots in developing countries by providing funding and technical support to civil society.

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The Society for Environmental Exploration and the University of Dar es Salaam have been conducting collaborative research into environmental issues since July 1989 under the title of Frontier Tanzania, one component of which is the Frontier Tanzania Forest Research Programme (FT FRP). Biological field surveys were conducted in the Coastal Forests of Tanzania from 1989 to 1994; in the East Usambara Mountains in collaboration with EUCAMP, Tanga, from 1995 to 2002; in the Udzungwa Mountains in collaboration with MEMA, Iringa, from 1999 to 2001; in the Mahenge Mountains in 2003; in Mpanga/Kipengere Game Reserve in collaboration with WWF-TPO, Dar es Salaam, in 2003; in the Uluguru Mountains in collaboration with CARE-Tanzania, Dar es Salaam, in 2004; and in the Mtwara Coastal Forests, funded by CEPF, Washington, in 2005.

BIODIVERSITY RESEARCH AND AWARENESS IN THE LESSER-KNOWN EASTERN ARC MOUNTAINS (BREAM)

The BREAM project is an initiative of Frontier Tanzania (a collaboration between the Society for Environmental Exploration and the University of Dar es Salaam) in partnership with WWF-Tanzania Program Office, and the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism; in collaboration with Michele Menegon and Francesco Rovero of the Museo Tridentino Di Scienze Naturali, Trento, Italy, and Andrew Perkin of the Nocturnal Primate Research Group, Oxford Brookes University, UK; funded by the Critical Ecosystem Partnership Fund.

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  - BREAM Kiswahili Report: Mahenge Mountains
- BREAM Volume 2: Nguru Mountains, Mvomero District.
  - BREAM Kiswahili Report: Nguru Mountains
- BREAM Volume 3: Rubeho and Ukaguru Mountains, Kilosa District.
  - BREAM Kiswahili Report: Rubeho Mountains
  - BREAM Kiswahili Report: Ukaguru Mountains
- BREAM Volume 4: Methodology Manual.

BREAM Resources
- BREAM Camera Trap Database
- BREAM Nocturnal Mammal Sound Recordings
- BREAM Amphibian Recordings

Consultant Reports
- Ahrends A., Jump A., Lovett J. C., Marchant R. 2006. Vegetation Data Analysis: Mselezi Forest Reserve. York Institute for Tropical Ecosystem Dynamics (KITE), University of York.
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- WWF-TPO. 2007. Capacity Building and Awareness Raising for local communities surrounding Sali and Mselezi Forest Reserves in Ulanga, Morogoro.

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[1] *Note that several of these reports are currently in preparation and will be made available by the completion of the BREAM Project, from the Frontier website www.frontier.ac.uk and the Eastern Arc website www.easternarc.or.tz. Resources will be available by consultation, please contact Frontier Tanzania.*

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LIST OF ABBREVIATIONS AND ACRONYMS

ABRI	African Butterfly Research Institute
BC	Base Camp
BREAM	Biodiversity Research and Awareness in the lesser-known Eastern Arc Mountains
CAP	Community Action Plan
CMEAMF	Conservation and Management of the Eastern Arc Mountain Forests
CEPF	Critical Ecosystem Partnership Fund
CI	Conservation International
CITES	The Convention on International Trade in Endangered Species
CF	Coastal Forests
CP	Centre-Point of the Work Unit
DNRO	District Natural Resources Officer
DCFO	District Catchment Forestry Officer
EAM	Eastern Arc Mountains
EACF	Eastern Arc Mountains and Coastal Forests
EE	Environmental Education
FBD	Forestry and Beekeeping Division
FR	Forest Reserve
FT	Frontier Tanzania
FT FRP	Frontier Tanzania Forest Research Programme
FTEA	Flora of Tropical East Africa
GEF	Global Environment Facility
ICBP	International Council for Bird Preservation (now Birdlife International)
IUCN	The World Conservation Union
JFM	Joint (Participatory) Forest Management
LEAP	List of East African Plants
MNRT	Ministry of Natural Resources and Tourism
MTSN	Museo Tridentino Di Scienze Naturali, Trento, Italy
NPRG	Nocturnal Primate Research Group, Oxford Brookes University, UK
SEE	Society for Environmental Exploration
TFCG	Tanzania Forest Conservation Group
UNDP	United Nations Development Programme
VCCC	Village Community Conservation Committee
VEC	Village Environmental Committee
VEO	Village Executive Officer
WCS	Wildlife Conservation Society
WCST	Wildlife Conservation Society of Tanzania
WU	Work Unit
WWF-TPO	World Wide Fund for Nature – Tanzania Programme Office
WWF-EARPO	World Wide Fund for Nature - East Africa Regional Programme Office
ZS	Zoological Site

REPORT STRUCTURE

This report provides information on Sali and Mselezi forest reserves of the Mahenge Mountains, describing the plant and faunal diversity with species inventories and an assessment of richness, with particular emphasis on endemic and threatened species. It also includes an assessment of human resource use and disturbance in the forests, and details the information gained on community awareness and important issues affecting the local communities with regards to the forest.

The report is comprised of eight main sections, outlined below:

The *Executive Summary* provides an overview of the BREAM surveys in the Mahenge Mountains, Ulanga District, inclusive of key findings.

The *Overview* provides background information on the Eastern Arc Mountains, CEPF, and the BREAM project aims and objectives.

The *Introduction* details background information on the BREAM project in the Mahenge Mountains, Ulanga District, including a brief history of previous research.

The *Methodology* section summarises research methods implemented in this project phase, based around the work unit, a standardised compilation of methods specifically developed for BREAM. For a comprehensive description of methodologies please refer to *BREAM Volume 4: Methodology Manual*.

The sections on Sali FR and Mselezi FR each contain the following sub-sections: *Study Site, Methodology, Results, Discussion, Conclusions and Recommendations, Management Priorities*. The *Study Site* and *Methodology* provide information pertinent to each reserve and the number of work units utilised. The *Results* section reports the findings of survey work within each reserve, detailing Fauna, Vegetation, Human Disturbance and Community Knowledge. The *Discussion* illustrates the important results, highlighting species of conservation concern and human resource use issues. The *Conclusions and Recommendations* section makes management recommendations and summarises findings, and finally lists *Management Priorities*.

The *Mahenge Mountains* section addresses the findings as a whole, comparing the Mahenge Mountain block with other Eastern Arc Mountains and suggesting conservation priorities within this context.

The *Appendices* provide details of the taxonomic verifications, GPS co-ordinates, summaries of data collected, and full species lists for vegetation and fauna.

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1. EXECUTIVE SUMMARY

N. OWEN & V. WILKINS

1.1 STUDY OVERVIEW

Funded by the Critical Ecosystem Partnership Fund (CEPF), the Biodiversity Research and Awareness in the lesser-known Eastern Arc Mountains (BREAM) project is an initiative of Frontier Tanzania (a collaboration between the Society for Environmental Exploration and the University of Dar es Salaam); in partnership with the WWF-Tanzania Program Office and the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism; in collaboration with Missouri Botanical Gardens, USA; Michele Menegon and Francesco Rovero of the Museo Tridentino Di Scienze Naturali, Trento, Italy; and Andrew Perkin of the Nocturnal Primate Research Group, Oxford Brookes University, UK.

The BREAM project is conducting research in five of the lesser-studied of 160 eligible sites within the Eastern Arc Mountains and Coastal Forests of Tanzania and Kenya hotspot (CEPF Ecosystem Profile 2005; since divided into the Eastern Afromontane hotspot and the Coastal Forests hotspot): Sali and Mselezi forest reserves (Mahenge Mountains, Ulanga District; sites 70 & 74); Kanga and Nguru South forest reserves (Nguru Mountains, Mvomero District; site 103); Mamiwa Kisara North and South forest reserves (Ukaguru Mountains, Kilosa District; site 146); Pala Ulanga and Ukwiva forest reserves (Rubeho Mountains, Kilosa District; site 146).

Project Aim: Knowledge of the biodiversity of a number of catchment forest reserves in the Morogoro Region is increased through systematic and intensive biodiversity surveys and human resource use assessments; and preserved through increased environmental awareness within communities in proximity to the reserves in the study area. Sensitisation to the regulations pertaining to catchment forest reserves combined with income generation initiatives will assist in the prevention of further degradation of biodiversity within the selected areas of the hotspot.

Project Objectives: Rapid biodiversity surveys of vegetation and fauna, using systematic survey methodologies, field observations and opportunistic collections to survey small mammals, butterflies, bats, herpetofauna, large mammals, primates, nocturnal mammals, birds and plants. Human resource use assessment and forest disturbance surveys, using systematic survey methodologies, and field observations. Community days and environmental education activities, documenting indigenous knowledge and forest awareness, presenting Frontier Tanzania's work, and recording issues of concern to local peoples. Training of forest officers in systematic survey methodologies and species identification. To collate and disseminate baseline biodiversity and forest disturbance information through the production of reports. Capacity building and initiation of sustainable community forest projects in conjunction with WWF-TPO.

The Mahenge Mountains are situated in south-eastern Tanzania, and are the southernmost isolated outlier of the Eastern Arc Mountains. Covering 2,802.3km^2, they are located at 08°37'–08°38'S 36°42'–36°44'E, and rise from 460-1,500m asl; with the area of remaining forest estimated at 19km^2 (Mbilinyi & Kashaigili 2005). The mountains are bordered by the Kilombero Valley (the largest freshwater wetland at low altitude in East Africa and a recently designated Ramsar site) to the west, separating this mountain block from the Udzungwas; and by the Selous Game Reserve (the largest game reserve in Africa) to the east and south. The Mahenge Mountains are continuous with the Mbarika Mountains to the east, part of the mountain complex located to the north of Lake Nyasa. The Mahenge Mountains are recognised as an important water catchment and natural resource site for the surrounding area.

Table 1: Methodologies employed and summary of survey effort in the Mahenge Mountains (Sali and Mselezi forest reserves)

Survey technique (and sampling unit)	Target	Sali FR sampling effort	Mselezi FR sampling effort
Vegetation			
Vegetation plot (50m x 20m; 12 per work unit)	Trees	24 vegetation plots	12 vegetation plots
Regeneration plot (6m x 6m; 12 per work unit)	Trees	24 regeneration plots	12 regeneration plots
Zoosite vegetation plot (10m x 50m; 3 per work unit)	Trees	3 vegetation plots	3 vegetation plots
Zoosite regeneration plot (6m x 6m; 3 per work unit)	Trees	3 regeneration plots	3 regeneration plots
Opportunistic observation/collection	All plant life forms		
Fauna			
Sherman traps (100 traps x 8 trap-nights per work unit)	Small mammals	1600 trap-nights	800 trap-nights
Bucket pitfall traps (33 buckets x 8 trap-nights per work unit)	Reptiles, amphibians, rodents	528 trap-nights	264 trap-nights
Animal sign transects (4 transects x 1km per work unit)	Larger mammals	8 transects, 8km	4 transects, 4km
Large mammal transects (4 transects x 3.5km per work unit)	Larger mammals	8 transects, 28km	4 transects, 14km
Nocturnal mammal transects (2 transects x no. of hours per work unit)	Nocturnal mammals	14.33 hours	10.3 hours
Camera trapping (10 cameras x no. trap days)	Larger mammals	290 camera trap-days	None
Large mammal and galago traps (opportunistically set)	Larger mammals and galagos	40 trap-nights	15 trap-nights
Bat mist net surveys (net-metre-hours)	Bats	370 net-metre-hours	276 net-metre-hours
Bird mist net surveys (net-metre-hours)	Birds	11,920 net-metre-hours	7,748 net-metre-hours
Bird randomised walks (12 observation hours per work unit)	Birds	24 observation hours	12 observation hours
Visual encounter surveys (quadrats) (16 quadrats x 1 man-hour per work unit)	Reptiles, amphibians	32 man-hours	16 man-hours
Visual encounter surveys (transects) (4 transects x 4 man-hours per work unit)	Reptiles, amphibians	32 man-hours	16 man-hours
Acoustic nocturnal recordings (opportunistically conducted)	Amphibians, nocturnal mammals		
Canopy traps (6 traps x 8 trap-days per work unit)	Butterflies	96 trap-days	48 trap-days
Sweep netting (2 man-hours x 8 days per work unit; 3 veg-plot man-hours per work unit)	Butterflies	38 man-hours	19 man-hours
Opportunistic observation/collection	All animal taxa		
Human Resource Use and Disturbance			
Transects (4 transects x 1km per work unit)	Human disturbance	8 transects, 8km	4 transects, 4km
Opportunistic observation	Human disturbance		
Community Knowledge			
Interviews	Local knowledge	15 interviews	15 interviews
Discussion	Local knowledge		

A range of different methodologies (both systematic and opportunistic) were employed to reach the various objectives (table 1), and in order to enable simple replication they were compiled into a standardised work unit, a 2.2 x 2.2km grid, which was replicated the requisite number of times in proportion to the size of the remaining forested area within the reserve. Each work unit consisted of 1 zoological site (surveying small mammals, bats, nocturnal mammals, birds, herpetofauna and butterflies), 3 zoosite vegetation and regeneration plots, 12 standard vegetation and regeneration plots, 4 disturbance transects, and 4 large mammal transects, laid out surrounding a Centre-Point (CP).

Community days included structured interviews, environmental education in the form of games, a presentation, and a village discussion.

Fieldwork in the Mahenge Mountains, Ulanga District, was conducted in 9 weeks, from 7th October to 9th December 2005. A total of six weeks (two work units) were spent in Sali FR; from 12th October to 29th November 2005. Survey work was conducted from 30th October to 29th November 2005, and the Sali village community day was held on the 24th November 2005. A total of two weeks (one work unit) was spent in Mselezi FR with survey work conducted from 25th November to 9th December 2005. The community day for Mpangayao hamlet and Isongo village was held on the 6th Dec 2005.

1.2 BIODIVERSITY CONSERVATION VALUE

Mahenge Mountains

The limited previous scientific work and incomplete species inventories conducted in the Mahenge Mountains, combined with the small and fragmented areas of forest remaining; mean that Mahenge has ranked low on the list of conservation priorities for the Eastern Arc (CEPF 2005, Burgess *et al.* 2007). Assessments of the Mahenge Mountains previously described the area as containing one single block endemic vertebrate species, one Eastern Arc endemic vertebrate, nine Eastern Arc near endemic vertebrates, and six Eastern Arc endemic trees (Burgess *et al.* 2007; Mariaux & Tilbury 2006). Despite this, as part of the Eastern Arc the Mahenge Mountains were expected to contain many more species of interest and further work was deemed necessary to enable an accurate update and assessment of conservation priority.

This study has significantly improved our knowledge of the Mahenge Mountains and increased the conservation importance of this area, with a greater number of vertebrate and plant endemics that can now be attributed to Mahenge and that represent new records for this mountain block (table 2). The two reserves surveyed demonstrated the diverse nature of the block, which encompasses a range of altitudes.

Table 2: Faunal vertebrate and plant endemics in the Mahenge Mountains: listing previous records (from Burgess et al. (2007); Loader et al.(2003); Lovett et al. (2006); Lovett & Pócs (1993); Tropicos (2007); new records from this survey shown in parentheses; and subsequent new total for the Mahenge Mountains

	FAUNAL VERTEBRATE ENDEMICS				
	Mahenge Mtn Endemics	**EA Endemics**	**Near Endemics**	**Total Endemics**	**PLANT ENDEMICS**
Previous surveys	1	1	9	11	31
BREAM	7 (6)	7 (6)	22† (11)	36 (23)	17 (10)
New Mahenge total	7	7	22	36	41

†This includes two species that were not classed as near endemics in Burgess *et al.* (2007) but that leading experts in the field have now reclassified. For comparison purposes with other mountain blocks using figures from Burgess *et al.* (2007) these two species are excluded.

Comparing the Mahenge Mountains with other Eastern Arc Mountain blocks using figures and methods from Burgess *et al.* (2007) illustrates the dramatic increase in conservation importance of the Mahenge Mountains based on results from this survey.

Considering numbers of endemic vertebrates (36 species; 14.4%; 7 strict endemics, 7 Eastern Arc endemics and 22 near endemics; including the discovery of up to six species that are new to science), Mahenge rises to seventh most important; but incorporating a measure of forest area into ranking analyses raises the Mahenge Mountains to fourth most important Eastern Arc mountain block (after the Ulugurus, East Usambaras and Udzungwas). For threatened vertebrate species the Mahenge Mountains rises to fifth most important from twelfth. For endemic butterflies the Mahenge Mountains rises to second most important after the Rubehos.

Mahenge holds 22 endemic tree species, representing just over a third of all Eastern Arc endemic trees. Once forest area is corrected for Mahenge becomes second in terms of biological importance for Eastern Arc endemic tree species, only less significant than the East Usambaras. This is reiterated by the high number of endemics of other plant life forms as well as numbers of Potentially Threatened and Red Listed plant species. The fact that reserves within the Mahenge Mountains are at a range of altitudinal habitats gives potential for the block to harbour numerous endemic plants.

The research conducted in Sali and Mselezi forest reserves provides a concrete baseline dataset for monitoring purposes, enabling future assessments of changes in biodiversity values and human resource use over time, as well as furthering scientific knowledge of the Eastern Arc as a whole.

Further research is necessary as thorough and comprehensive botanical and faunal surveys of the other forest reserves in the Mahenge Mountain block will produce a clearer picture of the importance of the block relative to the others. Conservation of the remaining Mahenge Mountain forests is vital to the preservation of the endemic and newly discovered species found in this mountain block. The majority of the species of conservation concern were recorded solely from Sali FR making this a priority site within the Mahenge Mountains; but although Mselezi FR was less diverse the species documented therein are also worthy of scientific interest and conservation concern.

Sali Forest Reserve

Sali FR hosts a high diversity and richness of species for its small size, with an impressive degree of endemism along with the discovery of several species new to science. The pristine nature of the forest is solely a result of the remoteness and inaccessibility of the reserve. This tiny isolated pocket of forest is a last refuge for many Mahenge endemics, fragmented enough for mountain block speciation to have occurred but also important as a migratory corridor between two areas noted as harbouring significant populations of large mammals. This rich diversity of fauna, particularly herpetofauna, and high proportion of endemics, threatened species and forest-dependents, highlights Sali FR as an area of conservation importance and worthy of further research. Sali FR hosts a total of 22 new records of vertebrate endemics including potentially six vertebrate species new to science (one lizard *Cnemaspis sp. nov*, one chameleon *Kinyongia sp. nov?*; four amphibians *Callulina sp. nov, Probreviceps sp. nov., Hoplophryne sp. nov., Nectophrynoides sp. nov. 2*).

A high number of threatened and endemic species were recorded for all plant life forms, which included 16% of Eastern Arc tree endemics, and a total of 18 species of conservation concern. The tree species *Sibangea pleioneura* was recorded here, only previously recorded in the Udzungwa Mountains; and the Mahenge endemic *Peddiea lanceolata* was also documented. Other plant life forms included four species of conservation concern. Most tree species recorded were either montane or lowland/montane with a high proportion of forest specialists; the most predominant plant community was *undifferentiated (sub) montane forest*, reinforcing the largely untouched nature of the reserve.

Mselezi Forest Reserve

Mselezi FR is severely degraded and under serious threat from human disturbance. This has impacted negatively on the wildlife present in the forest, with generally low species richness across several faunal taxa. Despite this, several Eastern Arc endemics and near endemics are still present and conservation measures should focus on these. Additionally, the results of research into the hyrax population at this site have shown the presence of both tree hyrax *Dendrohyrax validus* (Eastern Arc near endemic; the only known record of this species in the Mahenge Mountains) and bush hyrax *Heterohyrax cf. brucei*. Mselezi FR is the first known locality where these two species associate closely. The large numbers of both species provides a unique opportunity to study the ecological and behavioural differentiation of hyrax species occurring sympatrically. In addition to this species, Mselezi hosts six new records of endemic vertebrates (also recorded in Sali FR) including a new species of gecko *Cnemaspis sp. nov.*

Mselezi FR consists of highly disturbed and fragmented mixed woodland, with the two dominant plant communities being dense closed canopy woodland and dry open canopy woodland, interspersed by anthropogenically altered vegetation. The remaining dense closed canopy woodland was isolated to areas of high altitude, steep slopes and rocky outcrops. Most trees found in the reserve are lowland species with some lowland/montane species present, and very few were forest specialists. Despite its lowland nature and the substantial levels of current and previous disturbance, Mselezi FR contained a high level of plant diversity and richness; hosting seven plant taxa of conservation concern including the IUCN Vulnerable near endemic *Lettowianthus stellatus*, which was the second most abundant tree species present in the reserve. Mselezi is also of interest as a transitional area between the lowland Coastal Forests and montane Eastern Arc, further research in the reserve may help clarify the relationship between the two areas.

1.3 HUMAN RESOURCE USE AND DISTURBANCE

The growing human population within the Mahenge Mountains is resulting in an increased demand on natural resources. Many of the problems faced by these reserves are typical of those pressuring other Eastern Arc forest reserves, such as the lack of investment in local communities and law enforcement.

Sali FR was generally undisturbed as it is presently remote enough to hinder most illegal activities. However the reserve is beginning to show signs of disturbance with the highest quality forest found at higher altitudes. Work Unit 1 of the survey work, which had more human access, showed lower tree species richness, fewer tree species of conservation concern and less regeneration of canopy species in comparison to Work Unit 2 which was more isolated. Analysis also showed areas with a water association to have signs of disturbance, but it was unclear whether this was due to human association with water presence or the water body creating disturbance. The majority of human disturbance noted was hunting (snares) and fire damage, with little wood extraction. The main threat is from hunting, with populations of forest antelopes potentially under stress from high hunting pressures. This is particularly important since the interviews reported that certain species have seen declines in recent years. Wood extraction in the reserve is currently negligible, but this could be a potential future issue which can be avoided through protecting and maintaining current local sources of poles and timbers. Fire damage within the reserve at the time of surveying was at a localised level; however the destructive capacity of fire makes it a very serious issue which needs to be addressed.

Human disturbance in Mselezi FR is intense and widespread, the most critical problems being fire damage, cultivation, trapping and pole and timber extraction. This is facilitated by the structure of the reserve, as a well used road runs directly through the centre of the reserve; the settlement of Mpangayao borders this road and encroaches into the forest. Clearance and fire damage has left large areas of dry scrub and thickets. Fire damage is the biggest threat throughout the reserve, and has led to fragmentation and loss of much of the forest. Although hunting was relatively low this is probably due to the low levels of target species populations due to previous hunting pressures; and continued hunting threatens to drive many of these species to extinction. Timber production is currently extremely intensive with several caches of timber planks found during field work, supplying an external market aided by local people. Target timber species have already been depleted at lower altitudes, pushing timber extraction to higher altitudes. There is confusion within the community about the location of the reserve boundaries, arising from the initial establishment of the reserve in 1954 which excluded the valley floor. After a variation order in 1982 the valley floor was then included within the boundaries of the FR. Many of the villagers do not realise there has been a change in forest boundaries and continue to utilise the area, unaware that they are infringing more and more into the forest reserve. Without awareness raising of these issues, Mselezi FR is likely to be lost in the not too distant future, a sentiment echoed by many of the villagers. However due to the heavily degraded and fragmented nature of the forest rapid and effective conservation measures are needed to facilitate preservation of those important species still present. The potential of the reserve to regenerate as high quality secondary forest is unclear as there is a lack of research in this area but replanting could be initiated utilising species present in the reserve. Immediate action is also needed to prevent illegal exploitation and facilitate sustainable resource use policies within the local communities.

1.4 COMMUNITY KNOWLEDGE

The communities in the Mahenge Mountains surrounding both Sali and Mselezi FRs are enthusiastic to learn more about the importance of their forests. A common trend appears to be that the management and protection of the reserve by local communities is suppressed by a lack of resources. Currently, no local livelihoods rely directly on the forests remaining in a pristine state, meaning there is little economic incentive for community participation. Communities have expressed a desire for additional support to help with management; better communication facilities to allow prosecution of those who break the law; and also training and awareness raising to increase understanding of the participatory management process. Although local people appreciate that the forest needs protecting, there is still some confusion over the purpose of the reserve, therefore environmental education to raise awareness of the importance of catchment forest reserves is essential.

Communities surrounding Sali FR were keen to participate in the JFM scheme, yet the communities surrounding Mselezi FR appeared disillusioned with the lack of support they had received in implementing the JFM contract.

Additionally in Mselezi FR, it is claimed that the lack of support and funding provided to the Environmental Committee is currently preventing effective management and protection of the reserve. The community is aware of the degradation of the forest reserve but feels that without support it is unable to stop the destruction. The community requested more environmental education and awareness raising in order to allow them to understand and manage the forest better. People in the community do want to see the forest preserved but feel that they do not have the resources or expertise to ensure that this happens. The community was aware that in another 10 years, there will be little remaining forest in Mselezi FR, and it was acknowledged by the local community that illegal timber extraction, fire damage, hunting and the growing population of the village are all contributing to the loss of the forest. The community felt that people should think of the next generation and so should be protecting their natural resources.

1.5 MANAGEMENT PRIORITIES

Current management priorities for the Mahenge Mountains should include environmental education, boundary demarcation, and the implementation of the Joint Forest Management scheme, applied in current contracts and expanded to other forest reserves in the area. Management plans need to involve and be developed in conjunction with the local communities, to reduce illegal activities and provide alternative resources in order to address current conservation issues, as initiated by the WWF-TPO capacity building workshop. This is a first step in raising awareness among local communities and generating interest, involvement and incentives on their part to conserve, protect and sustainably manage their forest reserves and resources.

The Joint Forest Management scheme has admirable aims and if implemented correctly should achieve a significant level of success. However, the current JFM contract for Mselezi FR has not put into place any conservation or management measures due to a lack of support by government representatives and a lack of understanding regarding its meaning and implementation within the local community. It has been suggested that one reason for this is the lack of financing for forest officers to visit outlying forest reserves and their peripheral communities, which is vital if these officers are to provide advice, education, support and law enforcement. After the WWF-TPO capacity building workshop, FBD agreed to station dedicated Forestry Officers at each village to facilitate this.

In terms of conservation priorities, Sali FR offers most potential for successful conservation of the widest range of Eastern Arc species. The surveys in Sali FR have been conducted before human resource use and disturbance have grown to significant levels, providing an exceptional opportunity to conserve this forest and maintain its pristine nature. There may even be some scope for limited and regulated eco-tourism in Sali FR, which is pristine forest with spectacular scenery, gigantic trees and opportunities to spot wildlife.

Although very few species of conservation concern were found in Mselezi FR alone, species of conservation concern confined to lower altitude Eastern Arc forest reserves are more vulnerable to disturbance and therefore more conservation efforts are needed to preserve these reserves; to ensure that a range of altitudinal Eastern Arc forests and their associated species are conserved. In addition, the association between the hyrax species and the fact that the reserve is a transitional state between coastal and montane forest provides an incentive for further research and conservation. However, conservation measures may be too late for Mselezi FR, which has been exploited almost beyond redemption. Nevertheless there is potential for Mselezi to be the basis for a pilot forest regeneration project as part of the JFM scheme. The interesting biodiversity findings in Mselezi and the human need for this catchment forest to be preserved for the environmental services it offers does mean that conservation of this area continues to be a necessity and immediate action needs to be taken to ensure this forest has a future. The following lists Management Recommendations for both Sali and Mselezi FRs based on this study's findings.

1. **Boundary reassessment and clear demarcation of both forest reserves** are required to remove ambiguities over boundary location and prevent encroachment. This is particularly important considering the variation order initiated on Mselezi FR, of which local communities are unaware. At present, the boundaries perceived by residents are very different to those defined on land cover and land use maps, and not all forest officers are aware of these discontinuities. A priority should be defining the boundaries close to villages surrounding the reserves, particularly at Mpangayao hamlet.
2. **Resettlement of people located within Mselezi FR** may be necessary in conjunction with the first recommendation to fully enforce reserve boundaries. However, suitable compensation will need to be paid to these people and an alternative home provided for this to be an acceptable solution. Should resettlement not be an option, human expansion in Mpanganyao hamlet must be monitored by FBD to ensure settlements and cultivation do not expand past permitted areas into the forest reserve, and that current cultivation within the reserve is curtailed.
3. **Achievable management plans** need to be developed and **adequate budgets allocated** for their implementation and for law enforcement, as well as for supporting the local community to enable implementation of the JFM schemes. WWF-TPO conducted a workshop as part of the capacity building component of this project, facilitating the preparation of management plans by the communities surrounding the reserve (appendix 11e). However this will need to be supported and maintained by Catchment Forestry Officers.
4. **Assist the Village Environmental Committees** to establish bylaws to address and act on conservation management issues. Support in the enforcing of bylaws and empowerment will be necessary to facilitate disciplinary measures to combat illegal exploitation, such as introducing the use of fines. Financial support and professional training for the Environmental Committee should be a priority as without support or resources the committees are currently frustrated and ineffective.
5. **Patrols** should be conducted by Forest Officers in conjunction with the village Environmental Committees, and carried out on a regular basis to control illegal activities, particularly in relation to hunting as well as encouraging local people to report any illegal activities they witness. Financial support will be necessary to supply adequate equipment to the Environmental Committee.
6. **Support for the prosecution of illegal activities** through improved communication channels between the Environmental Committee and prosecuting authorities; as well establishing protocols for reporting illegal activities both within the village and externally.
7. **Improved liaisons** between the local Forestry Officer and the villages of Sali and Mpangayao. This would allow the communities to highlight problems, and the Forestry Officer to provide guidance and support; as well as being an opportunity to facilitate funding applications for community projects such as a tree nursery, new cottage industries etc. The Forestry Officer would have to be provided with adequate funds to ensure regular meetings.

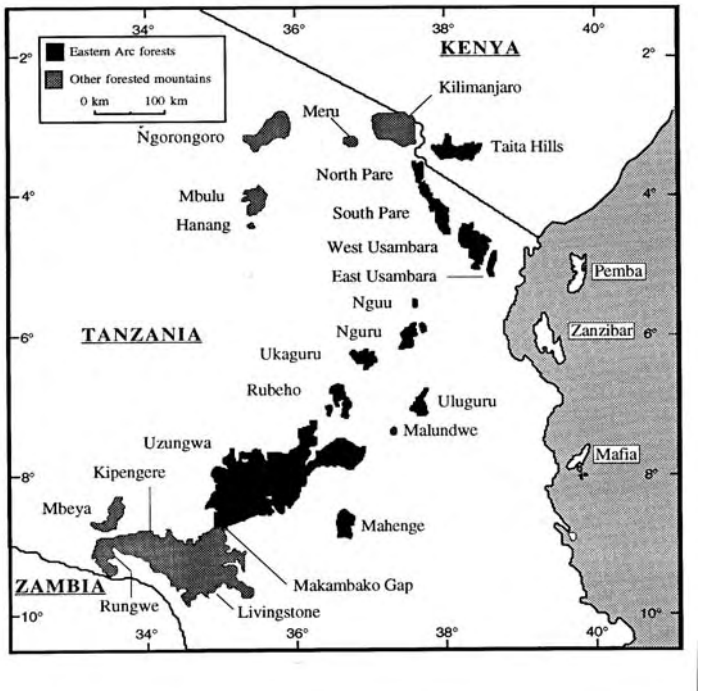
8. **Regeneration of Mselezi FR** through tree planting to replace disturbed land with tree species that were formerly present and to reduce encroachment by scrub and dry forest species. Tree planting outside the borders of the reserve would also create a buffer zone around the reserve and facilitate the provision of alternative resources specified in Recommendation 9. The establishment of successful tree nurseries could also provide potential business opportunities in the community.
9. **Provide alternative resources for sustainable use** through planting tree species in village areas that can be set aside for village use. Sustainable resource use and practices here must be encouraged. Planting could include quick growing tree species to meet demands for firewood and timber (Rodgers & Burgess 2000), and plant species commonly used for food and medicine. Sustainable hunting of locally abundant species could also be encouraged in these areas, with education to designate quotas and sustainable practices.
10. **Conduct environmental education and awareness raising** about the boundaries of the forest reserves; its importance for the protection of water sources, soil and biodiversity; and the negative effects of human disturbance, including practical advice on controlling activities that can cause damage, for example using firebreaks to limit fires, and addressing the impact of poaching. Education in schools is particularly important, targeting future generations as well as being a resource to apply schemes such as tree planting. Teachers should be encouraged to use the forest and the natural environment in their lessons and to teach the importance of the forest and its resources, especially the traditional uses of forest plants.
11. **Investment in rural development** in the impoverished communities surrounding the forest reserves is necessary to establish essential services and infrastructures, and to help ensure effective and sustainable use of other natural resources in order to alleviate their dependence on the forest reserve. Alternative sources of income should be encouraged to deflect dependence away from the forest reserves. This could be achieved through cottage industries such as bee keeping, the growing of saleable crops and jewellery making.

2. OVERVIEW

N. OWEN & P. RUBIO

2.1 THE EASTERN ARC MOUNTAINS

The Eastern Arc is a chain of geologically ancient crystalline mountains, stretching from south-east Kenya through eastern Tanzania (Lovett 1985; fig. 1). Influenced by the Indian Ocean climatic regime (Lovett 1988; 1990; 1993), the mountains are made up of thirteen separate blocks, from the Taita Hills in Kenya to the Makambako Gap south-west of the Udzungwa Mountains in southern Tanzania (Lovett & Wasser 1993). From south to north, these consist of: Udzungwa, Mahenge, Malundwe, Rubeho, Ukaguru, Uluguru, Nguru, Nguu, East Usambara, West Usambara, South Pare, North Pare and Taita Hills; with the highest point reaching over 2,600m asl (Kimhandu Peak in the Ulugurus). Nationally, the Eastern Arc Mountains are a vital water catchment area, supplying water throughout the region, including the major cities of Dar es Salaam, Morogoro, Iringa, Chalinze and Tanga.



The mountains are formed mainly of block-faulted Pre-Cambrian basement rocks uplifted around 100 million years ago, and the Indian Ocean climate produces high rainfall on the east-facing side (e.g. 3,000mm/year on the eastern slopes of the Ulugurus and 600 mm/year on the western slopes), supporting the montane forests. Once heavily forested, the original forest cover was estimated at 23,000km^2 2,000 years ago (Newmark 1998), but now less than 30% of the original forest remains with estimates of only 3,000-5,000km^2 dispersed throughout the mountain range, primarily on the less-accessible mountain-tops (Mbilinyi & Kashaigili 2005).

Figure 1: Map of the Eastern Arc Mountains that support moist forest, shown in black (Lovett 1993)

Isolated for millions of years, the Eastern Arc Mountains are recognised globally for their rich biodiversity and endemic species (Brooks *et al.* 2001, 2002; Lovett 1998a, b, c; Myers 1990; Myers *et al.* 2000), holding the highest number of endemic plant and vertebrate species per unit area in the world (Myers *et al.* 2000). Ninety-seven vertebrate species have been recognised to date as strict endemics to these mountains, confined to fragmented and isolated forests, montane grasslands and wetlands: 20 species of birds, 10 species of mammals, 29 species of reptiles and 38 species of amphibians, with more than 10 additional species in the process of being described (Burgess *et al.* 2007). Another 71 species are near endemics, found either in the adjacent montane forests of the Southern Rift (southern Tanzania to Malawi, Mozambique and Zimbabwe) or in the north (from Mt. Hanang north to the Kenyan highlands), or the lowland Coastal Forests. Currently, 72 of these endemic or near endemic species are threatened by extinction (8 Critical, 27 Endangered and 36 Vulnerable; IUCN 2005) with seven more wide-ranging species also threatened. Of the over 2,000 plant species in the Eastern Arc, 800-1,500 are estimated to be endemic (Burgess *et al.* 2007; Lovett & Wasser 1993; Lovett 1998b; Mittermeier *et al.* 1998, Myers 1988; 1990; Myers *et al.* 2000).

Part of the uniqueness of this area is attributed to the presence of ancient (and possibly contiguous) forest cover, allowing the accumulation and survival of taxa with ancient affinities with West Africa, Madagascar, S. America and S.E. Asia (Burgess *et al.* 1998a; Fjeldså 1994; Fjeldså & Lovett 1997; Lovett & Wasser 1993; Lovett *et al.* 2004) combined with local speciation and evolution of taxa in fragmented forest blocks (Burgess *et al.* 1998b; Roy *et al.* 1997). It is also thought that the Indian Ocean monsoon climatic regime has enabled the eastern coastal areas to maintain stable and warm conditions for at least the past 30 million years (Axelrod & Raven 1978), contributing to the survival of these taxa (Fjeldså *et al.* 1997).

The Eastern Arc faces a range of threats stemming from the growing and impoverished human population within the region combined with a lack of resources to enforce protection and encourage sustainable use. Main threats include commercial and subsistence agriculture (cultivation, grazing) and wood extraction (timber, fuel, charcoal), as well as fire damage, hunting, mining and unauthorised settlement. This occurs despite most of the remaining forest being found within government forest reserves, some of which are important for water catchment and thus permit no legal exploitation. Assessment of levels of threat has illustrated that the Eastern Arc is one of the most endangered regions of global biodiversity significance, vulnerable to an increasing risk of plant and vertebrate extinction, and likely to suffer the highest loss of species per unit area (Balmford 2001a, b; Brooks *et al.* 2002).

This combination of high endemicity and degree of threat has led to the Eastern Arc Mountains being recognised as one of 25 global Biodiversity Hotspots designated by Conservation International (originally part of the Eastern Arc and Coastal Forests of Tanzania and Kenya hotspot but this was recently split and the Eastern Arc designated as part of the Eastern Afromontane Biodiversity Hotspot; CEPF 2005; Mittermeier *et al.* 2004; Myers *et al.* 2000). It has also been highlighted as an Endemic Bird Area by Birdlife International (ICBP 1992; Stattersfield *et al.* 1998); an Important Bird Area (Baker & Baker 2002); a Globally Important Ecoregion by WWF (Burgess *et al.* 2004a, b; Olson & Dinerstein 1998); and it has been termed one of 11 "hyperhot" priorities for conservation investment (Mittermeier *et al.* 2004).

2.2 BIODIVERSITY RESEARCH AND AWARENESS IN THE LESSER-KNOWN EASTERN ARC MOUNTAINS (BREAM) PROJECT

In the last 30 years there has been a surge of interest in the Eastern Arc Mountains as the international community has recognised the global biodiversity significance of this region, along with the threat these tropical forests face. Many of the Eastern Arc mountain blocks have been the subject of recent research, documenting new endemic species and highlighting conservation priorities, although the faunal inventories of all Eastern Arc mountain blocks are still incomplete.

Funded by the Critical Ecosystem Partnership Fund (CEPF), the Biodiversity Research and Awareness in the lesser-known Eastern Arc Mountains (BREAM) project is an initiative of Frontier Tanzania (a collaboration between the Society for Environmental Exploration and the University of Dar es Salaam) in partnership with the WWF-Tanzania Program Office and the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism; in collaboration with Missouri Botanical Gardens, USA; Michele Menegon and Francesco Rovero of the Museo Tridentino Di Scienze Naturali, Trento, Italy; and Andrew Perkin of the Nocturnal Primate Research Group, Oxford Brookes University, UK. The aim is to conduct biodiversity surveys, human resource use assessments and environmental education in forest reserves that remain under-studied in the Eastern Arc Mountains.

The BREAM project is conducting research in five of the lesser-studied 160 eligible sites within the hotspot (CEPF Ecosystem Profile 2005; table 3): Sali and Mselezi forest reserves (Mahenge Mountains, Ulanga District; sites 70 & 74); Kanga and Nguru South forest reserves (Nguru Mountains, Mvomero District; site 103); Mamiwa Kisara North and South forest reserves (Ukaguru Mountains, Kilosa District; site 146); Pala Ulanga and Ukwiva forest reserves (Rubeho Mountains, Kilosa District; site 146).

Specific aims and objectives of this project were defined in the CEPF Project Proposal as:

AIM

Knowledge of the biodiversity of a number of catchment forest reserves in the Morogoro Region is increased through systematic and intensive biodiversity surveys and human resource use assessments; and preserved through increased environmental awareness within communities in proximity to the reserves in the study area. Sensitisation to the regulations pertaining to catchment forest reserves combined with income generation initiatives will assist in the prevention of further degradation of biodiversity within the selected areas of the hotspot.

Table 3: List of forest reserves to be surveyed in the BREAM project

Catchment Forest Reserve	District	Mountain Range	Map Reference	Size (ha)	Output number
Mselezi	Ulanga	Mahenge	8º46' – 8º52 (S), 36º43' 36º44' (E)	2,245	1
Sali			8º54' – 8º57' (S), 36º37' – 36º41' (E)	1,890	
Kanga	Mvomero	Nguru	37º19' – 6º21' (S), 35º57' – 36º57' – 36º59' (E)	6,664	2
Nguru South			6º01' – 6º13' (S), 37º26' – 37º37' (E)	18,793	
Mamiwa Kisara North	Kilosa	Ukaguru	6º21' – 6º30' (S), 36º53' – 37º03' (E)	8,203	3
Mamiwa Kisara South			6º26' – 6º35' (S), 36º54' – 37º00' (E)	6,266	
Pala Ulanga	Kilosa	Rubeho	7º12' – 7º22' (S), 36º47' – 36º50' (E)	10,610	
Ukwiva			6º58' - 7º21' (S) 36º34' - 36º51' (E)	54,635	

OBJECTIVES

1. Rapid biodiversity surveys of vegetation and fauna, using systematic survey methodologies, field observations and opportunistic collections to survey small mammals, butterflies, bats, herpetofauna, large mammals, primates, nocturnal mammals, birds and plants.
The results of this research will enable compilation of comprehensive species lists, assessment of species richness and diversity, identification of species distributions, as well as providing baseline information for future monitoring and information on the biological value of the forests.

2. Human resource use assessment and forest disturbance surveys, using systematic survey methodologies and field observations.
Analysis of human disturbance and resource use will quantify the extent of anthropogenic use and threats to the forest, generate information relevant to the development of management recommendations and highlight urgent issues that need to be addressed.

3. Community days and environmental education, documenting indigenous knowledge and forest awareness, presenting Frontier Tanzania's work, and recording issues of concern to local peoples.
Raising community environmental awareness will contribute to decreasing illegal unsustainable activities such as poaching and timber extraction and generate an appreciation of the forest resources, while highlighting areas in which the community needs support. Collation of community knowledge will produce a historical and present-day record of the utilisation of forest resources and changes in the forest over time.

4. Training of forest officers in systematic survey methodologies and species identification.
This will help to improve enforcement of the forest reserve regulations, and better direct conservation management through increased knowledge of biodiversity and monitoring techniques.

5. To collate and disseminate baseline biodiversity and forest disturbance information through the production of reports. Data and Technical Reports will be contributed to the Biodiversity Database of the Department of Zoology and Marine Biology, UDSM; the CEPF Conservation Outcomes database; the TROPICOS database of Missouri Botanical Gardens; the IUCN Red List process; and the Forest and Beekeeping Division database through the Monitoring and Evaluation Unit. A Swahili summary of findings will also be made available to local communities participating in BREAM community days.

6. Capacity building, initiation of sustainable community forest projects and the development of Community Action Plans (CAPs) in conjunction with WWF-TPO. WWF-TPO will organise capacity building and training workshops for village leaders and other stakeholders based on the research findings, as well as environmental education workshops for school teachers. In particular WWF-TPO will train communities on energy-efficient stove construction and provide the necessary materials, reducing the demand for firewood and hence the strain on natural resources in these communities; facilitate the development of CAPs for forest management and conservation; and facilitate funding applications for communities under the CEPF Small Grants scheme.

2.3 THE CRITICAL ECOSYSTEM PARTNERSHIP FUND (CEPF)

The Critical Ecosystem Partnership Fund (CEPF) is designed to safeguard the world's threatened biodiversity hotspots in developing countries. It is a joint initiative of Conservation International (CI), the Global Environment Facility (GEF), the Government of Japan, the MacArthur Foundation and the World Bank. CEPF supports projects in hotspots, the biologically richest and most endangered areas on earth. A fundamental purpose of CEPF is to ensure that civil society is engaged in efforts to conserve biodiversity in the hotspots. An additional purpose is to ensure that those efforts complement existing strategies and frameworks established by local, regional and national governments. A current focus is on conserving the Eastern Afromontane hotspot and the Coastal Forests hotspot (originally the Eastern Arc and Coastal Forests hotspot) and the globally threatened species found therein. The EACF region was approved for grant funding in July 2003 and active grant making started in January 2004. The total allocation is $7 million to:

- Increase the ability of local populations to benefit from and contribute to biodiversity conservation,
- Restore and increase connectivity among fragmented forest patches in the hotspot,
- Improve biological knowledge in all 160 eligible sites in the hotspot,
- Establish a small grants programme in the hotspot that focuses on critically endangered species, and small-scale initiatives to increase connectivity of biologically important habitat patches,
- Develop and support efforts for further fundraising for the hotspot.

2.4 THE FRONTIER TANZANIA FOREST RESEARCH PROGRAMME (FT FRP)

Established since 1989, Frontier Tanzania is a collaboration between the Society for Environmental Exploration and the University of Dar es Salaam. Frontier Tanzania has been conducting baseline biodiversity surveys of the Eastern Arc and Coastal Forests since inception, with a wealth of technical reports published from work in the Coastal Forests and the following Eastern Arc Mountains: East Usambaras, Udzungwas, Mahenge and the Ulugurus[2].

Work in the East Usambaras and Ulugurus enabled the development of an effective, systematic and cost-effective methodology for conducting baseline biodiversity surveys and human resource use assessment. The methods used in this study have been based on this and is comprehensively documented in *BREAM Volume 4: Methodology Manual*, of this series of project reports.

Frontier Tanzania provides information and recommendations from their research to the Catchment Forest Project of the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism, as well as providing training to Forest Officers in survey techniques to build capacity for monitoring and protection. The aim of the FT FRP is to conduct baseline research in lesser-known areas within the Eastern Arc Mountains, helping to further scientific knowledge, identify conservation priorities and facilitate development of effective management plans.

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[2] *A list of all Frontier publications can be found at www.frontier.ac.uk. Selected reports are available to download.*

3. INTRODUCTION

N. OWEN

3.1 THE MAHENGE MOUNTAINS

The Mahenge Mountains are situated in south-eastern Tanzania, and are the southernmost isolated outlier of the Eastern Arc Mountains (fig. 1). Covering 2,802.3km^2, they are located at 08°37'–08°38'S 36°42'–36°44'E; and rise from 460-1,500m asl. The mountains are bordered by the Kilombero Valley (the largest freshwater wetland at low altitude in East Africa and a recently designated Ramsar site) to the west, separating this mountain block from the Udzungwas; and by the Selous Game Reserve (the largest game reserve in Africa) to the east and south. The Mahenge Mountains are continuous with the Mbarika Mountains to the east, part of the mountain complex located to the north of Lake Nyasa. The Mahenge Mountains are recognised as an important water catchment and natural resource site for the surrounding area. The growing human population within the Mahenge Mountains (currently standing at circa 32,000) has significantly encroached into the forested areas, and Mahenge has been severely affected by loss of habitat. The mountains are estimated to have lost 89% of their original forest cover (Newmark 1998), although the rate of loss appears to have declined dramatically in the last few decades (annex 1 fig. 59a). Various estimates have been made of the remaining forest area, achieved through a variety of methods: 291km^2 (Newmark 2002), 5km^2 (ground surveys: Lovett and Pócs 1993; Frontier Tanzania 2001, 2004a, 2004b), with the latest estimate standing at 19km^2 (Mbilinyi & Kashaigili 2005) from satellite imagery and ground-truthing. The Mahenge Mountains straddle two plant eco-regions, the Eastern Arc Forest and the Northern Zanzibar-Inhambane Coastal Forest Mosaic (Burgess *et al.* 2004b; equivalent in part to the Conservation International Coastal Forests Hotspot; CEPF 2005).

Eight forest reserves are located in the Ulanga District, Morogoro Region; seven of these are sited on the Mahenge Mountains, under the jurisdiction of Catchment Forest, a sub-division of the Forestry and Beekeeping Division of the Ministry for Natural Resources and Tourism. Reserve management is co-ordinated by the Catchment Forest Regional Headquarters in Morogoro, and administered by the Ulanga District Office. Six of the forest reserves form the main part of the mountains: Mahenge Scarp, Nawenge, Mselezi, Myoe, Muhulu and Sali. Ligamba FR is an outlying reserve that covers a hilltop south-west of the main mountain range. An additional forest reserve in Ulanga that is not considered part of the Mahenge Mountains is Nambiga FR, an area of groundwater forest located to the west. Excluding the latter, together they cover 49.6km^2 (4,956ha) of the Mahenge Mountains.

Ulanga District has an annual operational budget of TSh4million, excluding salaries; the second lowest funded of the 14 Districts within Tanzania (after Mpwapwa with TSh1.3million for the management of four forest reserves); the highest funded District is Morogoro with TSh84.5 million for eight forest reserves (Burgess & Kilihama 2005). Ulanga District employs 18 Catchment Forest Officers, responsible for the management of the forest reserves; Mpwapwa District has 5 while Morogoro District has 42 (Burgess & Kilihama 2005). The ecology and location of forest reserves in Ulanga District is a result of the Tanzanian Government's gazettement of forest areas on the basis of their water catchment value. Management strategies for catchment forest reserves (where these exist) are primarily based on the need to protect water supplies rather than specifically for biodiversity conservation. However, biodiversity conservation and the preservation of water catchments are mutually compatible to the extent that both rely on the prevention of deforestation and illegal exploitation of forest reserve resources.

Currently, government policy permits no legal resource extraction in catchment forest reserves, but the most significant current threats are from fire, extraction of wood products and agricultural encroachment. A history of licensed exploitation combined with poor regulation has been a continuing threat to the reserves in Ulanga District. Government licenses were granted for logging in all Ulanga District forest reserves in the 1970s and 1980s, but limited resources for regulation could not prevent harvesting of illegal timber products. Licenses were revoked in 1993, yet illegal logging continues,

particularly in those forest reserves closest to human settlements. Charcoal production is licensed in non-reserve forests, but insufficient resources for adequate regulation means that unlicensed charcoal (including that from within forest reserves) is also produced. A low level of employment also fuels the demand for cheap forest products and provides the manpower for illegal activities. Illegal farm expansion is a major cause of deforestation within many Ulanga District forest reserves; such as in Nambiga and Mahenge Scarp forest reserves, where farms of peripheral settlements encroach into the reserve; and in Nawenge and Mselezi forest reserves where farms of villages within the reserves expand beyond permitted areas. The most significant threat to these forest reserves is the escalating demand for natural resources by a rapidly growing local population, thus proximity to human settlement is recognised by Catchment as the main indicator of level of threat to a forest reserve. Exploitation therefore affects some reserves more than others, particularly those with peripheral or included settlement.

The Joint Forest Management (JFM) scheme has been implemented in Nawenge and Mselezi forest reserves, giving local communities responsibility for managing their reserves under supervision and with the assistance of FBD; with the aim of reducing illegal activities through education and incentives for self-regulation.

The BREAM project conducted research in Sali and Mselezi forest reserves (annex 1 fig. 59a). Mselezi FR covers an important local catchment and ranked high on the list of management priorities in the 1993 catchment forest reserves assessment (Lovett & Pócs 1993), being under pressure from encroachment, ruby mining, logging and fire, and part of the Joint Forest Management scheme. Sali was acknowledged as being a remote catchment and not under great pressure, although the presence of encroachment, pitsawing and fire damage was reported. Both these reserves warranted surveying to assess the level of biological endemism, and to prioritise conservation initiatives for the Eastern Arc Mountains in light of the increasing human pressure on reserve resources.

3.2 PREVIOUS RESEARCH

Until the early 1990's, the Mahenge Mountains were considered to be 'hardly explored…in urgent need of biological inventory' (Rodgers 1993). Since then, there has been some work in the larger reserves although there has still not been much comprehensive and systematic surveying of the area. Parts of the Mahenge Mountains were the focus of research by Frontier Tanzania, covering Nawenge FR (Frontier Tanzania 2004a), Mahenge Scarp FR (Frontier Tanzania 2004b), and Nambiga FR (Frontier Tanzania 2001). A botanical appraisal of catchment forest reserves conducted in 1993 (Lovett & Pócs) provides information on the region and each forest reserve. Rees (1964) produced a checklist of mammals and amphibians of the Ulanga District, this however does not clarify which species were recorded in the Mahenge Mountains, and includes many lowland species from the Selous Game Reserve and the Kilombero Valley. Sali FR has been the subject of some surveying for herpetofauna and small mammals in the 1960s (Rees 1964; Poynton 1977, 1991, 2003) but with little associated botanical and habitat research. The herpetofauna species inventory was recently updated, in a short study focusing on amphibians and chameleons (Loader *et al.* 2003). No other published data were obtainable for Mselezi FR. Botanical collections have been made in the Mahenge Mountains but apart from those stated in the Flora of Tropical East Africa, the majority of these records are as yet unpublished (R. Gereau & Q. Luke pers. comm.).

This limited previous scientific work and incomplete species inventories, combined with the small and fragmented areas of forest remaining means that Mahenge has ranked low on the list of conservation priorities for the Eastern Arc (Burgess *et al.* 2007). Assessments of the Mahenge Mountains previously described the area as containing one single block endemic vertebrate species, one Eastern Arc endemic vertebrates, nine Eastern Arc near endemic vertebrates, and six Eastern Arc endemic trees (Burgess *et al.* 2007; Mariaux & Tilbury 2006). Biodiversity results from this study were used to revise knowledge of the Mahenge Mountains, updating the previous research conducted in the area.

4. METHODOLOGY

N. OWEN & V. WILKINS

The methodologies used to survey the forests were compiled on the basis of their practicality in the field, systematic nature, ease of replication, suitability to the project objectives; and they have all been rigorously tested and refined through previous work in the field. In addition, these methods have been regularly used in the Eastern Arc Mountains by organisations such as Frontier Tanzania and the Tanzania Forest Conservation Group (TFCG), as well as scientists in the fields of herpetofauna, nocturnal mammals and large mammals. The use of these standardised methods enables comparison with other similar Eastern Arc forest studies. For full descriptions of the methods and standardised datasheets used as well as specimen collection and curation procedures, please refer to and cite appropriate sections from *BREAM Volume 4: Methodology Manual*.

The methods aim to provide qualitative and quantitative information in the following categories:

1) Species inventory and relative abundances of key faunal taxa: mammals, herpetofauna, birds and butterflies.
2) Species inventory, relative abundances and community composition of plant habitats and key indicator species.
3) Identification and relative abundances of endemic, near endemic, forest-dependent and threatened species in the forest reserves studied, to highlight conservation priorities.
4) Major types of human resource use and forest disturbance, and proportion of habitat affected.
5) Indigenous knowledge and community views concerning the forest, and issues raised as being of importance to forest management.

Fieldwork in the Mahenge Mountains, Ulanga District, was conducted in 9 weeks, from 7th October to 9th December. Summaries of the data are provided with this report series, and the original dataset is lodged at the University of Dar es Salaam.

4.1 KEY DEFINITIONS

The criteria of ecological type, habitat and endemic status were used to analyse the uniqueness of the forest biodiversity and its vulnerability to disturbance. Plant and faunal lists were compiled highlighting those of conservation concern through status and level of threat. However, recently or newly discovered species will not have any listing of threat status, but are likely to be listed as Vulnerable or greater once recognised.

Taxonomic References: general information on forest-dependency, endemism, conservation status, taxonomy and nomenclature.

All taxa:	Burgess *et al.* (2007); CITES (2006); IUCN Red List (2006);
Mammals:	Grubb *et al.* (2003); Kingdon (2001); Kingdon (1989); Kingdon (1974);
Birds:	Stevenson & Fanshawe (2002);
Reptiles:	Spawls *et al.* (2002);
Amphibians:	Channing & Howell (2006); Passmore & Carruthers (1995); Schiøtz (1999);
Butterflies:	Collins & Bampton (2007); Congdon (unpubl.); De Jong & Congdon (1993); Kielland (1990); Larsen (1996);
Vegetation:	Ahrends *et al.* 2006; Ahrends & Marchant (2006); Beentje (1994); Burgess *et al.* (2007); Clarke (1995); *Flora of Tropical East Africa* (FTEA 1952-); *List of East African Plants* (LEAP; Knox 2000); *List of Potentially Threatened Plants in the EACF hotspot of Kenya and Tanzania* (Gereau & Luke 2003, revised 2006); Lovett *et al.* (2006);

Conservation Status: This is given by status on the IUCN Red List (2006); listings on CITES Appendix I, II, or III (2006); and for butterflies, status in an assessment of risk by the African Butterfly Research Institute (ABRI; Collins & Bampton 2007). At risk species are those listed on the IUCN Red List threatened categories (CR, EN, VU, NT, CD), with threatened species classed as CR, EN, or VU.

IUCN Categories (2001):

- **CR** - Critically endangered; extremely high risk of extinction in the wild.
- **EN** - Endangered; very high risk of extinction in the wild.
- **VU** - Vulnerable; high risk of extinction in the wild.
- **NT** - Near Threatened; taxa that do not qualify as Critically Endangered, Endangered or Vulnerable now, but are close or are likely to qualify for a threatened category in the near future.
- **CD** - Conservation Dependent (1994 Category that still applies to some taxa); taxa which are the focus of taxa specific or habitat specific conservation programmes targeted towards the taxon in question, the cessation of which would result in the taxa qualifying for one of the threatened categories over the next 5 years.
- **LC -** Least Concern; taxa that do not qualify for conservation dependent or near threatened. This includes widespread and abundant taxa.
- **DD** - Data deficient; insufficient evidence to assess risk of extinction.
- **NE -** Not evaluated.

CITES Categories (1973 amended 1979):

- **CITES Appendix I** - all species threatened with extinction which are or may be affected by trade. Inter-country trade is subject to particularly strict regulation and may only be authorised in exceptional circumstances.
- **CITES Appendix II** - all species which although not necessarily now threatened with extinction may become so unless trade is subject to strict regulation, and to ensure that trade is brought under effective control.
- **CITES Appendix III** – species identified as being subject to regulation within certain jurisdictions for the purpose of preventing or restricting exploitation.

ABRI Conservation Status Categories (2007):

- **CR** - Critically endangered; species known only from one or two localities within the Eastern Arc and Coastal Forest hotspot, and its habitat is unprotected and diminishing.
- **E** - Endangered; species is confined to the Eastern Arc and Coastal Forest hotspot, and its habitat is under threat.
- **V** – Vulnerable; species is confined to the hotspot, but is known to occur in at least one locality which is adequately protected; this effectively means that they occur in a National Park.
- **T -** Threatened; species is confined to the hotspot (or nearly so), but is widely distributed within it.
- **NT** - Near threatened; species is endemic to eastern Africa, with distributions extending beyond the confines of the hotspot, but with the bulk of the world population within it.
- **NE** – Not evaluated by ABRI
- **'LC'** – Species evaluated by ABRI and not considered to be at risk have been assigned 'Least Concern' for the purposes of this report.

Endemic Status: The endemic status of species was based on those given in Burgess *et al.* (2007).

- **E** – endemic: found only in the Eastern Arc Mountains (as defined here and in the Africa-wide assessment of 'ecoregions' by the World Wildlife Fund (Burgess *et al.* 2004a, b; 2006); listed as ecoregion 19.
- **SE** – strict endemic: found only in a particular mountain block of the Eastern Arc.

- **NE** – near endemic: found in the Eastern Arc Mountains and one or more adjacent WWF ecoregions (Burgess *et al.* 2004a, b; 2006), Northern Inhambane–Zanzibar Coastal Forest Mosaic (ecoregion 20; from Kenya to Mozambique); Southern Rift Montane Forest–Grassland Mosaic (ecoregion 74 which includes Rungwe, Matengo, Namuli, Nje, Malawisi); the East African Montane Forests (ecoregion 18 which includes the highlands of northern Tanzania and Kenya such as Kilimanjaro, Meru and Kenya Highlands).
- **W** – widespread distribution

Habitat: Habitat types are defined after Lovett & Pócs (1993), based on elevation and rainfall ranges (table 4).

Table 4: Habitat types after Lovett & Pócs (1993)

Forest type	Altitude (m asl)	Rainfall (mm)
DL – dry lowland	0 – 800	1000 – 1500
L – lowland	0 – 800	>1500
SMF – submontane	800 – 1250	>2000
MF – montane	1250 – 1800	>1500
UM – upper montane	1800 – 2900	>1500

Faunal Specific Categories

Ecological Type: Ecological requirements of species were determined using the following criteria (following Iverson 1991b, and Mlingwa *et al*. 2000).

- **FF** – Forest-dependent or specialist species: species previously recorded as restricted to primary or closed canopy forest only and typical of the forest interior, e.g. wet evergreen forest, dry evergreen forest and/or riverine forest; does not include forest edge or secondary forest species; likely to disappear if the forest is modified to any great extent.
- **F** – Forest dwelling or generalist species, but not forest-dependent: species previously recorded in primary or closed canopy forest as defined above and that are able to exist in forest edge, clearings, modified, fragmented and secondary forest, deciduous forest and woodland; however, these species continue to depend upon forests for some of their resources, such as nesting sites, thus they may also be adversely affected by forest destruction.
- **f** – Forest visitor species: species that sometimes occur in forests but are more typical of other habitats, especially moist woodlands and thickets. They are not dependent upon forests and their presence in a forest may sometimes be an indication of disturbance.
- **O** – Non-forest species: species that do not occur in primary or secondary forest or at the forest edge, e.g. species that have been recorded in bushland, heathland, thicket, secondary scrub, grassland, rocky outcrops, swamps, wastelands and cultivation.

Key to Distribution of Fauna: EA = Eastern Arc; CF = Coastal Forests; SR = Southern Rift;
H = Kilimanjaro, Meru and/or Kenya Highlands; W = Widespread;

Plant Specific Categories

Life Form:

- **T** – Tree species
- **H** – Herbaceous species
- **S** – Shrub species
- **C** – Climber species
- **L** – Liana species

Habit: assigned by Ahrends *et al.* (2006) and Ahrends & Marchant (2006) utilising Beentje (1994); Clarke (1995); Lovett *et al.* (2006).

- **fs** – forest specialist
- **fg** – forest generalist
- **g/w** – predominantly grassland/woodland species

Key to Distribution of Vegetation: following Lovett *et al.* (2006).
Coastal (C); Eastern Arc (EA); Northern (N); Lake Nyasa (LN); Lake Tanganyika (LT); Lake Victoria (LV); Mountains (north to south): Taita Hills (Ta), Pares (P), Usambara (Us), East Usambara (EUs), West Usambara (WUs), Northern Nguru (NNg), Southern Nguru (SNg), Nguu (Ng), Uluguru (Ul), Malundwe (Mal), Ukagurus (Uk), Rubehos (Ru), Udzungwa (Udz), Mahenge (Ma).

Potentially Threatened Plant Species: Gereau & Luke (2003, revised 2006).
This category was created by Roy Gereau of Missouri Botanical Gardens and Quentin Luke of the East African Herbarium to highlight the plants in the Eastern Arc Mountains and Coastal Forests hotspot of Tanzania and Kenya that were of restricted distribution and low abundance; prior to the initiation of the Red List process.

4.2 PREVIOUS RECORDS

Biodiversity results from this survey were used to update previous research in the Mahenge Mountains to create a comprehensive species inventory. Previous research was used to determine new records, but only for those taxa identified to species level. Frontier Tanzania's previous research in Mahenge, encompassing Nawenge FR (2004a), Mahenge Scarp FR (2004b), and Nambiga FR (2001) was utilised for widespread plant and faunal species. Although Nambiga FR is part of the Ulanga District catchment forest reserves, it is low altitude ground water forest and is not considered Eastern Arc forest typical of the Eastern Afromontane Hotspot, falling more under the Coastal Forests Hotspot or Northern Zanzibar-Inhambane Coastal Forest Mosaic (CEPF 2005; Burgess *et al.* 2004b). However, since many species are shared between these eco-regions, these records have been included to fully describe the Mahenge Mountains landscape, although not counted as previous records for the Mahenge Mountains. For endemic species (vertebrate fauna), Burgess *et al.* (2007) was used as the authoritative guide to their presence in the Mahenge Mountains, particularly in cases where Frontier Tanzania may not have had confirmed proof of presence. For both widespread and endemic herpetofauna Loader *et al.* (2003) was used as the most up-to-date species list for Mahenge. For the distribution of endemic butterflies, Collins & Bampton (2007) was used. For vegetation, previous published records were sourced from Burgess *et al.* (2006), Lovett *et al.* (2006), and Lovett & Pócs (1993). Unpublished records were accessed from the Missouri Botanical Gardens Tropicos database (R. Gereau pers. comm.), East African Herbarium (Q. Luke pers. comm.) and FTEA journals.

4.3 THE WORK UNIT

A range of different methodologies were employed to reach the various objectives, and in order to enable simple replication they were compiled into a standardised work unit, a 2.2 x 2.2km grid (fig. 2), which was replicated the requisite number of times in proportion to the size of the remaining forested area within the reserve. This maintained an even sampling effort across all forest reserves in this study. The work unit was specifically developed for BREAM to enable an array of methods to be used systematically and aspects have subsequently been adopted by other organisations such as TFCG.

Each work unit consisted of 1 zoological site, 3 zoosite vegetation plots and 3 zoosite regeneration plots, 12 standard vegetation plots, 12 standard regeneration plots, 4 disturbance transects, and 4 large mammal transects, laid out surrounding a Centre-Point (CP). Each transect began 100m from the CP in the appropriate direction to prevent any overlap in data collection.

The zoological site was the base for a number of faunal surveys, and was sited within the work unit in an area representative of the chosen elevation and general habitat; within 500m of the basecamp for security purposes. GPS co-ordinates were obtained for all working locations (appendix 3).

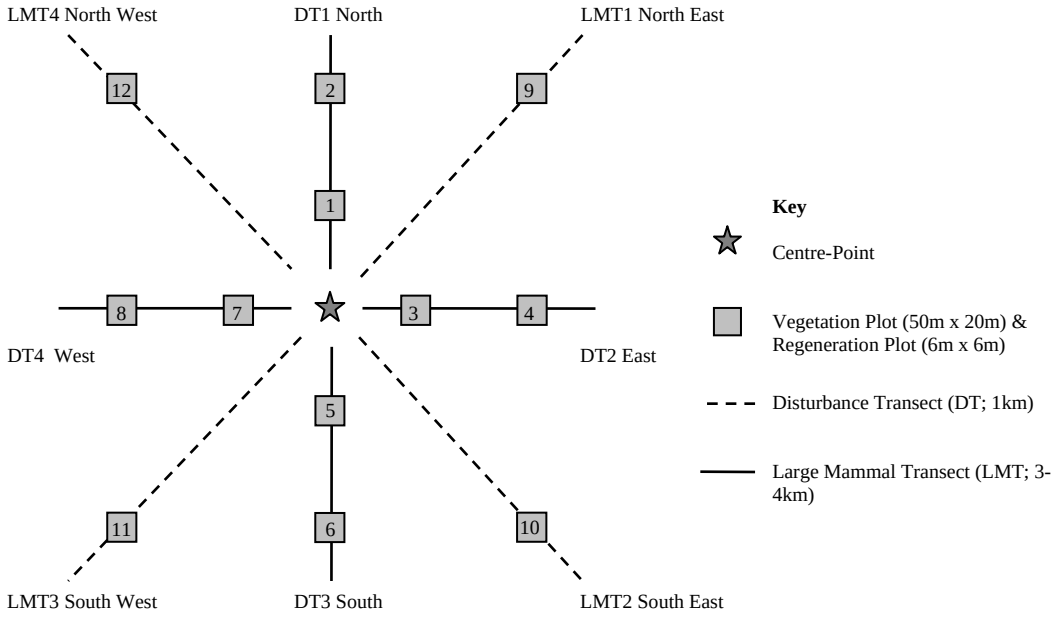

Figure 2: Diagram of the Work Unit

4.4 FAUNA

A range of methodologies were used to study the forest fauna, to compile species inventories, calculate relative abundances, and assess richness and diversity. The taxonomic groups chosen for study were mammals, reptiles, amphibians, birds and butterflies; taxa that hold many endemic species combined with practicalities of surveying and identification. Faunal assessment methods were primarily conducted at the zoological site, each of which lasted for a period of eight nights, and additional methods were conducted using the transects delineated in the work unit. Brief habitat notes were taken on the location of every method and sighting. All equipment was disinfected between forest reserves and mountain blocks to prevent the spread of chytrid fungus and other pathogens.

4.4.1 Specimens

For every capture, detailed information was collected where possible on identification, sex, morphology, breeding status and biometrics. In the case of butterflies, herpetofauna, small mammals and bats, specimens of each species were taken for taxonomic verification. Where possible, hair and tissue samples were taken from larger mammals for taxonomic verification. Photographs also provided an additional means of identification when taking a specimen was not possible. Specimens and photos were then lodged at the University of Dar es Salaam and sent to taxonomists for verification (appendix 1). Nocturnal mammal vocalisation recordings and accompanying data sheets were submitted to a nocturnal mammal specialist, A. Perkin (NPRG, Oxford Brookes) for analysis and generation of a species list, utilising standard field guides, publications, a vocalisation database held at Oxford Brookes University and the specialist's own unpublished data.

4.4.2 Mammals

For the purpose of this study, mammals have been categorised into three groups: small mammals (species captured by sherman and bucket pitfall traps, including rodents and shrews); large mammals (terrestrial mammals recorded by all other methods, including sengis); and bats.

Sherman Trapping
Small mammals were sampled using 100 Sherman traps (standard size), divided into three ellipses around each of the bucket pitfall lines, with traps placed 5m apart. Traps were placed to sample a variety of micro-habitats, to capture both terrestrial and arboreal species. Traps were baited each evening (1600-1700hrs) with toasted coconut and peanut butter, and checked early each morning (0700-0800hrs) during the eight-day zoological site. When individuals were to be released, each was given a distinct mark by trimming patches of fur in a given pattern to enable it to be identified if recaptured. A total of 800 sherman trap-nights were conducted per work unit.

Bucket Pitfall Traps
These sampled smaller mammals such as shrews and juvenile rodents. The method is briefly described under the herpetofauna methodology.

Mist netting
Bats were sampled using varying combinations and configurations of mist nets in the vicinity of the zoological site, in a variety of habitat types across assumed flight corridors such as rivers and paths. Netting sessions were held for approximately four hours at dusk (1830-2230hrs) and three hours before dawn (0330-0630hrs), for two nights during the eight-day zoological site.

Diurnal Large Mammal Transects
Transects, or "directional walks" were used to count all visual and aural encounters of large mammals, including primates, diurnal antelopes, forest carnivores and sengis, as well as record mammal signs such as dung and tracks within a metre of either side of the transect line. Four transects were delineated in each of the four quadrants, starting at 100m from the CP, in the compass directions north-east, north-west, south-east, south-west, and continuing along a least-resistance route in these general directions. The distance of each transect was approximately 2km by GPS, walked in the early morning over four hours (0700-1100hrs) at a pace of 1km/hour equivalent to approximately 3-4km on the ground when accounting for the steepness of the terrain. Thus, a total of approximately 14km of transects (at on average 3.5km per transect) were walked per work unit.

Mammal Sign Transects
The presence of large mammals was also assessed through spoor and sign surveys conducted along the four 1km north, south, east and west disturbance transects. A 1metre strip on either side of the transect line was assessed for dung, tracks and other signs to supplement data obtained on the dedicated diurnal large mammal transects. A total of 4km or 8km^2 of sign transects were surveyed per work unit.

Nocturnal Large Mammal Transects
For nocturnal and crepuscular mammals (particularly galagos and hyrax) nocturnal transects were conducted to record the presence and relative abundance through vocalisations and descriptions of visual observations. Recordings were made of vocalisations using a sound recorder (analogue Marantz PMD-222 audiocassette recorder and a Sennheiser K6-ME66 directional microphone), for comparison with a reference sound library, and deposited at the University of Dar es Salaam and at Oxford Brookes University. Nocturnal transects were conducted for approximately four hours after dusk (1830-2230hrs) and three hours before dawn (0330-0630hrs), covering between 500m - 1km, on two nights per work unit. At least 3 static surveys were conducted on each transect, recording the presence and relative abundance of galago species from a static point for 15 minutes at the beginning, middle and end of each transect.

Camera Trapping
10 Vision Scout and CamTrakker infra-red sensor camera traps were placed throughout the forest reserve: deployed in pairs where two cameras were set at relatively close distance together (maximum of 100-200m apart) and different pairs were then spread approximately 1 km apart. This design allows sampling of relatively different sites within each area (by elevation, habitat type, vegetation pattern, morphology). Camera trapping sites were baited with duiker dung, carrion such as fish heads, and/or a

cat lure scent. Each camera was run for approximately 30 days per forest reserve. Films were 36-exposure, 200 ISO. The minimum interval between consecutive pictures was set at one minute.

Large Mammal Trapping
Chardonneret live-traps for galagos and small carnivores such as palm civets and genets were set periodically. They were baited with banana and pombe for galagos; and carrion, live crabs, and cat lure scent were used for attracting small carnivores. They were set throughout the night (1730-2230hrs and 0330-0630hrs) during the nocturnal work, and set occasionally on evenings (1730-2100hrs), and checked every two hours. Biometrics, tissue and hair samples, and photographs were taken of any captures and deposited at UDSM; galago tissue was also sent to the Alpine Ecological Centre in Italy.

4.4.3 Avifauna
Mist Netting
Birds were sampled using varying combinations and configurations of mist nets in the vicinity of the zoological site. Lines were cut through the vegetation to allow mist nets to be erected, targeting birds of the lower story. A total of 149 net-metres were utilised at each work unit. Nets were opened for a full day (0530-1815hrs) and checked regularly. Four netting days were conducted per work unit. When individuals were to be released, each was marked by clipping a tail feather to enable it to be identified if recaptured. Specimens were taken for later DNA analysis and deposited at the University of Copenhagen.

Randomised Walks
General field observations on randomised walks were utilised to record birds occurring at low densities and those of the upper strata that could not be sampled using mist nets. Particular attention was paid to mixed feeding flocks. A total of 12 hours were spent on randomised walks in each work unit.

4.4.4 Herpetofauna
Bucket Pitfall Traps
Herpetofauna were sampled using a standard trap array of 33 bucket pitfall traps in each zoological site, consisting of three 50m linear transects each containing eleven 10litre plastic buckets positioned 5m apart, sunk into the ground with a plastic drift fence stretching between each bucket. Each line was placed 50m apart, encompassing a range of micro-habitats. Traps were checked early each morning (0700-0800hrs) and when re-baiting (1600-1700hrs), during the eight-day zoological site. A total of 264 bucket pitfall trap-nights were conducted in each work unit.

Visual Encounter Surveys
VESs collect and study a representative sample of the reptile and amphibian communities of the forest, with reference to associated vegetation types, through quadrats and transects. VESs sample fossorial species, arboreal and water associated species. Sixteen VES quadrats were conducted within a 10m x 10m area for one man-hour each (1400-1600hrs), per work unit. Four VES transects of 100m were conducted, each for four man-hours (1900-2100hrs), per work unit. VESs were located to sample both water- and non-water-associated habitats and a range of micro-habitats within these; and aimed to capture and identify all herpetofauna individuals present in the survey area. A total of 32 man-hours were spent on VESs per work unit.

Acoustic Recordings
Nocturnal acoustic monitoring techniques were used to detect the frog species assemblage by recording the species-specific calls made by males in reproductive condition. Herpetofauna acoustic sampling was conducted for one hour in the evening (1900-2100hrs) within a specified area, recording vocalisations and attempting to capture the individual vocalising to link specimens with calls. In addition, landscape recordings were made to illustrate the number of different species and individuals calling within that area. Recordings were made of vocalisations using a sound recorder (analogue Marantz PMD-222 audiocassette recorder and a Sennheiser K6-ME66 directional microphone).

4.4.5 Butterflies

Canopy Traps

Canopy traps aim to collect a representative sample of fruit and carrion feeding canopy dwelling forest butterfly species. Blendon style canopy traps (38cm round base x 69cm high) were located at different canopy levels within the zoological site; 2 at each of the 3 bucket lines. The traps were raised for a full day (0700-0800 to 1600-1700hrs) and baited with fermented banana. A total of 48 trap-days were conducted in each work unit.

Sweep Netting

Timed sweep netting collects a representative sample of the butterfly species in the forest under-storey as well as other habitats such as scrub/thickets and around ground herbs and grasses. Sweep netting was conducted for a total of two sweep netting man-hours per zoological site-day (between 11:00-12:00hrs or 15:00-16:00hrs), within a specified habitat. Additionally, 15 minutes of sweep netting was conducted at each of the 12 vegetation plots to increase the number of different habitats and locations sampled in the reserve. A total of 19 sweep netting man-hours were conducted per work unit.

4.4.6 Opportunistic Observations and Collections

Opportunistic observations and the opportunistic collection of specimens were carried out where possible, for all target faunal taxa throughout the survey. Specimen collections were made of herpetofauna and butterflies, and direct and indirect observations were made of mammals and birds to obtain a comprehensive species inventory. Opportunistic sound recordings were also obtained where possible. However, only taxonomically confirmed observations were included on the species inventory.

4.4.7 Faunal Analysis

Relative abundances were calculated per sampling effort, by time or by distance to provide a measure comparable to other studies using similar methods. Species diversity and equitability were analysed using the Shannon Wiener Diversity Index. Statistical techniques were used where possible to analyse methods and relationships.

For taxa with sufficient samples, data were analysed to explore community associations in relation to habitat using TWINSPAN (two-way indicator species analysis). This is a complex divisive clustering method; which ordinates samples using reciprocal averaging to then produce a dichotomy; which is refined iteratively. Samples are ordered into clusters based on their levels of similarity.

4.5 VEGETATION

Several methodologies were used to sample the vegetation in the forest reserve to produce a species inventory and assess diversity and community composition. Plant assessment methods were conducted throughout the work unit, on each transect and at the zoological site. A botanist was contracted to conduct the botanical methods, identification and collection of specimens in the field, with specimen identification carried out at the University of Dar es Salaam's Herbarium and the East African Herbarium, Nairobi. Botanical data were also submitted to the TROPICOS database.

4.5.1 Specimens

For taxa that could not be identified in the field, up to five voucher specimens of leaves and (if present) flowers and fruits were taken to ensure taxonomic verification. Detailed field notes accompany each specimen. Photographs also provided an additional means of identification when taking a specimen was not possible. Specimen duplicates are lodged at the UDSM Herbarium, the National Herbarium at Arusha, the East African Herbarium at Nairobi and Missouri Botanical Gardens, USA, for further verification. The collections are part of Yahya Abeid's (YA) series.

4.5.2 Vegetation Plots

Eight vegetation plots of 50 x 20m were placed at 250m and 750m along each of the 1km north, south, east and west disturbance transects. Four more vegetation plots were then placed in each of the four quadrants, where possible at a perpendicular distance of 850m to the east and west of the 750m vegetation plots located on the north and south disturbance transects. This ensured even sampling of the work unit. Additionally, longer vegetation plots of 10 x 50m were placed along each of the bucket pitfall lines to ascertain the botanical nature of the zoosite. Within each vegetation plot, every tree with a diameter at breast height (dbh measured at 1.3m high) of 10cm and above was recorded and identified or specimens collected. GPS co-ordinates and environmental characteristics were also recorded for each plot, including altitude, topography, aspect, signs of disturbance, features of interest and vegetation cover.

4.5.3 Regeneration Plots

At the centre of each vegetation plot, the regeneration layer was sampled in a 6m x 6m nested subplot. All trees with a dbh of less than 10cm were counted and identified. The percentage of ground cover (herbaceous vegetation, bare soil, leaf litter and rocks) as well as the coverage of other vegetation (grasses, forbs, mosses, lichens and ferns) were recorded and notes taken on soil type and colour.

4.5.4 Opportunistic Observations and Collections

Throughout the survey opportunistic observations and collections for all botanical life forms were made to ensure a comprehensive species inventory.

4.5.5 Vegetation Analysis

Botanical data were analysed utilising a combination of vegetation classification and ordination techniques, including:

(i) establishment of phytosociological groups using TWINSPAN;
(ii) a variation on the Braun-Blanquet approach;
(iii) the establishment of phytoecological groups using species indicator values;
(iv) clustering of structural groups;
(v) vegetation ordinations using Principal Component and Detrended Correspondence analyses;

Associations were only described when they have coherently been identified by these approaches to ensure that they were robust. The data were then further analysed to examine the effects of environmental gradients and regeneration properties within the plots, this was achieved by using different ordination, regression and general linear modelling techniques.

4.6 HUMAN RESOURCE USE AND FOREST DISTURBANCE ASSESSMENT

4.6.1 Disturbance Transects

Within each work unit four 1km disturbance transects were delineated, radiating out 100m from a Centre-Point in the direction of the north, south, east and west compass bearings. These transects recorded the intensity of pole and timber cutting and the incidence of other disturbance types within the forest. All timbers (dbh>15cm, 3m of straight trunk) and poles (dbh 5-15cm, 2m of straight trunk) 5m either side of the transect line were recorded, classified as live, old cut, new cut, or naturally dead.

4.6.2 Opportunistic Observations

Observations of human disturbance were recorded and GPS co-ordinates taken throughout the reserve to produce an overall picture of human resource use and the extent of human disturbance within the forest. Where possible, changes in forest cover as a result of disturbance were noted.

4.6.3 Resource Use and Disturbance Analysis

Disturbance data were analysed by a number of factors including location within the reserve, and according to environmental conditions such as altitude, gradient, and vegetation cover; in order to produce an assessment of human resource use throughout the reserve and highlight threats.

4.7 COMMUNITY DAYS

Community days were held in villages nearest to the forest reserve to provide an introduction to Frontier Tanzania's activities and the BREAM project, highlight the importance of the FR and its associated natural resources, raise awareness of issues relating to the FR, gather indigenous knowledge and opinions, and to provide environmental education on the management and preservation of the FR. Information from the Community Days has contributed to the compilation of a short Kiswahili Report accompanying this Technical Report, making available the transcript of the presentation, the minutes of the discussion and the interview results, as well as the executive summary of this Technical Report, in a more accessible format for local communities.

4.7.1 Structured Interviews

Structured interviews were held with a representative sample of the local community, surveying a broad range of ages and occupations as well as even numbers of males and females. Individual interviews were conducted by Tanzanian staff members. The interviews were designed to obtain local and indigenous knowledge about the forest, to gain an overview of natural resource use and illegal activities in the reserves, and to obtain information on the attitude and knowledge of local inhabitants concerning the reserve status. Appendix 11a lists the questionnaire used in the interviews.

4.7.2 Environmental Education

An important part of the community day was carrying out an environmental education session with the local school children. Educational games were used to teach about the water cycle, the food web, and identifying tracks and signs; giving the children a chance to learn about their natural environment and how it works, with particular emphasis on how important the forest is for clean water and for supporting plants and animals. Children and adults were also given the opportunity to look at and use some of the science and research equipment.

4.7.3 Community Presentation

A general presentation was held after the structured interviews to prevent any bias in the results, and was aimed at both adults and children. The presentation introduced Frontier Tanzania and the BREAM project, the Eastern Arc Mountains in general, the importance of the wildlife, forests and water both on a local and national scale, and the effects of human disturbance activities. Talks were given by our staff including the botanist, ornithologist, and District game scouts, and by invited speakers such as District Forest Officers, the Village Chairman and the Village Executive Officer.

4.7.4 Community Discussion

The community discussion held at the end of field work provided an opportunity for any issues, knowledge or concerns that were not covered in the presentation to be discussed and recorded. The discussion sessions were chaired by Frontier staff and everyone was welcome to contribute.

5. SALI FOREST RESERVE

5.1 STUDY SITE

N.OWEN

5.1.1 Site Summary (from Lovett & Pócs 1993)
Ulanga District, Morogoro Region
Location: 8º 54' – 8 º 7' S 36 º 37' – 36 º 41' E
Year of Establishment: 1954
Declaration: GN408 of 3/12/54
Variation order: Initiated in 1982 (Jb 2072)
Border map: Jb 207, Jb 2072 (1:25,000) 1982
Topographical maps: 1:50,000, Series Y 742, 251/3
Gazetted area: originally 1,424ha; now 1,890ha
Gazetted boundary length: 17,918m (18km) (Jb 2072)

Sali FR is located on the central part of the Mahenge Mountains; 30km south-west of Mahenge (annex 1 fig. 59a), covering hills south-west of the main Mahenge plateau. This information is taken from the assessment of the condition of the catchment forest reserves conducted by Lovett & Pócs (1993), except where new information was recorded in this project.

5.1.2 Topography
Sali FR consists of primary submontane forest, with some rocky outcrops and rock vegetation, submontane dry grasslands and submontane wetland areas. Grasslands occur on the edges of the reserve, with wetland areas throughout the forest. There are several peaks in the forest, with the highest being at approximately 1450m asl according to topographical map 251/3. The altitude range using GPS recorded in this survey ranged from 1000 - 1493m asl (compared to the previously recorded range of 1050 – 1300m asl). The soils are yellow ferralitic latosols or at rocky places lithosols developed on Precambrian crystalline gneisses. Rivers from the reserve flow into the Msingizi, Ruaha and Luhombero rivers.

5.1.3 Biodiversity
Lovett & Pócs (1993) consider the forests to be of the Eastern Arc type due to climate and altitude, and to be rich in endemic species, including several species of restricted distribution, including two species of endemic *Impatiens* spp. and the Eastern Arc endemic *Allanblackia stuhlmannii*. Sali is recognised as an important corridor for large mammal migration between the Kilombero Valley floodplain and the Selous Game Reserve, large mammals such as elephant and buffalo are reported to be resident during the dry season.

5.1.4 Climate
Under the Indian Ocean climatic regime, the climate is oceanic with oceanic/continental temperatures. Rainfall is estimated at 1700mm per year. The dry season is June to October, with the long rains falling between February and May, and the short rains from November to January. The daytime temperature ranges from: 18˚C min (July) and 23˚C max (November).

5.1.5 Land Use
This catchment forest reserve permits no legal exploitation, and as yet the steep terrain and isolated geography has been a hindrance to illegal activities. The boundary is unclear as there are no obvious beacons or trees planted. There are human paths on all the forest ridges and occasionally crossing through the forest, facilitating some exploitation. Forest records show there used to be settlements in the forest during the early part of the century. Past disturbance recorded from Sali FR included pitsawing, hunting, cultivation and some clearing on borders with nearby villages, and particular note was made that fire was a problem on all forest borders where montane grassland is part of the reserve, as it frequently spread from neighbouring farms into the reserve. Lovett & Pócs (1993) recommended

that the borders be clearly marked and planted but this had not been carried out by the time of our survey work.

5.1.6 Forest Reserve Management

There is no current active management plan or strategy in place for Sali FR, and all forms of exploitation are illegal.

5.2 METHODOLOGY

N.OWEN

A total of six weeks were spent in Sali FR (12th October – 29th November 2005). The first two weeks were spent training in the different methodologies, including a specialist training session conducted by external consultants from the Museo Tridentino Di Scienze Naturali, Italy, and the Nocturnal Primate Research Group, Oxford Brooks University. Survey work was conducted from 30th October – 29th November 2005, and the Sali village community day was held on the 24th November 2005.

Table 5: Work Unit details in Sali FR

Work Unit	Description of location		Grid ref Lat / Long	Grid ref UTM	Altitude (m asl)
1	Primary high canopy submontane forest, 1.5hrs walk from Sali village.	Zoological site 1	08° 56' 43.0" 036° 40' 20.4"	0244046 9010480	1050
	30/10/05 – 11/11/05	Centre-Point 1	08° 56' 46.5" 036° 39' 48.4"	0243068 9010365	1100
2	Dense low canopy submontane forest near to open wetland, in the northern more inaccessible part of the reserve.	Zoological site 2	08° 55' 51.0" 036° 39' 20.8"	0242214 9012065	1250
	12/11/05 – 22/11/05	Centre-Point 2	08° 55' 44.1" 036° 39' 8.9"	0241850 9012275	1270

Table 6: Sampling intensity and location of sample sites for camera traps in Sali FR

Camera Trap	Grid Reference	Altitude	Habitat	Start (dd/mm/yr)	End (dd/mm/yr)	Total days*
Vision Scout 1	0243906 9010338	1155	Closed dense forest, on gentle mid slope.	22/10/05	7/12/05	39
Vision Scout 2	0243428 9011970	1400	Large animal ridge top trail, semi-closed forest with grasses.	21/10/05	7/12/05	23
Vision Scout 3	0242393 9010690	1400	Small duiker trail, closed dense forest.	22/10/05	7/12/05	42
Vision Scout 4	0241579 9012171	1300	Large animal ridge top trail, semi-closed forest with grasses.	29/10/05	7/12/05	29
Vision Scout 5	0241797 9011846	1350	Several converging duiker trails, closed dense forest.	13/11/05	7/12/05	8
CamTrakker 11	0243630 9011557	1300	Small duiker trail, near large gaps, open regenerating forest.	21/10/05	7/12/05	45
CamTrakker 12	0242450 9010740	1400	Small duiker trail, closed dense forest with large gap nearby.	22/10/05	7/12/05	19
CamTrakker 13	0243068 9010385	1340	Small duiker trail near ridge-top, open forest.	31/10/05	7/12/05	38
CamTrakker 14	0241125 9011855	1320	Small duiker trail, steep upper slope, closed dense forest.	16/11/05	7/12/05	22
CamTrakker 15	0241850 9012320	1275	Several converging duiker trails, regenerating forest.	13/11/05	7/12/05	25
TOTAL						**290**

**Camera trap days are computed from deployment of camera traps until the film was full, the camera stopped functioning, or the camera was removed.*

Taking into consideration the small area of remaining forest, two work units were conducted in this reserve, stratified by altitude, and each work unit was placed to ensure the maximum area of the forest reserve was sampled. Work Unit 1 was sited at 1050m asl, and was nearest to settlements such as Sali village; Work Unit 2 was sited at 1250m asl, and was deeper into the forest and much less accessible to nearby villages (table 5). In addition, 10 camera traps were placed throughout Sali FR (table 6).

A summary of the methods used and total survey effort employed is outlined in table 7. Annex 1 fig. 59b shows the location of the work units, zoological sites, basecamps and camera traps within Sali FR.

Table 7: Methodology employed and summary of survey effort in Sali FR

Survey technique (and sampling unit)	Target	Total sampling effort
Vegetation		
Vegetation plot (50m x 20m; 12 per work unit)	Trees	24 vegetation plots
Regeneration plot (6m x 6m; 12 per work unit)	Trees	24 regeneration plots
Zoosite vegetation plot (10m x 50m; 3 per work unit)	Trees	3 vegetation plots
Zoosite regeneration plot (6m x 6m; 3 per work unit)	Trees	3 regeneration plots
Opportunistic observation/collection	All plant life forms	
Fauna		
Sherman traps (100 traps x 8 trap-nights per work unit)	Small mammals	1600 trap-nights
Bucket pitfall traps (33 buckets x 8 trap-nights per work unit)	Reptiles, amphibians, rodents	528 trap-nights
Animal sign transects (4 transects x 1km per work unit)	Larger mammals	8 transects, 8km
Large mammal transects (4 transects x 3.5km per work unit)	Larger mammals	8 transects, 28km
Nocturnal mammal transects (2 transects x no. of hours per work unit)	Nocturnal mammals	14.33 hours
Camera trapping (10 cameras x no. trap days)	Larger mammals	290 camera trap-days
Large mammal and galago traps (opportunistically set)	Larger mammals and galagos	40 trap-nights
Bat mist net surveys (net-metre-hours)	Bats	370 net-metre-hours
Bird mist net surveys (net-metre-hours)	Birds	11,920 net-metre-hours
Bird randomised walks (12 observation hours per work unit)	Birds	24 observation hours
Visual encounter surveys (quadrats) (16 quadrats x 1 man-hour per work unit)	Reptiles, amphibians	32 man-hours
Visual encounter surveys (transects) (4 transects x 4 man-hours per work unit)	Reptiles, amphibians	32 man-hours
Acoustic nocturnal recordings (opportunistically conducted)	Amphibians, nocturnal mammals	
Canopy traps (6 traps x 8 trap-days per work unit)	Butterflies	96 trap-days
Sweep netting (2 man-hours x 8 days per work unit; 3 veg-plot man-hours per work unit)	Butterflies	38 man-hours
Opportunistic observation/collection	All animal taxa	
Human Resource Use and Disturbance		
Transects (4 transects x 1km per work unit)	Human disturbance	8 transects, 8km
Opportunistic observation	Human disturbance	
Community Knowledge		
Interviews	Local knowledge	15 interviews
Discussion	Local knowledge	

5.3 SALI FR RESULTS

5.3.1 Fauna of Sali FR

Most faunal species have been taxonomically verified, however this is still pending for some species (primarily shrews); the following results have been compiled with both confirmed identifications as well as preliminary identifications for unverified species. Appendices 4 to 8 present faunal data.

Mammals

N. OWEN & A. PERKIN

A species inventory was compiled using data from sherman trapping, bat netting, bucket pitfall trapping, large mammal diurnal and nocturnal transects, camera trapping and opportunistic observations. In some cases, sightings and sign could only produce identifications to genus.

- *Species richness, diversity and composition*

Thirty-seven mammal species (with four taxa identified only to genera within which more species may be found) representing 22 families were recorded in Sali FR (appendix 4a). Twenty-three species represent new records for Mahenge, with eight of these new records also being found in Mselezi FR. Four additional species may have been present in Sali but sightings were unconfirmed (appendix 4b).

The presence of larger mammals (species which cannot be sampled through sherman or bucket pitfall trapping, including sengis) were recorded through visual observations, vocalisations, indirect observations of sign and camera trapping. Twenty-three species in 17 families were recorded using a combination of 36km of diurnal transects (28km of direct observation transects and 8km of sign transects), 290 camera trapping days, 14.33 hours (10.5km) of nocturnal transects, and opportunistic observations.

Approximately 28km of dedicated diurnal mammal transects were walked, recording visual, aural and sign (dung and tracks) sightings. This was supplemented by an additional 8km of sign-only transects, conducted along the human disturbance transects. Fourteen species and one group of species (small carnivores) were recorded using this method. Mean encounter rate was calculated as a measure of relative abundance for species for which there was sufficient data collected (fig. 3).

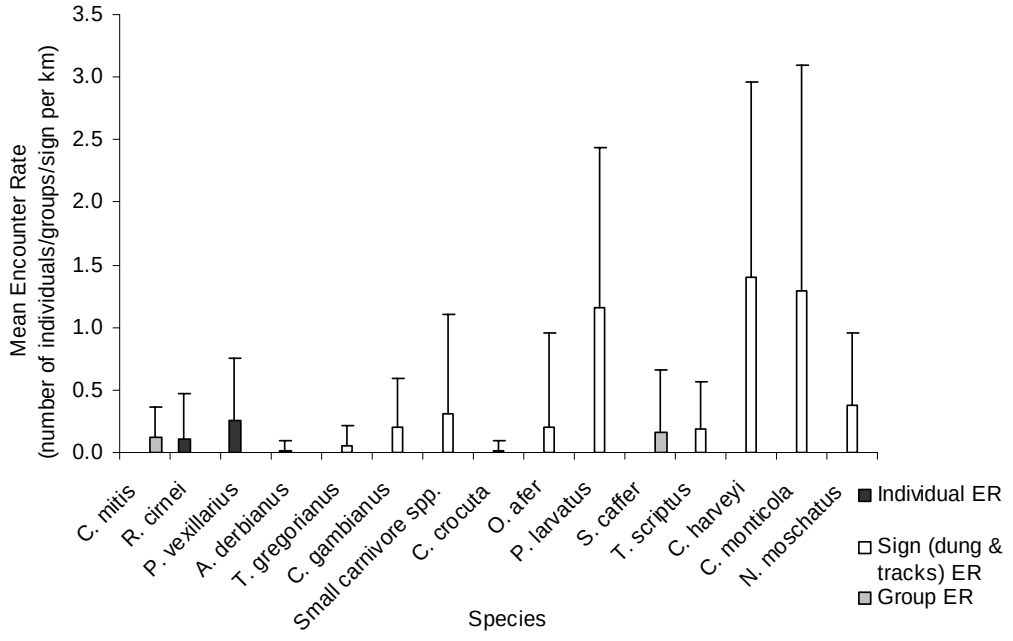

Figure 3: Encounter rates with associated standard deviations from large mammal transects in Sali FR

This was primarily based on the number of sign, although visual sightings were incorporated where possible for appropriate species. The most abundant species were red duiker *Cephalophus harveyi* (1.32±1.54sign/km), blue duiker *C. monticola* (1.21±1.78sign/km) and the bushpig *Potamochoerus larvatus* (1.08±1.27sign/km). All small carnivore sign was grouped together as it could not always be reliably identified to species level, so the encounter rate gives a measure of overall small carnivore abundance. A small amount of sign left by duiker species could not be identified to species level and this was excluded from the analysis. Appendix 4c summarises the diurnal transect data and encounter rates for Sali FR**.**

For camera trapping, the number of days was computed from deployment of camera traps until the film was full, the camera stopped functioning, or the camera was removed. A total of 149 events (number of mammalian individuals photographed, not including multiple photographs of the same species within an hour) were recorded from 290 camera trapping days using ten cameras spread throughout the forest reserve. Eleven species in eight families were recorded (*C. harveyi* and chequered elephant shrew *Rhynchocyon cirnei reichardi* are photographed in annex 2a fig. 61). The mean camera trapping rate (number of events divided by camera trap-day) for each species was calculated to give a measure of relative abundance (fig. 4). The most abundant species was the giant pouched rat *Cricetomys gambianus* (19.78±25.47events/camera trap-day), followed by *C. harveyi* (18.42±24.02events/camera trap-day), suni *Neotragus moschatus* (15.80±12.01events/camera trap-day) and bushy-tailed mongoose *Bdeogale crassicauda puisa* (15.02±12.62events/camera trap-day). Appendix 4d summarises camera trapping data for Sali FR.

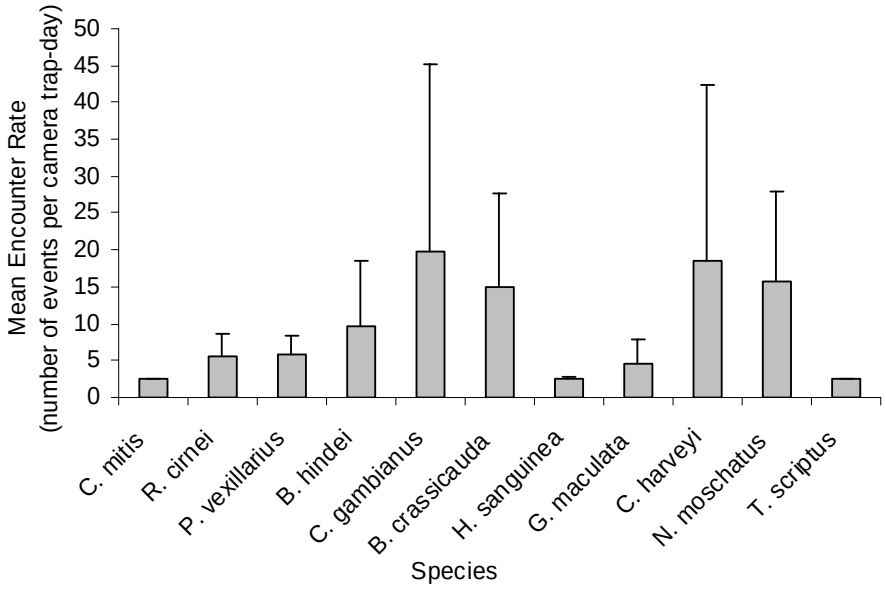

Figure 4: Encounter rates with associated standard deviations produced from camera trapping in Sali FR

Sufficient camera trapping data were obtained to calculate activity budgets for five mammal species in the reserve (fig. 5). *B. crassicauda puisa* is mainly nocturnal, with most activity in the evening (1900-0100hrs), with a lesser peak again in the early hours of the morning (0400-0700hrs). *C. harveyi* is predominantly diurnal, with a major peak in activity during the afternoon (1300-1900hrs), and a much smaller peak in the morning (0700-1000hrs). *N. moschatus* is exclusively diurnal, progressively more active throughout the day, peaking in the late afternoon (1600-1900hrs). *C. gambianus* is nocturnal, active in the evening and progressively less active through to the early morning (1900-0700hrs). *R. cirnei reichardi* appears crepuscular, with a peak at dusk (1600-1900hrs) and a smaller peak again around dawn (0700-1000hrs).

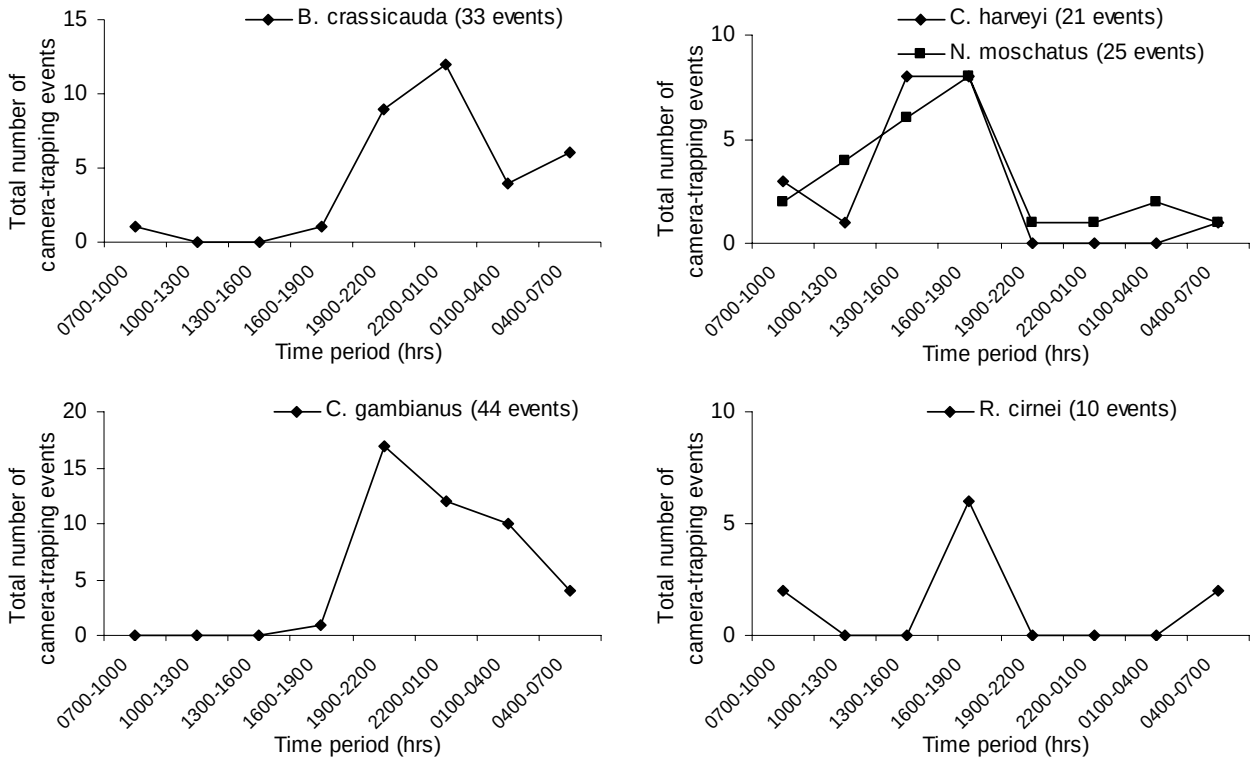

Figure 5: Activity budgets produced from camera trap data in Sali FR; for B. crassicauda; N. moschatus and C. harveyi; C. gambianus; R. cirnei

To assess the consistency between large mammal encounter rates given by transects and by camera trapping, and therefore infer their reliability as an index of relative abundance, those species which were recorded both on transects and on cameras were analysed for correlation (fig. 6; *C. harveyi, N. moschatus,* small carnivores, Svynnerton's bush squirrel *Paraxerus vexillarius cf byatti.,* bushbuck *Tragelaphus scriptus, R. cirnei reichardi*). There was a significant correlation in the relative abundances given by each method (Spearman's R = 0.771, p = 0.036; 1-tailed); for example *C. harveyi* has a high relative abundance by both camera trapping and mammal transects, followed by *N. moschatus*. This supports previous evidence that camera trapping is a reliable tool to assess the relative abundance of cryptic species (Silveira *et al.* 2003).

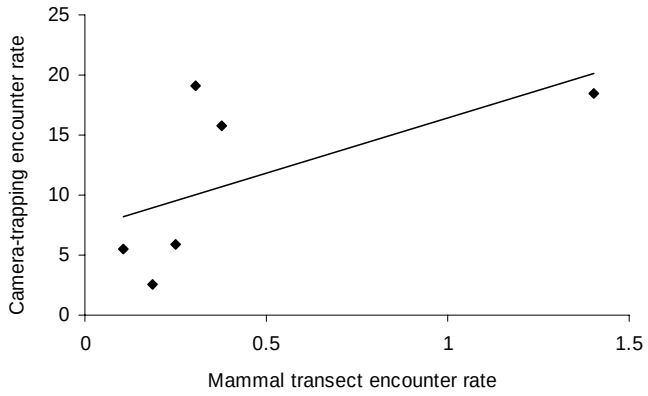

Figure 6: Comparing measures of relative abundance (encounter rates) given by camera trapping and mammal transects conducted in Sali FR

Opportunistic sightings included two observations of molehills in the reserve, indicating the presence of a mole species, most likely to be the golden mole *Chrysochloris stuhlmanni* (a species that contains Eastern Arc endemic sub-species).

A total of 14 hours and 20 minutes of nocturnal transects (approximately 10.5km) over four survey nights yielded high-quality recordings and frequent vocal encounters for a single species of galago, Grant's galago *Galagoides granti.* Relative abundance was calculated as the number of individuals encountered per hour of transect walked. Where possible, individuals were identified by their location so that repeated calls were not logged as a new individual. The mean encounter rate for *G. granti* was 3.9±1.83ind/hour. Appendix 4e summarises the nocturnal transect data and encounter rates for Sali FR**.** A single juvenile was also captured opportunistically by hand and a biopsy tissue and hair sample was taken for DNA analysis; photographs were also taken of key features used in morphological identification: facial markings, hands, feet and genitals (shown in annex 2a fig. 61c). For *G. granti*, the typical species advertising call 'incremental calls' were mostly heard but 'sweep screeches' alone and mixed with yaps and other 'rapid yap and screech calls' were also recorded. These latter calls are alarm calls and in one sequence (Sali FR side A # 562-70) these may have been stimulated by African wood owls, which were calling in the area. Figure 7 shows an incremental call of *Galagoides granti*. Note the low frequency range (>3KHz) due to the quiet recording and high background noise from insects and frogs. This call is emitted to more than 10-12KHz typically, however the incremental phrase and unit structure and the fundamental frequency of 1.07 KHz is consistent with other incremental calls recorded for this species.

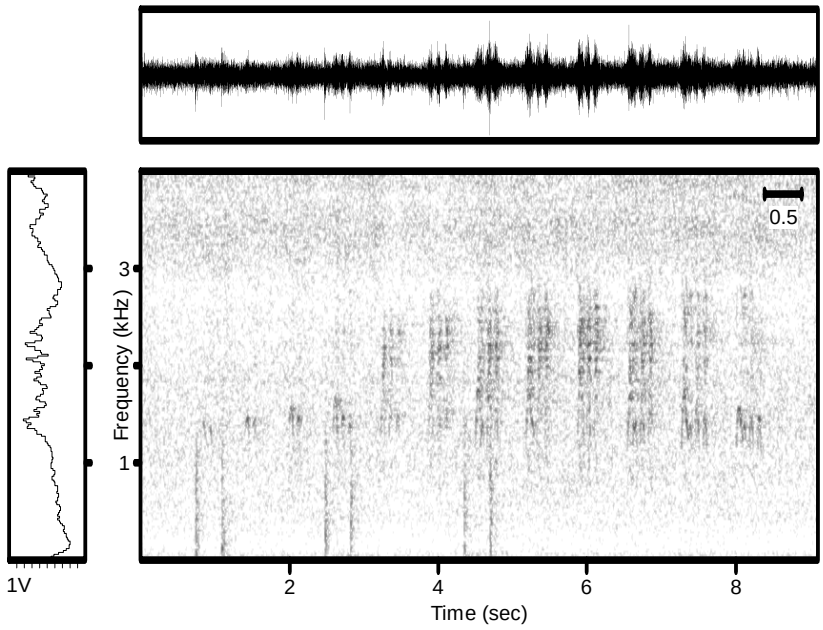

Figure 7: An example of a G. granti advertising call, the' incremental call' from Sali FR.

For the small mammals eight taxa (with five taxa confirmed to species and three confirmed to genus, with potentially more than one species recorded in each genus, particularly for shrews), representing four families were recorded from a total of 182 captures. 145 captures (excluding 102 recaptures) were made over 1600 sherman trapping nights; and 37 captures over 528 bucket pitfall trap-nights. Twenty-five specimens were taken. All taxa, apart from brush-furred mouse *Lophuromys flavopunctatus* and climbing shrew *Sylvisorex sp.,* were recorded at both sites, of these two the former was recorded from a single capture at WU2 and the latter from a single capture at WU1. The African wood mouse *Hylomyscus arcimontensis* was most abundant at both sites, accounting for 56% of captures at WU1 (5.25captures/100sherman trap-nights) and 49% of captures at WU2 (5.25captures/100sherman trap-nights); other common species included the soft-furred rat *Praomys delectorum* (WU1: 2captures/100sherman trap-nights; WU2: 0.75captures/100sherman trap-nights), the lesser pouched rat *Beamys hindei* (WU1: 1.25captures/100sherman trap-nights; WU2: 2.38captures/100sherman trap-nights); with less common species being the narrow-footed woodland mice *Grammomys sp*., and the African dormouse *Graphiurus cf. murinus.* The species assemblage and relative abundances were fairly similar at each work unit (fig. 8).

A possible three species of white-toothed shrews *Crocidura spp* were recorded, with a total of 32 individuals captured (13 at WU1 and 19 at WU2), of which 9 specimens were taken. One other genus of shrew, *Sylvisorex sp.* was recorded. Appendix 4f summarises small mammal data obtained through sherman trapping, bucket pitfalls and opportunistic observations for Sali FR.

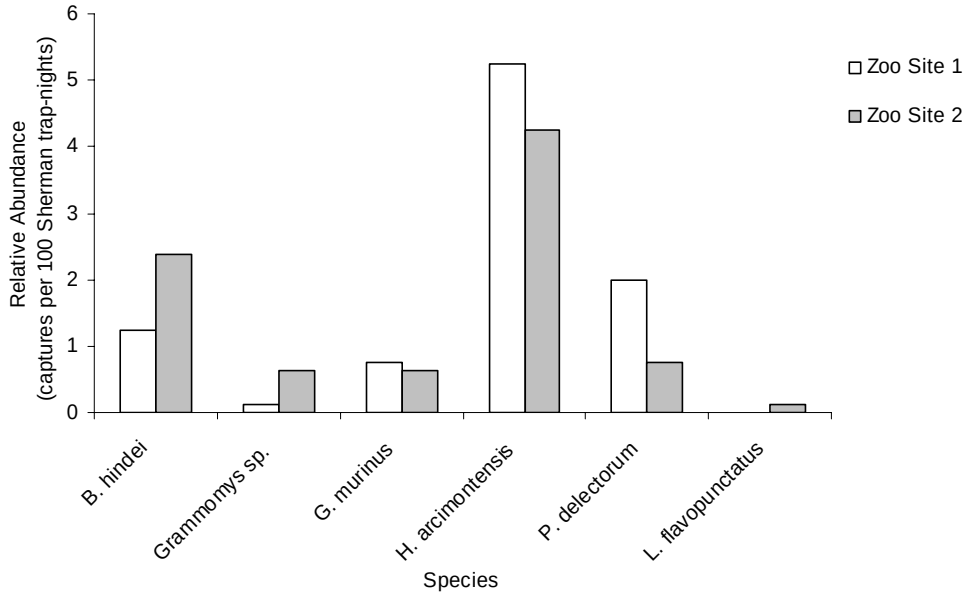

Figure 8: Relative abundance of small mammals produced from sherman trapping in Sali FR

Bat netting was conducted for a total of 370 net-metre-hours, (191 net-metre hours at WU1; 179 net-metre hours at WU2) yielding five species in three families out of nine individuals caught. *Myotis welwitschii* and *Epetesicus sp.* were caught at both sites; *Lissonycteris cf. angolensis* and *Rhinolophus clivosus* were caught at WU1; *Eptesicus cf. pusillus* was caught at WU2. Additionally, *Epomophorus walhbergi* was an opportunistic capture in a bird net set at WU2. Six specimens were taken. Not enough captures were made to calculate any measures of relative abundance. Appendix 4g summarises bat data obtained through mist netting for Sali FR.

- *Endemism, conservation status, and forest dependence*

Of the 37 mammal species recorded, 14 species in 9 families are of conservation concern (37.8%; full details of each species can be found in table 8): with four near endemics (10.8%; fig. 9) *Beamys hindei*, *Hylomyscus arcimontensis*, *Paraxerus vexillarius byatti* and *Galagoides granti*. Eleven species of conservation concern represent new records for Mahenge (including the former three near endemic species), with four of these new records also found in Mselezi FR.

Nine species are considered to be at risk on the IUCN Red List (24.3%; listed as either Vulnerable, Near Threatened or Conservation Dependent) with six also being CITES listed. Also on the IUCN Red List, four species are Not Evaluated or Data Deficient, and twenty are listed as Least Concern. Seven species are forest-dependent (18.9%).

In addition, unconfirmed records were collected for several species. Species identifications were not included on the final species list as their presence was not confirmed conclusively (appendix 4b), but these species are all potentially of conservation concern. The mountain galago *Galagoides orinus* (Eastern Arc endemic; forest-dependent; IUCN listed Data Deficient) was thought to have been heard on a couple of occasions but no sound recordings were obtainable to verify its presence. The black and rufous sengi *Rhynchocyon petersi* (Eastern Arc and Coastal Forests near endemic; IUCN listed Vulnerable) was thought to have been seen on several occasions but these fleeting glimpses were not corroborated by camera trapping data. An additional species of anomalure was witnessed that did not appear to fit any of the known species descriptions. A villager from the local community reported the sighting of a lion *Panthera leo* (IUCN listed Vulnerable) on the road near Sali village, just outside Sali FR.

Table 8: Mammalian species of conservation concern (categorised by endemicity, forest-dependency and/or conservation status) in Sali FR

Species	Common Name	Range	Habitat	IUCN (2006)	CITES (2006)	Previous Mahenge Records
CERCOPITHECIDAE						
Cercopithecus mitis cf. moloney Wolf 1822	Sykes monkey	W	FF	LC	II	Mahenge Scarp; Nambiga
GALAGONIDAE						
Galagoides granti Thomas & Wroughton 1907	Mozambique galago	NE – EA, CF	FF	DD	-	Mahenge Scarp
RHYNCHOCYONINAE						
Rhynchocyon cirnei reichardi Peters 1847	Chequered sengi	W	FF	NT	-	New Record
SCIURIDAE						
Paraxerus vexillarius byatti Kershaw 1923	Svynnerton's bush squirrel	NE – EA, SR	FF	VU	-	New Record
ANOMALURIDAE						
Anomalurus derbianus Gray 1842	Lord Derby's Anomalure	W	FF	LC	III	New Record
MURIDAE						
Beamys hindei Thomas 1909	Lesser pouched rat	NE – EA, CF, SR, H	F	NT	-	New Record† (Nawenge; Mahenge Scarp; Nambiga)
Hylomyscus arcimontensis Carleton & Stanley 2005	African wood mouse	NE – EA, SR	F	NE	-	New Record
Praomys delectorum Thomas 1910	Soft furred rat	W	F	NT	-	Nawenge; Mahenge Scarp
HYAENIDAE						
cf. Crocuta crocuta Erxleben 1777	Spotted hyaena	W	f/O	CD	-	New Record (Nambiga)
ELEPHANTIDAE						
Loxodonta africana Blummenbach 1797	African Elephant	W	f/O	VU	I	New Record (Nambiga)
BOVIDAE						
Syncerus caffer Sparrman 1779	Buffalo	W	f/O	CD	-	New Record (Nambiga)
Cephalophus harveyi Thomas 1893	Red duiker	W	FF	CD	-	New Record
Cephalophus monticola Thunberg 1789	Blue duiker	W	FF	LC	II	New Record
Neotragus moschatus Van Duben 1847	Suni	W	F	CD	-	New Record

†This record (*Beamys hindei)* from Frontier Tanzania's previous work has not been included in peer-reviewed literature (Burgess *et al.* 2007), and has therefore been considered unverified for Mahenge. This survey presents the first confirmed records of this species for the Mahenge Mountains.

Key to all Results Species Tables:

Range: SE = Strict Endemic, confined to the Mahenge Mountain block, E = Endemic, range restricted to the Eastern Arc Mountains, NE = Near endemic, range restricted to the Eastern Arc Mountains and at least one other African ecoregion (CF = Coastal Forests; SR = Southern Rift; H = Kilimanjaro, Meru and/or Kenya Highlands; W = Widespread;

Habitat: FF = forest-dependent, F = forest dwelling, f = forest visitor, O = non-forest species;

IUCN (2006) Status: VU = Vulnerable, EN = Endangered, NT = Near Threatened, CD = Conservation Dependent, LC = Least Concern, NE = Not Evaluated;

CITES (2006) Status: Appendices I, II, or III;

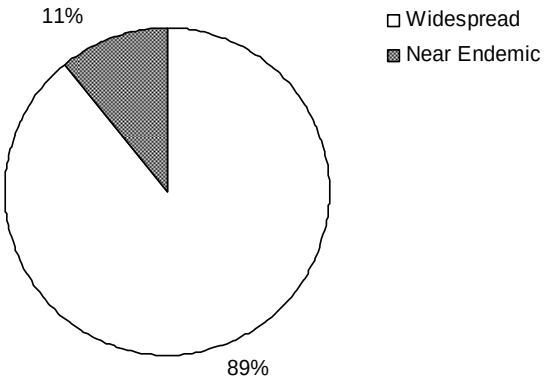

Figure 9: Mammal endemism in Sali FR

Avifauna

N. OWEN & J. KIURE

- *Species richness, composition and diversity*

A total of 59 bird species in 30 families were recorded in Sali FR (appendix 5a); with 46 species (24 families) recorded at WU1, 51 species (26 families) at WU2, and 38 species (23 families) were found at both sites. Thirty-six species represent new records for Mahenge, with fifteen of these new records also being found in Mselezi FR. Appendix 5b lists details of avian survey sites and survey effort.

A total of 12,963 net-metre-hours yielded a total of 19 species from 210 individuals (108 at WU1 and 102 at WU2), of which 17 species were found at WU1 and 16 at WU2; with 14 species shared by both work units (appendix 5c). A total of 24 man-hours of randomised walks and casual observations increased the species inventory by another 40 species. Thirty-seven blood samples and eight specimens were taken for both Mselezi and Sali forest reserves (appendix 5d). Breeding records were made for nine species (appendix 5e). Behavioural observations are described in appendix 5f.

There was a greater relative abundance of all birds at WU2 than WU1 (19.0ind/1000net-metre-hours and 14.2ind/1000net-metre-hours respectively). Species diversity and equitability was found to be good and similar at both sites (Shannon Weiner; WU1 H = 2.33, J = 0.82; WU2 H = 2.29, J = 0.83), and overall species diversity was good with species evenly distributed (H = 2.44, J = 0.83).

The most abundant species captured through mist netting at both sites was the olive sunbird *Nectarinia olivacea* (WU1: 3.6ind/1000nmh; WU2: 4.5ind/1000nmh; fig. 10). There was generally a higher abundance of birds at WU2, with other common species at this site being the little greenbul *Andropadus virens* (3.2ind/1000nmh), Placid's greenbul *Phyllastrephus placidus* (3ind/1000nmh), Sharpe's akalat *Sheppardia sharpei* (1.9ind/1000nmh), white-starred robin *Pogonocichla stellata* (1.5ind/1000nmh), and the forest batis *Batis mixta* (1.1ind/1000nmh). Common species at WU1 included Placid's greenbul *Phyllastrephus placidus* (2.8ind/1000nmh), Shelley's greenbul *Andropadus masukuensis* (1.8ind/1000nmh) and *A. virens* (1.1ind/1000nmh).

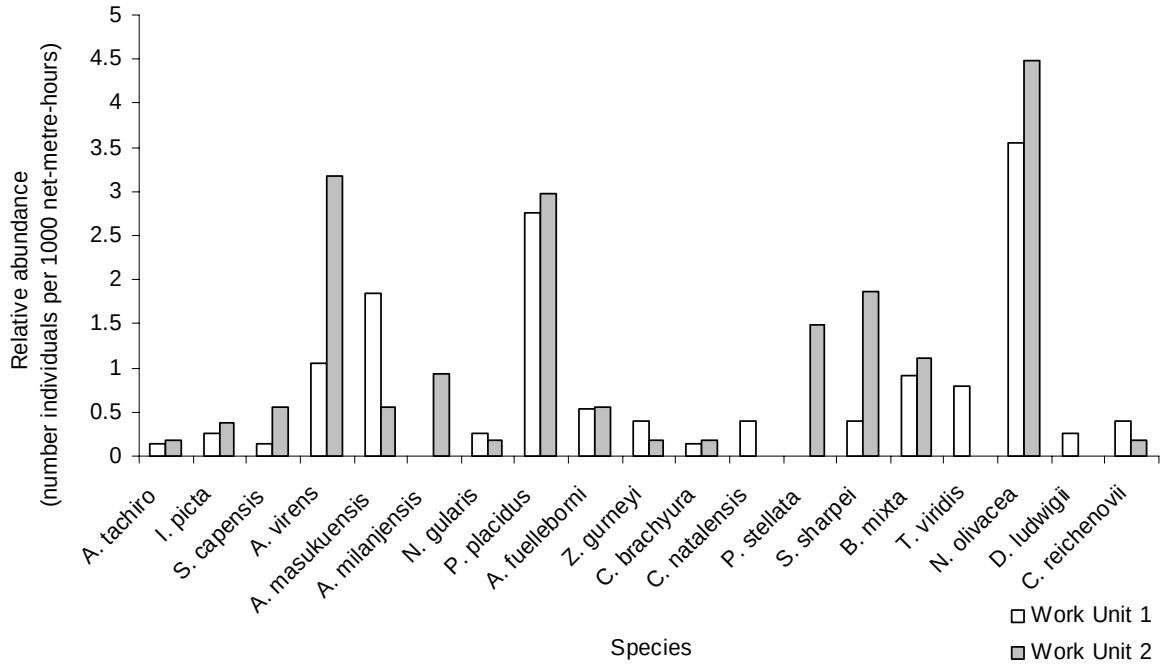

Figure 10: Relative abundance of birds produced from mist netting in Sali FR

- *Endemism, conservation status, and forest dependence*

Of the 59 bird species recorded, 24 species in 17 families are of conservation concern (40.7%; full details of each species can be found in table 9). Seventeen species of conservation concern represent new records for Mahenge (including five endemics), with six of these new records also found in Mselezi. Breeding records were made for nine species, seven of which are of conservation concern.

One species is an Eastern Arc endemic (1.7%; fig. 11) the Usambara eagle owl *Bubo vosseleri*. The distinctive call of species was clearly heard very close to BC2 on two separate occasions, soon after nightfall, by the ornithologist as well as several other team members. Five species (8.5%) are near endemics, green barbet *Stactolaema olivacea*, *Batis mixta*, *Andropadus masukuensis*, *A. milanjensis* and *Sheppardia sharpei*. Notably, breeding records were documented for seven species of conservation concern including the latter three endemics.

One species is considered to be at risk on the IUCN Red List (1.7%; the endemic *B. vosseleri* listed as Vulnerable), with nine being CITES listed. Two species have not yet been evaluated by IUCN, and 56 are listed as Least Concern. Five of the endemics are forest-dependant along with a further 18 widespread species (40%).

Additionally, the call of an unidentified owl species was heard, resembling the call of a new and as yet undescribed owl species originally recorded in Nguru South FR; although no recordings were obtainable. A small unidentifiable black bird that could not be assigned to family was also seen but mist-netting attempts were unsuccessful (J. Kiure pers obs.).

Table 9: Avian species of conservation concern (categorised by endemicity, forest-dependency and/or conservation status) in Sali FR

Species	Common Name	Range	Habitat	IUCN (2006)	CITES (2006)	Previous Mahenge Records
ACCIPITRIDAE						
Stephanoaetus coronatus Linnaeus 1766	African crowned eagle	W	FF	LC	II	Mahenge Scarp
MUSOPHAGIDAE						
Tauraco livingstonii Gray 1864	Livingstone's turaco	W	FF	LC	II	Nawenge; Mahenge Scarp
STRIGIDAE						
Bubo vosseleri Reichenow 1908	Usambara eagle owl	E – Usambaras, Nguru, Uluguru, Rubeho, Udzungwa	FF	VU	II	New Record
TROGONIDAE						
Apaloderma vittatum Shelley 1882	Bar-tailed trogon	W	FF	LC	-	New Record
BUCETORIDAE						
Bycanistes brevis Friedmann 1929	Silvery-cheeked hornbill	W	FF	LC	-	Nawenge; Mahenge Scarp
Bycanistes bucinator Temminck 1824	Trumpeter hornbill	W	FF	LC	-	Mahenge Scarp
Tockus alboterminatus[#] Büttikofer 1889	Crowned hornbill	W	FF	LC	-	Nawenge; Mahenge Scarp
RAMPHASTIDAE						
Stactolaema olivacea Shelley 1880	Green barbet	NE – EA, CF, SR	F	LC	-	New Record[†] (Nawenge; Mahenge Scarp)
PICIDAE						
Mesopicos griseocephalus Boddaert 1783	Olive woodpecker	W	FF	LC	-	New Record
CAMPEPHAGIDAE						
Coracina caesia Lichtenstein 1823	Grey cuckoo-shrike	W	FF	LC	-	New Record
PYCNONOTIDAE						
Andropadus masukuensis[#] Shelley 1897	Shelley's greenbul	NE – EA, SR	FF	LC	-	Mahenge
Andropadus milanjensis[#] Shelley 1894	Stripe-cheeked greenbul	NE – EA, H, SR	FF	LC	-	New Record
Phyllastrephus placidus Sharpe 1882	Placid's greenbul	W	FF	LC	-	New Record
TURDIDAE						
Alethe fuelleborni[#] Reichenow 1900	White-chested alethe	W (restricted range in EA)	FF	LC	-	New Record
Zoothera gurneyi Hartlaub 1864	Orange ground-thrush	W	FF	LC	-	New Record
CISTICOLIDAE						
Apalis melanocephala Fischer & Reichenow 1884	Black-headed apalis	W	FF	LC	-	New Record
SYLVIIDAE						
Bradypterus lopezi Alexander 1903	Evergreen forest warbler	W	FF	LC	-	New Record
MUSCICAPIDAE						
Cossypha natalensis Smith 1840	Red-capped robin-chat	W	FF	LC	-	New Record
Pogonocichla stellata[#] Vieillot 1818	White-starred robin	W	FF	LC	-	New Record
Sheppardia sharpei[#] Shelley 1903	Sharpe's akalat	NE – EA, SR	FF	LC	-	New Record
PLATYSTEIRIDAE						
Batis mixta Shelley 1889	Forest batis	NE – EA, CF, H	FF	LC	-	New Record
MALACONOTIDAE						
Malaconotus nigrifrons Reichenow 1896	Black-fronted bush-shrike	W	FF	NE	-	New Record

Species	Common Name	Range	Habitat	IUCN (2006)	CITES (2006)	Previous Mahenge Records
DICRURIDAE						
Dicrurus ludwigii Smith 1834	Square-tailed drongo	W	FF	LC	-	Mahenge Scarp
ESTRILIDIDAE						
Cryptospiza reichenovii[#] Hartlaub 1874	Red-faced crimsonwing	W	FF	LC	-	New Record

[†]This record (*Stactolaema olivacea)* from Frontier Tanzania's previous work has not been included in peer-reviewed literature (Burgess *et al.* 2007), and has therefore been considered unverified for Mahenge. This survey presents the first confirmed record of these species for the Mahenge Mountains.
[#]Opportunistic breeding records were documented for these birds. For further details see appendix 5e.
For Key to Results Species Tables see Mammal Table Key

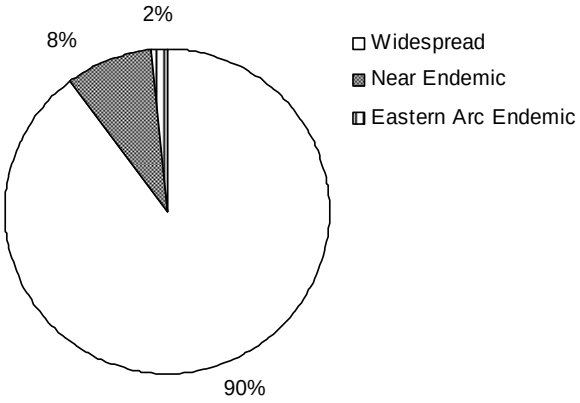

Figure 11: Avian endemism in Sali FR

Herpetofauna

N. OWEN & S. GOMBEER

A species inventory was compiled using data from bucket pitfall trapping, visual encounter surveys (VES), and opportunistic observations and collections. Additionally, villagers produced specimens of herpetofauna caught in farms at the forest edge of the reserve.

Amphibians

- *Species richness, diversity and composition*

Twenty-six amphibian species (with three taxa identified only to genus, one genus *Arthroleptis* may hold more than one species) representing six families were recorded in this survey, (appendix 6a). Up to four species may be new to science; two of which are pictured in annex 2a fig. 62. Ten species represent new records for Mahenge.

A total of 1306 individuals were encountered, 1147 at WU1 and 159 at WU2. Over 528 bucket pitfall nights 999 captures were made, 288 captures over 84 man-hours of visual encounter surveys, and 19 casual observations. Of these, 108 specimens were taken. Plotting the species accumulation over time indicates a levelling off of the curve, demonstrating that this is a fairly accurate estimation of species richness (fig. 12).

Twenty species (5 families) were found at WU1, and 19 species (6 families) at WU2, of these 12 species were found at both sites. Species diversity was found to be higher at WU2 (Shannon Weiner; H = 1.46) compared to WU1 (H = 2.19), as species at WU2 were more evenly distributed with a higher equitability index (J = 0.76) than WU1 (J = 0.49).

Overall species diversity was found to be reasonable although equitability was on the low side (H = 1.76, J = 0.54); also apparent from the skewed relative abundances of each species as the species assemblage was dominated by species from the genus *Arthroleptis*.

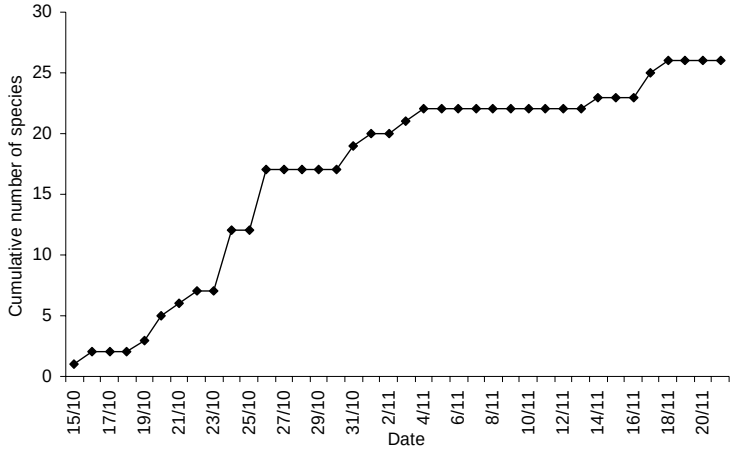

Figure 12: Amphibian species accumulation over time for Sali FR

Only nine species were caught using both bucket pitfall traps and visual encounter surveys, VES caught an additional ten species, and the pitfall traps caught an additional five species, indicating that both these methods are important to survey as wide a range of species as possible.

Relative abundance of each species was calculated per 100 VES man-hours and/or per 100 bucket pitfall trap-nights, depending on the species targeted by each method. For bucket pitfalls (fig. 13), three species had a significantly higher relative abundance at WU1 than all other species: *Arthroleptis sp.* (142ind/100trap-nights), *Arthroleptis xenodactyloides* (158ind/100trap-nights), and *A. reichei* (50ind/100trap-nights). For all other species, and for all species at WU2, relative abundances by this method were low.

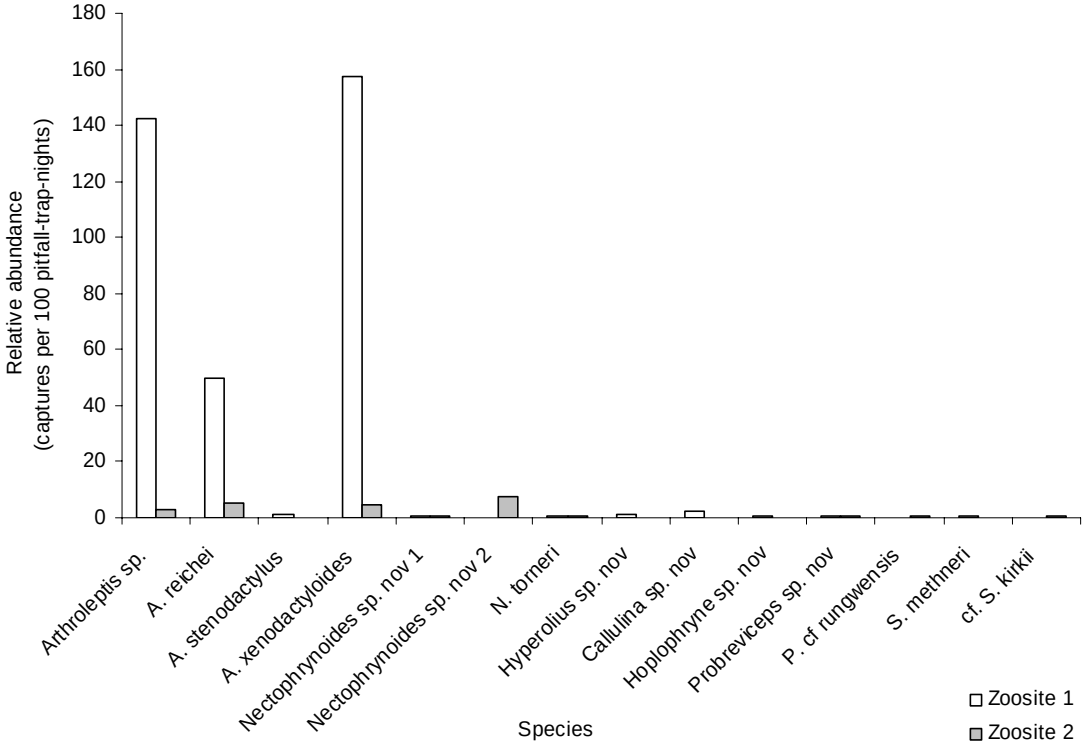

Figure 13: Relative abundance of amphibians caught in bucket pitfall traps in Sali FR

For VES (fig. 14), *Arthroleptis sp.* (104ind/100man-hours) and *Arthroleptides yakusini* (98ind/100man-hours) had the highest relative abundance at WU1, with *Leptopelis vermiculatus* (128ind/100man-hours) most abundant at WU2. Of note is the generally high abundance of *Arthroleptis* species at WU1. No species were present in similar abundances at both sites. Appendix 6b summarises the amphibian data obtained through visual encounter surveys, bucket pitfalls and opportunistic collections for Sali FR.

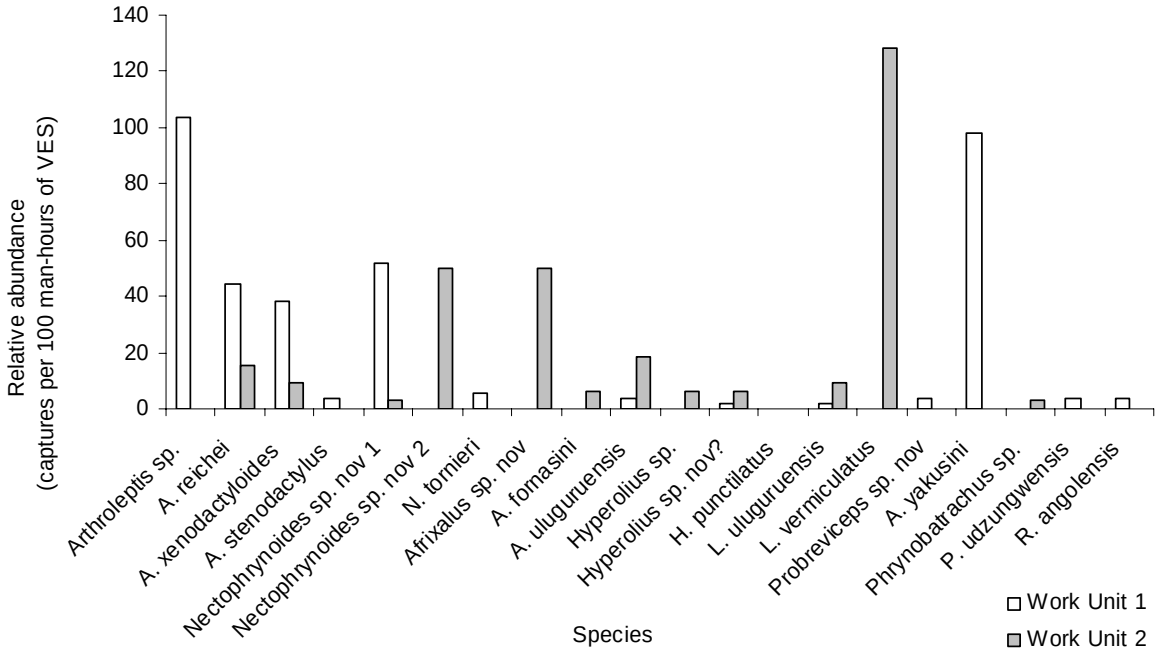

Figure 14: Relative abundance of amphibians caught on VES in Sali FR

- *Endemism, conservation status, and forest dependence*

Of the 26 species recorded in Sali FR, 19 species in 6 families are of conservation concern (73.1%; full details of each species can be found in table 10), with up to 17 (65.4%) endemics (fig. 15). Ten species of conservation concern represent new records (including six of the known endemics and four potentially new species) for Mahenge.

Four species appear to be new to science as they do not fit any known species description based on preliminary morphological and genetic analyses; and they may be strict endemics (15.4%) to the Mahenge Mountain block (M. Menegon pers. comm.; *Callulina sp. nov, Hoplophryne sp. nov, Nectophrynoides sp. nov 2, Probreviceps sp. nov*). Two additional undescribed species, *Afrixalus sp. nov, Nectophrynoides sp. nov 1,* resemble recently discovered and as yet undescribed specimens from Udzungwa Scarp (M. Menegon pers. comm.), thus will likely be Eastern Arc endemics along with three additional species, *Arthroleptides yakusini, Leptopelis uluguruensis, Phrynobatrachus udzungwensis* (19.2%).Eight more species are near endemics (30.8%), found in the Eastern Arc and adjacent eco-regions, *Afrixalus uluguruensis* (complex), *Arthroleptis reichei, Hyperolius punctilatus, Leptopelis vermiculatus, Nectophrynoides torneri, Probreviceps cf. rungwensis, cf. Scolecomorphus kirkii* and *Spelaeophryne methneri.*

Seven species are considered to be at risk on the IUCN Red List (26.9%; listed as Endangered, Vulnerable, Near Threatened or Conservation Dependent) with *N. tornieri* also being CITES listed. Nine species are listed as Least Concern. Seventeen species are forest-dependent (65.4%; all the endemics apart from *Spelaeophryne methneri;* and one additional widespread species, *Leptopelis flavomaculatus).*

Table 10: Amphibian species of conservation concern (categorised by endemicity, forest-dependency and/or conservation status) in Sali FR

Species	Common Name	Range	Habitat	IUCN (2006)	CITES (2006)	Previous Mahenge Records
SCOLECOMORPHIDAE						
cf. Scolecomorphus kirkii Boulenger 1883	Kirk's caecilian	NE – EA, SR	FF	C	-	Sali; Mahenge Scarp; Nawenge
ARTHROLEPTIDAE						
Arthroleptis cf. reichei Nieden 1910	Reiche's squeaker	NE – EA, SR	FF	NT	-	New Record
BUFONIDAE						
Nectophrynoides tornieri Roux 1906	Tornier's forest toad	NE – EA, SR	FF	LC	I	Sali
Nectophrynoides sp. nov 1		E? – Udzungwa?	FF?			New Record
Nectophrynoides sp. nov 2		SE?	FF?			New Record
HYPEROLIIDAE						
Afrixalus sp. nov?		E? – Udzungwa?	FF?			New Record
Afrixalus uluguruensis complex Barbour & Loveridge 1928	Uluguru spiny reed frog	NE – EA, CF	FF	VU	-	Sali
Hyperolius puncticulatus Pfeffer 1893	Spotted reed frog	NE – EA	F	LC	-	Sali Nawenge
Leptopelis flavomaculatus Gunther 1864	Yellow spotted tree frog	W	FF	LC	-	Sali Nambiga
Leptopelis uluguruensis Barbour & Loveridge 1928	Uluguru tree frog	E – E. Usambara, Nguru, Nguu, Uluguru, Udzungwa	FF	VU	-	New Record
Leptopelis vermiculatus Boulenger 1909	Vermiculated tree frog	NE – EA, SR	FF	VU	-	Sali
MICROHYLIDAE						
Callulina sp. nov		SE?	FF?			New Record
Hoplophryne sp. nov		SE?	FF?			New Record
Probreviceps sp. nov		SE?	FF?			New Record
Probreviceps cf rungwensis Loveridge 1932	Snouted forest frog	NE	FF	VU	-	New Record
Spelaeophryne methneri Ahl 1924	Scarlet snouted frog	NE – EA, CF, SR	F	LC	-	Sali; Nambiga; Nawenge
RANIDAE						
Arthroleptides yakusini Channing *et al.* 2002	Southern torrent frog	E – Nguu, Uluguru, Mahenge, Udzungwa	FF	EN	-	Sali
Phyrnobatrachus udzungwensis Grandison & Howell 1983	Udzungwa puddle frog	E – Nguu, Nguru, Uluguru, Udzungwa	FF	VU	-	New Record

For Key to Results Species Tables see Mammal Table Key

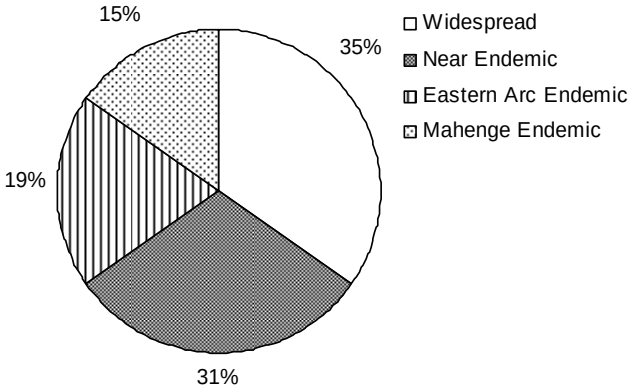

Figure 15: Amphibian endemism in Sali FR

Reptiles

- *Species richness, diversity and composition*

Twenty-six reptile species representing nine families were recorded in this survey (appendix 7a). Fourteen species represent new records for Mahenge, two of which were also found in Mselezi FR. Up to two species appear to be new to science (one of which was also found in Mselezi FR); photographs are displayed in annex 2a fig. 62.

A total of 107 individuals were encountered, 60 at WU1, 28 at WU2. Five captures were made over 528 bucket pitfall nights, 44 captures over 64 man-hours of visual encounter surveys, and 39 casual observations. Of these, 38 specimens were taken. The count of species richness appears to be an underestimation as the species accumulation curve is still showing an upward trend (fig. 16).

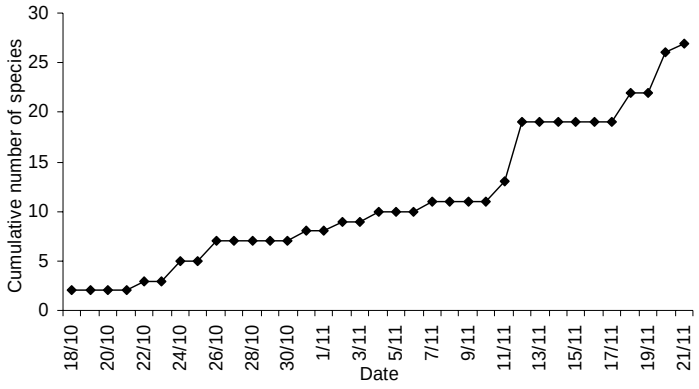

Figure 16: Reptile species accumulation over time for Sali FR

Eleven species (8 families) were found at WU1, and 6 species (5 families) at WU2; of these 3 species were found at both sites. A further twelve species (from 19 individuals) were brought by villagers from the forest edge. Overall species diversity was found to be high with species being evenly distributed (Shannon Weiner; H = 3.26, J = 0.64).

Relative abundance of each species was calculated per 100 VES man-hours and/or per 100 bucket pitfall trap-nights, depending on the species targeted by each method. For bucket pitfalls, only two species were captured, of which *Cnemaspis sp. nov* was found at both work units, with slightly greater abundance at WU2 (0.38ind/100 pitfall trap-nights at WU1 compared with 0.76ind/100 pitfall trap-nights at WU2); the other species being *Melanoseps loveridgei*, only found at WU2 (0.76ind/100 pitfall trap-nights).

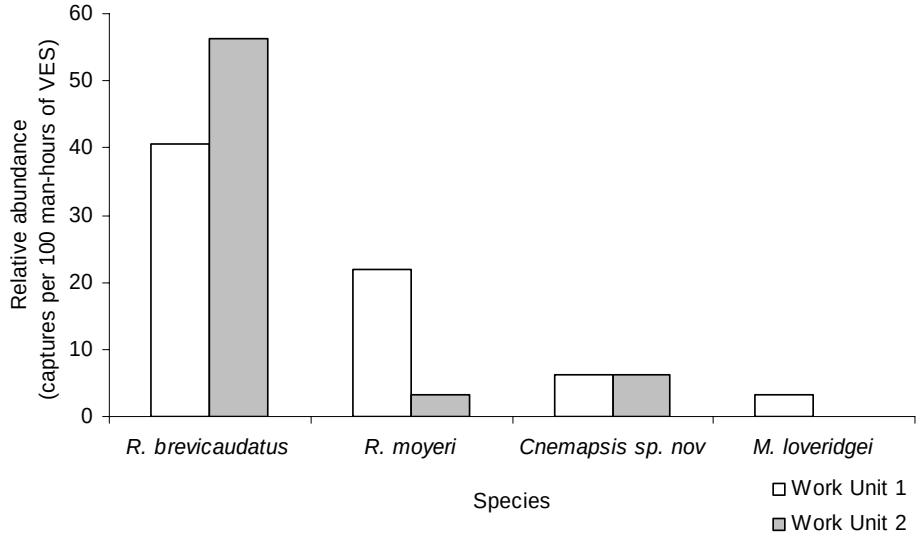

Figure 17: Relative abundance of reptiles caught on VES in Sali FR

For VES (fig. 17), four species were captured. *Rieppeleon brevicaudatus* was the most common species, more abundant at WU1 (56ind/100man-hours) than WU2 (41ind/100man-hours), followed by *Rhampholeon beraduccii*, common at WU1 (22ind/100man-hours). Appendix 7b summarises the reptile data obtained through visual encounter surveys, bucket pitfalls and opportunistic collections for Sali FR.

- *Endemism, conservation status, and forest dependence*

Of the 26 species recorded in Sali FR, seven species in five families are of conservation concern (26.9%; full details of each species can be found in table 11), with a potential two species being new to science, and up to seven endemics (23.1%). Five of these species represent new records for Mahenge (including four endemics), with two of these new records also being found in Mselezi FR.

On the basis of preliminary morphological and genetic analyses, two are potentially new species, *Cnemaspis sp. nov* and *Kinyongia sp. nov?,* both of which are likely to be strict endemics (M.Menegon pers. comm.) along with the recently described *Rhampholeon beraduccii* (15.4% strict endemics; fig. 18) to the Mahenge Mountain block. One species *Xyeledontophis sp.* resembles the Eastern Arc endemic *Xyeledontophis uluguruensis* (3.8% Eastern Arc endemic). Two species are near endemics (7.7%) *Rieppeleon brevicaudatus* and *Crotaphopeltis tornieri*, found in the Eastern Arc and adjacent eco-regions.

Five species are forest-dependent (all the endemics except *R. brevicaudatus* and *R. beraduccii*, as well as the widespread *Natriciteres sylvatica*; 19.2%). Twenty species are Not Evaluated on the IUCN Red List and two species are listed on CITES Appendix II.

Table 11: Reptile species of conservation concern (categorised by endemicity, forest-dependency and/or conservation status) in Sali FR

Species	Common Name	Range	Habitat	IUCN (2006)	CITES (2006)	Previous Mahenge Records
GEKKONIDAE						
Cnemaspis sp. nov		SE?	FF?			New Record
CHAMAELEONIDAE						
Rieppeleon brevicaudatus Matschie 1892	Bearded pygmy chameleon	NE – EA, CF	F	NE	-	Sali; Nawenge; Mahenge Scarp
Rhampholeon beraduccii Mariaux & Tilbury 2006	Pygmy chameleon	SE – Mahenge	F/f	NE	-	Sali
Kinyongia sp. nov?		SE?	FF?			New Record
COLUBRIDAE						
Crotaphopeltis tornieri Werner 1908	Tornier's cat snake	NE – EA, SR	FF	NE		New Record
Natriciteres sylvatica Broadley 1966	Forest marsh snake	W	FF	NE	-	New Record
Xyeledontophis sp.	Dagger toothed snake	E?	FF			New Record

For Key to Results Species Tables see Mammal Table Key

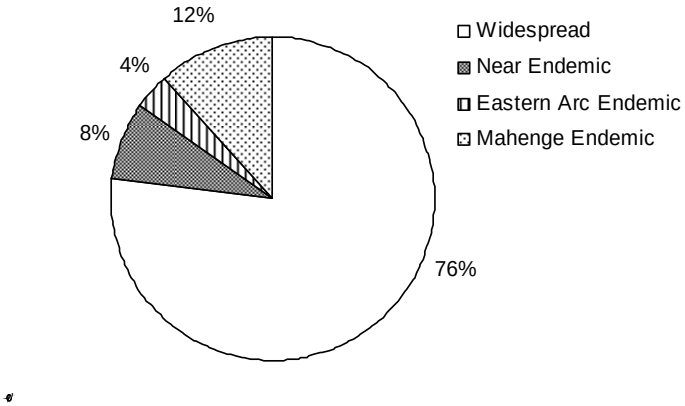

Figure 18: Reptile endemism in Sali FR

Herpetofaunal Communities

TWINSPAN analysis was conducted using the VES transect and VES quadrat data combined. Analysis using species abundances showed no obvious clustering in relation to habitat, capture method or forest reserve whereas analysis using presence-absence produced some separation into different communities (see appendix 7c for diagrammatic output).

The samples divided into a set of samples solely from Sali FR indicated by *Leptopelis vermiculatus* and *Afrixalus uluguruensis* (complex), which further divided into samples from rocky stream habitats and forest habitats; and a set primarily made up of samples from Mselezi FR with some from Sali FR indicated by species such as *Arthroleptis stenodactylus* and *A. xenodactyloides.*

Butterflies

S. GOMBEER

- *Species richness, composition and diversity*

A total of 74 species of butterfly representing eight families were recorded in Sali FR (appendix 8a). Forty-eight species represent new records for Mahenge, with four of these new records also being found in Mselezi FR.

A total of 299 captures were made (149 at WU1 and 150 at WU2), 29 captures from 96 canopy trapping days, 263 captures from 38 sweep net-hours as well as seven opportunistic collections. Of these 94 specimens were taken. Appendix 8b summarises the butterfly data obtained through canopy traps, sweep netting and opportunistic collections in Sali FR.

Forty-four species (eight families) were found at WU1 and 49 species (seven families) at WU2, with only 20 species being found at both sites. The species accumulation curve for Sali FR shows a small levelling off at WU1, before the move between camps (6th Nov-11th Nov), implying the species list for that site is fairly comprehensive; however the curve is still showing an upward trend at WU2 thus the species inventory for that site is incomplete (fig. 19).

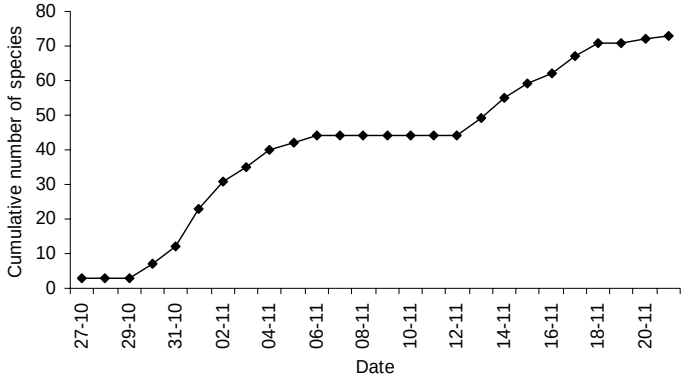

Figure 19: Butterfly species accumulation over time for Sali FR

Species diversity was found to be high and similar at both sites (Shannon Weiner; WU1: H = 3.24; WU2: H = 3.41) with an overall extremely high species diversity but an uneven distribution of species (H = 3.67, J = 0.54).

Considering species assemblages as represented by the ten most abundant species found at each work unit (table 12), *Appias lasti* (17% of sweep-net captures at WU1; 23% at WU2) and *Uranothauma falkinsteini* (14% of sweep-net captures at WU1; 6% at WU2) were two of the three most abundant species at both sites and thus the two most abundant species within Sali FR. Apart from these two species, the species assemblage appears to be different at each site. *Bicyclus campinus* was the most abundant species in canopy traps at WU1, accounting for 63% of captures, while *Euxanthe tiberius* was most abundant at WU2 canopy-traps, with 33% of captures.

TWINSPAN analysis was conducted using the sweep netting and canopy trapping data combined; analyses utilised the abundances of species and presence-absence data (see appendix 8c for diagrammatic output).

Both analyses produce a separation of communities through canopy trapping and through sweep netting; indicated by *Charaxes cithaeron*. The forest canopy thus supports a different community to the understory species sampled using sweep nets; demonstrating that the use of canopy traps is a valuable technique to obtain a more complete representation of the butterfly community.

Sali FR appears to have a significantly distinct understory species community from Mselezi FR; and two communities within Sali FR can be distinguished: a distinct wetland community indicated by *Eicochrysops Hippocrates* and a forest based community.

Table 12: The ten most abundant butterfly species found in (a) WU1 and (b) WU2, in Sali FR, with relative abundances by canopy trapping (number of individuals per 100 canopy trap-days) and/or sweep netting (number of individuals per 100 sweep net man-hours).

Family	Species	Relative abundance (per 100 sweep net man-hours)	Relative abundance (per 100 canopy trap-days)
(a) WU1			
Pieridae	*Appias lasti*	115.79	0.00
Lycaenidae	*Uranothauma falkensteini*	94.74	0.00
Danaidea	*Amauris niavius*	52.63	0.00
Satyridea	*Bicyclus campinus*	21.05	10.42
Pieridae	*Eurema senegalensis*	47.37	0.00
Acraeidae	*Acraea pentapolis*	31.58	0.00
Pieridae	*Eurema floricola*	31.58	0.00
Nymphalidae	*Salamis parhassus*	31.58	0.00
Acraeidae	*Acraea cerasa*	21.05	0.00
Papilionidae	*Graphium policenes*	21.05	0.00
(b) WU2			
Pieridae	*Appias lasti*	152.63	0.00
Lycaenidae	*Eicochrysops hippocrates*	42.11	0.00
Lycaenidae	*Uranothauma falkensteini*	36.84	0.00
Nymphalidae	*Euxanthe tiberius*	0.00	14.58
Lycaenidae	*Leptotes pirithous*	31.58	0.00
Papilionidae	*Graphium policenes*	26.32	0.00
Nymphalidae	*Junonia sophia*	26.32	0.00
Nymphalidae	*Precis tugela*	26.32	0.00
Nymphalidae	*Tirumala formosa*	26.32	0.00
Nymphalidae	*Charaxes xiphares*	26.32	0.00

- *Endemism, conservation status, and forest dependence*

Of the 74 species recorded in Sali FR, twenty-five species in eight families are of conservation concern (33.7%; full details of each species can be found in table 13). Of these species, 13 represent new records for Mahenge (including five endemics), with three of these new records also found in Mselezi FR.

Cymothoe aurivilli is an endemic, recorded only in the Eastern Arc Mountains (1.4%; fig. 20). Four species are near endemics (5.4%; *Bicyclus danckelmani, Neptis nina, Papilio pelodorus vesper* and *Papilio fuelleborni fuelleborni,* found in the Eastern Arc, the Southern Highlands and parts of Malawi. All of the endemics are forest-dependent, along with an additional 17 widespread species (31.5%). Seven species are considered to be at risk according to the African Butterfly Research Institute (Collins & Bampton 2007), with *Cymothoe aurivilli* listed as Vulnerable; and *Amauris crawshayi* and *Bicyclus danckelmani* as Threatened.

Table 13: Butterfly species of conservation concern (categorised by endemicity, forest-dependency and/or conservation status) in Sali FR

Species	Range	Habitat	IUCN (2006)	CITES (2006)	Conservation status (ABRI 2007)	Previous Mahenge Records
ACRAEIDAE						
Acraea aganice Hewitson 1852	W	FF	-	-	LC	Mahenge Scarp
Acraea cerasa Hewitson 1861	W	FF	-	-	LC	NR
Acraea johnstoni Goodman 1885	W	FF	-	-	LC	Nawenge
Acraea pentapolis Ward 1871	W	FF	-	-	LC	NR
Acraea satis Ward 1871	W	FF	-	-	LC	Mahenge Scarp
DANAIDAE						
Amauris crawshayi Butler 1897	W	F	-	-	T	New Record
Amauris niavus Linnaeus 1758	W	FF	-	-	LC	Mahenge Scarp; (Nambiga)
NYMPHALIDAE						
Charaxes cithaeron Felder 1885	W	FF	-	-	LC	Mahenge Scarp; (Nambiga); Nawenge
Charaxes xiphares Cramer 1781	W	FF	-	-	LC	NR
Cymothoe aurivilli Staudinger 1899	E - Nguru, Nguu, Uluguru, Rubeho, Udzungwa	FF	-	-	V	NR
Euphaedra castanoides Hecq 1985	W	FF	-	-	LC	NR
Euxanthe tiberius Grose-Smith 1889	W	FF	-	-	NT	Mahenge Scarp
Lachnoptera iole ayresi Trimen 1879	W	FF	-	-	LC	NR
Neptis nina Staudinger 1896	NE - EA & Pugu Hills	FF	-	-	LC	NR
Pseudacraea dolomena Hewitson 1865	W	FF	-	-	LC	NR
SATYRIDAE						
Bicyclus danckelmani Rogenhofer 1891	NE – EA, H & SR	FF	-	-	T	NR
PAPILIONIDAE						
Graphium policenes Cramer 1775	W	FF	-	-	LC	NR (Nambiga)
Papilio dardanus Brown 1776	W	FF	-	-	LC	Mahenge Scarp
Papilio fuelleborni fuelleborni Karsch 1900	NE - EA, SR & Malawi	FF	-	-	NT	NR
Papilio pelodurus vesper Butler 1895	NE – EA, SR & Malawi	FF	-	-	LC	NR
Papilio phorcas Cramer 1775	W	FF	-	-	LC	NR
PIERIDAE						
Eurema floricola Boisduval 1833	W	FF	-	-	LC	Mahenge Scarp Nawenge
HESPERIDAE						
Celaenorrhinus bettoni Butler 1902	W	FF	-	-	LC	NR
LYCAENIDAE						
Alaena picata Sharpe 1896	W	F	-	-	NT	NR
Oboronia beuronica Karsch 1895	W	F	-	-	NT	NR

Species	Range	Habitat	IUCN	CITES	Conservation status (ABRI 2007)	Previous Mahenge Records
Uranothauma delatorum Heron 1909	W	FF	-	-	LC	NR
Uranothauma falkensteini Dewitz 1879	W	FF	-	-	LC	Nawenge

For Key to Results Species Tables see Mammal Table Key;
Conservation status (ABRI 2007): V = Vulnerable, T = Threatened, NT = Near Threatened, LC = 'Least Concern';

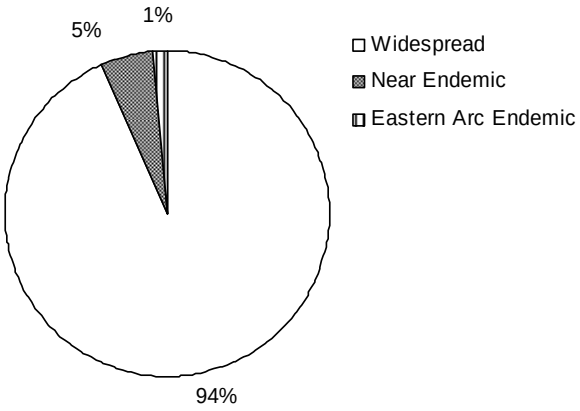

Figure 20: Butterfly endemism in Sali FR

5.3.2 Vegetation of Sali FR

A. AHRENDS & V. WILKINS

Vegetation data were collected utilising 30 vegetation and regeneration plots within two systematic work units as well as through opportunistic collections. Systematic surveying concentrated on tree species as the dominant life form in the forest reserve and so a comprehensive species list was achieved; however other life forms were only collected opportunistically and due to time and survey effort constraints these species lists are incomplete. Appendix 9 presents plant data.

- *Species richness, composition and diversity*

Using the latest identifications, a total of 150 species in 56 families were recorded in Sali FR (appendix 9a). Eleven species were recorded in both Sali and Mselezi FRs. In the field 11 plant taxa were identified to species and a further 139 plant species were collected as specimens; of which 68 have been identified to date and 71 specimens still have incomplete identifications. Sixty-eight species represent new records for the Mahenge mountains.

Trees

A collection of 122 specimens and 11 field records were obtained in Sali FR, for 118 different tree species in 43 families. In the field 11 plant taxa were identified to species and of the tree species with specimens 48 species have been identified to date and 59 specimens still have incomplete identifications. Of those species identified, 39 tree species were forest specialists, 16 trees were forest generalists and 3 were grassland/woodland tree species (Ahrends & Marchant 2006); 52 tree species represent new records for Mahenge.

Overall tree species diversity for the reserve was very high with species very evenly distributed (Shannon Wiener; H= 3.75, J= 0.82). The most abundant species/sub-species recorded in Sali FR were, in order of abundance, *Cassipourea gummiflua*, *Rawsonia? sp.*, *Drypetes natalensis var. natalensis* and *Tabernaemontana pachysiphon.* WU2 had a higher tree diversity and better species equitability (Shannon Weiner; H = 3.67, J = 0.81) in comparison to WU1 (Shannon Weiner; H = 3.3, J = 0.73).

Other plant life forms

For other life forms 34 specimens of 32 species in 21 families were collected: 1 climber, 4 lianas, 6 shrubs and 21 herbaceous plant species. Of the 32 plant species for which specimens were obtained, 17 have been identified to date and 15 specimens still have incomplete identifications. Sixteen species represent new records for the Mahenge Mountains.

- *Endemism, conservation status and forest dependence*

A total of 18 plant species are of conservation concern, due to endemism and/or conservation status (full details of each species can be found in table 14). Fourteen species are classed as endemics or near-endemics, seven species are classed as Potentially Threatened (Gereau & Luke 2003), and ten species are present as Vulnerable on the IUCN Red List. Thirty-nine tree species and one herbaceous species are forest specialists. Twelve of these species represent new records for the Mahenge Mountains.

Trees

Fourteen tree species were found to be of conservation concern, due to endemism and/or conservation status. Eleven species are classed as endemics (fig. 21), one Mahenge endemic, nine Eastern Arc endemics and one near endemic. Three species are classed as Potentially Threatened (Gereau & Luke 2003), and ten species are present as Vulnerable on the IUCN Red List. Of these species eight are new records for the Mahenge Mountains.

Other plant life forms

For other life forms four species were found to be of conservation concern, due to endemism and/or conservation status. Three species were classed as Eastern Arc endemics, four species were classed as Potentially Threatened, and no species are present on the IUCN Red List. Of these species two represent new records for Mahenge Mountains.

Table 14: Plant species of conservation concern (categorised by endemicity and/or conservation status) in Sali FR

Family	Species	Author	Life Form	Habit	Endemic Status	Threatened Status	Previous Mahenge Records
Acanthaceae	*Justicia interrupta*	(Lindau) C.B. Clarke	S	fs	-	PT	Mahenge Scarp
Annonaceae	*Monodora globiflora*	Couvreur Ined.	T	-	-	PT	New Record
Araceae	*Anchomanes abbreviatus*	Engl.	H	-	E	PT	New Record
Balsaminaceae	*Impatiens confusa subsp. longicornu*	Grey-Wilson	H	-	E	PT	Muhulu
Caricaceae	*Cylicomorpha parviflora*	Urb.	T	fs	-	PT	Nawenge
Euphorbiaceae	*Sibangea pleioneura*	Radcl.-Sm.	T	fs	E	VU	New Record
Guttiferae (Clusiaceae)	*Allanblackia stuhlmannii*	Engl.	T	fs	E	VU	Sali; Muhulu; Nawenge
Icacinaceae	*Alsodeiopsis schumannii*	(Engl.) Engl.	T	fs	E	VU	New Record
Lamiaceae	*Vitex amaniensis?*	W. Pieper	T	fs	E	VU	New Record
Lauraceae	*Beilschmiedia kweo?*	(Mildbr.) Robyns & R.Wilczek	T	fs	E	VU	New Record
Leguminosae (Papilionaceae)	*Baphia semseiana?*	Brummitt	T	fs	E	VU	New Record
Melastomataceae	*Gravesia pulchra var. pulchra*	(Gilg.) Wickens	H	-	E	PT	New Record
Rubiaceae	*Craterispermum longipedunculatum?*	Verdc.	T	-	E	VU	New Record
Rubiaceae	*Morinda asteroscepa?*	K.Schum.	T	fs	-	VU	New Record
Rubiaceae	*Pavetta lynesii*	Bridson	T	-	E	VU	New Record
Rubiaceae	*Psychotria megalopus*	Verdc.	T	-	E	VU	Nawenge
Sterculiaceae	*Leptonychia usambarensis*	K.Schum. ex Engl.	T	fs	NE	-	New Record
Thymelaeaceae	*Peddiea lanceolata*	Domke	T	-	SE	PT	Sali

Key to Plant Results Table
Life Form: T = Tree, S = Shrub, H = Herb;
Habit: fs = forest specialist, fg = forest generalist, g/w = predominantly woodland and grassland species (Ahrends & Marchant 2006);
Endemic Status: SE = Strict Endemic, confined to the Mahenge Mountain block, E = Endemic, range restricted to the Eastern Arc Mountains, NE = Near endemic, range restricted to the Eastern Arc Mountains and at least one other African ecoregion;
Threatened Status: VU = Vulnerable (IUCN 2006), PT = Potentially Threatened (Gereau & Luke 2003, revised 2006);

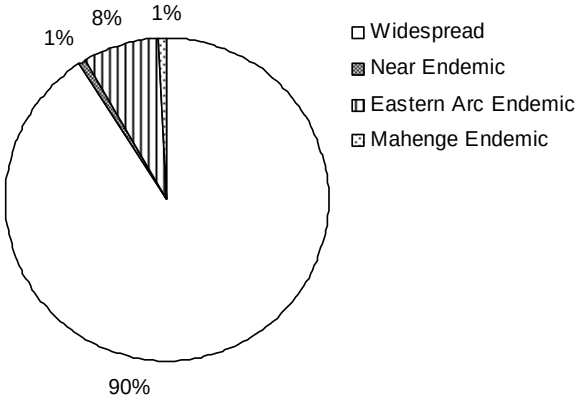

Figure 21: Tree endemism in Sali FR

- *Tree Communities and Vegetation Characteristics*

The majority of tree species recorded in the reserve occur in both lowland and montane areas; but there was also a good number of exclusively (upper) montane species and a few exclusively lowland specialist species. However, classifying the tree species in Sali into communities through multivariate analysis was very difficult, as there was a strong continuum in species composition between plots. Only two plant communities could be isolated due to the strong continuities present in the data, these were:

(i) Undifferentiated (sub) montane forest: with a higher number of moisture dependent species and no signs of disturbance; dominated by either *Parinari excelsa*, characterised by high basal area and a greater number of larger trees (>20cm dbh); or domination by *Xymalos monospora*, characterised by high ground and shrub cover.

(ii) Semi-riverine/disturbed forest: these plots had disturbance resilient species such as: *Alangium chinense, Bersama abyssinica, Cordia africana, Solaneciom mannii* and *Maesa lanceolata*; which are mostly open-area species or forest generalists. However, there were also a number of moisture indicating species present. Only one plot had any physical signs of human disturbance while the other plots were characterised by the presence of a stream.

More information regarding these vegetations associations is displayed in table 15.

- *Environmental Gradients*

Analysis revealed that vegetation was not influenced by a single environmental factor but by a combination of factors with a similar weight, these were:

(i) Presence of paths and clearances: increased number of open area and disturbance resilient species, the density of small trees and the regeneration of pioneers.

(ii) Position on the slope: plots at a higher altitude had a greater number of forest specialist and montane species, exhibited a higher basal area and density of larger trees and more stable regeneration.

(iii) Water association: plots with streams, dry river beds or wetlands contained a greater number of forest generalist and disturbance resilient species, exhibited higher shrub cover and a greater number of pioneers regenerating.

Table 15: Sali FR vegetation associations

Vegetation association	Characteristic species	Vegetation structure	Regeneration	Site Characteristics	Robustness	Wider Applicability across the Eastern Arc
undifferentiated (sub) montane forest (var 1 dominated by *Parinari excelsa*; var 2 dominated by *Xymalos monospora*)	*Parinari excelsa, Ocotea usambarensis, Xymalos monospora*	variable	canopy species	variable	relatively robust (identified as an isolated group by the TWINSPAN and phyto-sociological analyses)	The established groups were subject to spatial autocorrelations. Their wider applicability is therefore doubtful.
semi-riverine/disturbed forest	*Alangium chinense, Maesa lanceolata, Rauvolfia caffra*	tree density high, basal area high, high canopy, canopy cover high, shrub cover high	canopy species	sectioned by stream or clearing	robust (identified as an isolated group by the TWINSPAN, phyto-sociological analyses and vegetation structure analyses)	

- *Regeneration*

The available data suggested that canopy species were regenerating in the majority of WU2 plots, species included *Alsodeiopsis schumannii, Xymalos monospora, Parinari excelsa* and *Newtonia buchananii*; and sub-canopy species restocking in the remainder. For the two plots that had been impacted by fire damage, one had no regeneration and the other only had open-area species regenerating.

For more information and greater detail regarding the botanical data analysis for Sali FR please refer to the BREAM Consultant Report by Ahrends & Marchant (2006).

5.3.3 Human Resource Use and Disturbance in Sali FR

V. WILKINS

A total of 8km of disturbance transects were conducted, covering an area of 80,000m^2 (8ha) of the total 1890 ha of Sali FR. Each 1km transect was divided into twenty 50m sections, giving a total of one hundred and sixty 50m sections.

Pole Extraction

Displayed in table 16 are the percentages and total number of pole extractions, live and naturally dead poles (appendix 10a gives further details). The highest proportion of surveyed poles were still alive representing 96% of the sample, with naturally dead poles representing the remaining 4%. The percentage of cut poles was negligible with a total of only six cut poles in the entire area surveyed. Three old cut poles were present on disturbance transect 1 (north of BC1); one old cut pole on each of disturbance transects 7 (south of BC2) and 8 (west of BC2); and a fresh cut pole on transect 6 (east of BC2).

Table 16: Pole extraction in Sali FR

	Total poles surveyed	Live poles	Naturally dead poles	Fresh cut poles	Old cut poles	Total cut poles
Numbers	3797	3657	134	1	5	6
% of total		96	4	>1	>1	>1

Timber Extraction

Displayed in table 17 are the percentages and total number of timber extractions, and the numbers of live and naturally dead timbers (appendix 10a gives further details). The highest percentage was of live timber representing 93%, with naturally dead timbers contributing the remaining 7%. No cut timbers were found in the forest reserve.

Table 17: Timber extraction in Sali FR

	Total timbers surveyed	Live timbers	Naturally dead timbers	Fresh cut timbers	Old cut timbers	Total cut timbers
Numbers	2875	2671	204	0	0	0
% of total		93	7	0	0	0

Other Disturbance

Additional forms of disturbance recorded in Sali FR included fire damage, hunting and footpaths (table 18). These are detailed below.

Table 18: Disturbance classified by type and occurrence in Sali FR

Disturbance Type	Total number of incidences	% of 50m sections on Disturbance Transects	Location
Fire Damage	10	0	Large Mammal Transects LT2 SE, LT3 SW; Veg Plots 11 & 12; Casual;
Hunting	42	3.8	Disturbance Transects DT3 S, DT6 E; Large Mammal Transects LT2 SE, LT5 NE; Casual;
Footpaths	12	5	Large Mammal Transect LT6 SE; Disturbance Transects DT1 N; DT2 E; DT3 S; DT6 E;

Fire Damage

Several incidents of fire damage were documented; four incidents on large mammal transect 2 (south-east of BC1) and 3 (south-west of BC2). Two vegetation plots (plots 11 and 12, south-west and south-east of BC1) were completely burnt. Additionally, several casual observations of fire damage were noted on the edges of the reserve; for example Gongo peak lies within Sali FR, on arrival at the forest reserve this peak was forested, on departure extensive fires (probably lit to clear ground for cultivation) had entered, destroyed parts of the forest and cleared the peak (shown in annex 2a fig. 63b).

Hunting

Within Sali FR a total of 42 traps were found; some recorded on disturbance and large mammal transects, with the majority found through casual observations. Of the traps found, 40 were wire snares, one was a 'duiker fence' and one a buffalo *Syncerus caffer* rope snare (shown in annex 2a fig. 63a). Seven snares or traps were present in 3.8% of the one hundred and sixty 50metre sections, but occurring only on transects 3 (four traps; south of BC1) and 6 (three traps; east of BC2). Six of these seven traps were wire snares and one was a duiker fence. Four snares were also found on large mammal transects, on transect 2 (two traps; south-east of BC1) and on transect 5 (two traps; north-east of BC2). A further 31 wire snares were recorded through casual observations and the setting of snares was also witnessed.

Footpaths

A total of twelve human paths were recorded. Eight paths were present on the disturbance transects (on transects 1, 2 and 3 surrounding BC1; transect 6 east of BC2) occurring on 5% of the one hundred and sixty 50 metre sections. Four human footpaths were recorded on large mammal transect 6 (east of BC2).

5.3.4 Community Knowledge of Sali FR

A. MACHA & V. WILKINS

Sali Village is the closest settlement to Sali FR, and the community day was held there on 24th November 2005. Sali is a small rural community, the main occupation for the local people is cultivation. The community day involved 50 local adults and more than 60 school children. Appendix 11a summarises the structured interview questionnaire and 13b lists all adult participants in the Sali Village Community Day.

Structured Interviews
Structured interviews were conducted on the morning of the community day, before the presentation and discussion. Fifteen residents were interviewed.

1. Personal Details
38% of residents interviewed were between the ages of 36-49; the rest of the interviewees ranged from ages 20-35 and 50-70, but there was a deficit of young people between 15-19. The main occupation of residents was agriculture (80%), the rest were public servants. Most people interviewed were long-term residents of the area with 70% having lived in the area for over 10 years. Relatively even numbers of both males and females were interviewed.

2. What do you know about Sali FR?
40% of the respondents knew the forest was a reserve. 20% knew the forest reserve area as simply the old colonial footpath to Mahenge, however most of these people were living further away from the reserve. Some people thought the forest was protected as a water catchment and a few individuals had been there to pick *Phoenix reclinata* (Ukindu). The concept of a participatory approach in forest management for the forest was not well known to the residents and most were keen to learn more about it.

3. Why is the forest reserved?
About 90% of the respondents had some idea that the forest was reserved as a water catchment. Others thought that the forest was being protected for the next generation as well as providing habitat for animals that live in the forest.

4. Are there any animals living in the forest?
Sykes *Cercopithecus mitis* and vervet *C. pygerythrus* monkeys, leopard *Panthera pardus*, blue duiker *Cephalophus monticola* and red duiker *C. harveyi*, baboons *Papio cynocephalus*, hyrax Procavidae *spp.* and galago Galagonidae *spp.* were stated as having large populations in the forest. Bushpigs *Potamochoerus larvatus* and suni *Neotragus moschatus* were said to be present but in smaller numbers. People also reported having seen hyena Hyaenidae *spp.* and buffalo *Syncerus caffer* in the reserve but very rarely. However, neither vervets, baboons or hyrax were recorded within the reserve in the biodiversity surveys.

5. How has the forest changed over the past 10, 20 or 30 years?
People reported a decline in the vegetation that surrounds the forest reserve, and numbers of buffalo, suni, red and blue duiker have decreased rapidly in the last 10 years. Elephants *Loxodonta africana* were sighted in the area from the 1930s to early 1970s but not in recent years.

6. What climatic changes have you become aware of?
People reported that the temperature has been increasing locally, and this has affected rainfall in the area. People also felt there had been a rise in malaria in recent years.

7. What type of meat do you eat?
Sykes, vervet monkeys, bushpigs, suni, red and blue duiker and hyrax are regularly eaten by the villagers. Most of this meat is sourced from the forest, but some is also bought from Ruaha village, coming from the Selous Game Reserve. The price for a piece of meat ranges from TSh1000 to 1500 and can drop to TSh500 per piece.

8. Where do you get firewood from?
All respondents stated that firewood was obtained from their immediate surroundings and that the forest reserve is too far from the village for firewood.

9. Why do you think people burn the forest?
Most reported agriculture as the main activity causing fires in the forest. These fires are not intentional but the villagers fail to control the fires which are being used to clear scrub. Young people also thought that burning the bushes was an easy way of catching animals. It was also suggested that in dry weather some fires are probably caused by discarded cigarettes.

10. Where do you get building materials?
All stated they sourced building materials from their immediate surroundings and not the reserve.

11. What traditions do you have that are related to the forest reserve?
There were no traditional beliefs in Sali that were related to the forest reserve.

12. What are your views on the utilisation of the forest reserve with respect to its conservation?
Respondents focused on the following issues: enough resources and applicable regulations should be in place before granting the management contract to the village; environmental education should be conducted to raise awareness in the local community; and members of the Environmental Committee should live closer to the forest.

13. Do you plant trees? If yes, what types of tree do you plant?
Responses showed that most villagers do not plant trees, with the exception of fruit trees in their farms.

14. Do you keep livestock? Where do they get food?
Villagers believed that they do not keep animals that could harm the forest, and they do not allow the animals to graze in the reserve.

15. Do you have an Environmental Committee in your village? Is it useful?
Sali has an Environmental Committee, and most residents agreed that having the Environmental Committee is a good thing, but they were concerned that it does not have the appropriate equipment and training to fulfil its role. It was also suggested that improving communications between Sali and Ruaha would help simplify and speed up prosecutions relating to the forest.

Community Discussion
During the discussion residents were encouraged to give their opinions and to ask questions in relation to the presentation and the interviews, as well as any extra issues that they felt should be discussed. The discussion was lively and a good proportion of the people present made an active contribution.

Topics Raised:

1. Letters to the Village Environmental Committee and Village Government from relevant government departments regarding forest management are very important i.e.: at the National, Regional, District and Village level.
2. Joint Forest Management (JFM) is not well known to indigenous people, they requested Catchment staff to offer JFM awareness.
3. The money that is being paid to the District as forest fees should be reaching the village to help in forest management.

4. Moral obligations to protect forest resources are low because there is no infrastructure to support them, i.e. there is no police station, and only a poor road network.
5. Problems might occur when attempting to prosecute accused people over illegal activities in the forest, as the village is far from the police post and there is no reliable transport.
6. The government should train people and help to provide alternatives to burning land prior to cultivation, for example subsidies for agricultural equipment such as tractors.
7. More environmental education should be provided to the village and to the local forestry officers, especially on participatory approaches in forest management.
8. A copy of the report produced should be made available to the village.

5.4 SALI FR DISCUSSION

5.4.1 Fauna of Sali FR

N. OWEN & A. PERKIN

Two hundred and twenty-two faunal species (in 75 families) were recorded in Sali FR in this survey (table 19), of these 148 were vertebrate species (in 67 families), and 74 butterfly species (in 8 families). Of the vertebrates, the majority were small fauna: birds and herpetofauna; with 59 (39.9%) birds, 26 (17.6%) reptiles, 26 (17.6%) amphibians, and 37 (25%) mammals.

Table 19: Faunal species recorded in Sali FR, categorised by widespread species and those of conservation concern: endemic, threatened and forest-dependent; new records for the Mahenge Mountains are shown in parentheses.

Taxa	No. of families	No. of species[a]	Wide-spread species	Strict Mahenge endemics[b]	Eastern Arc endemics[c]	Eastern Arc near endemics[d]	IUCN[e] (2006)	CITES[f] (2006)	Forest-dependent species[g]	Total number of species of conservation concern[h]
Mammals	22	37 (23)	33 (20)	0	0	4 (3)	9	6	7	14 (11)
Birds[i]	30	59 (36)	53 (31)	0	1 (1)	5 (4)	1	9	23	24 (17)
Amphibians	6	26 (10)	9 (0)	4 (4)[j]	5 (4)	8 (2)	7	1	17	19 (10)
Reptiles[k]	9	26 (14)	20 (10)	3 (2)[l]	1 (1)	2 (1)	0	2	5	7 (5)
Butterflies	8	74 (48)	69 (43)	0	1 (1)	4 (4)	0	0	22	25 (13)
Vertebrate Total	67	148 (83)	115 (61)	7 (6)	7 (6)	19 (10)	17	18	52	64 (43)
% total of vertebrate species			77.7	4.7	4.7	12.8	11.5	12.2	35.1	43.2
All taxa total	75	222 (131)	184 (104)	7 (6)	8 (7)	23 (14)	17	18	74	89 (56)
% total of all species			82.9	3.2	3.6	10.4	7.7	8.1	33.3	40.1

[a]Includes all verifiable opportunistic observations as well as those from systematic methodologies.
[b]Species thought to occur only in the Mahenge Mountains.
[c]Species found only in the Eastern Arc.
[d]Species found in the Eastern Arc Mountains and adjacent locations such as Coastal Forests, Southern Rift, Highlands;
[e]Species recognised as threatened with extinction to varying degrees.(listed on the IUCN Red List as Endangered, Vulnerable, Near Threatened, Conservation Dependent only; excludes Data Deficient, Not Evaluated and Least Concern)
[f]Species recognised as threatened with extinction and so with varying restrictions on trade.
[g]Species dependent upon and associated with primary forest.
[h]Includes endemic species, IUCN Red Listed species, forest-dependent species; excludes CITIES listed species;
[i]Includes birds seen at the forest edge.
[j]All four of these species appear to be new to science
[k]Includes reptiles caught at the forest edge.
[l]Two of these species appear to be new to science

Summaries of faunal species according to endemism, forest-dependency and conservation status can be found in Section 8: The Mahenge Mountains. Within the vertebrate species, the number of endemics made up 22.3% (33 species), a high proportion of the total number of species. The endemics are divided as follows (fig. 22): 7 (4.7%) may be strictly endemic to the Mahenge Mountain block, 7 (4.7%) are endemic to the Eastern Arc Mountains, with 19 (12.8%) near endemics, found in the Eastern Arc and adjacent eco-regions. Of these, ten near endemics, one Eastern Arc endemic and one strict Mahenge endemic were also recorded in Mselezi FR.

Of all vertebrate endemic species found in Sali, 22 represent new records for the Mahenge Mountains (six strict Mahenge endemics, six endemics, ten near endemics); and six of these appear to be new to science (strict Mahenge endemics) based on preliminary morphological and genetic analyses. Six of these new records were also recorded in Mselezi FR (five near endemics and one strict Mahenge endemic).

A small proportion of vertebrate species are considered to be at risk (11.5%; 17 species), recognised by IUCN: nine (6.1%) are threatened (Endangered or Vulnerable); and eight (5.4%) are at lower risk (Near Threatened or Conservation Dependent). A further 26 are listed as Not Evaluated or Data Deficient (17.6%), with 85 listed as Least Concern (57.4%). Eighteen species are listed on CITES. The number of species recognised to be at risk may increase with further research and re-classification.

Much of the fauna found was typical of good submontane forest, with a third of vertebrate species being strictly forest-dependent (35.1%; 52 species); and when considering all taxa including butterflies a similar proportion were forest-dependent (33.3%; 74 species).

Taking into account endemism, threatened status and forest-dependency, over a third of the species are of conservation concern (89 species; 40.1%) for all taxa studied, with a slightly higher proportion of vertebrate species of conservation concern (64 species; 43.2%).

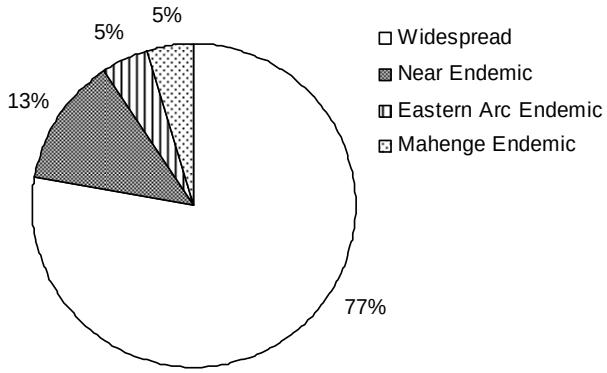

Figure 22: Vertebrate endemism in Sali FR

Mammals

Thirty-seven mammal species (in 22 families) were recorded in Sali FR: 8 small mammal species, 6 bat species, and 23 species of larger mammals. Over a third of these species (14 species; 37.8%) are of conservation concern, due to endemism, threatened status or forest-dependency. Four near endemic species were recorded (10.8%) and seven (18.9%) species are classed as forest-dependent. Nine species are considered to be at risk on the IUCN Red List (24.3%); with two threatened (Vulnerable) and seven at lower risk (Near Threatened or Conservation Dependent). Six species are CITES listed.

Species Assemblages
A relatively high number of mammal species for the small size of Sali FR was recorded, and of particular interest is the fact that larger mammals make up the greatest proportion of mammal species in Sali FR. The most common medium to large mammals detected by camera traps were red duiker *Cephalophus harveyi,* giant pouched rat *Cricetomys gambianus,* and suni *Neotragus moschatus*; the most abundant in terms of sign were *C. harveyi,* blue duiker *C. monticola* and bushpig *Potamochoerus larvatus.*

Typical forest antelope species were present, *C. harveyi* and *C. monticola*; as well as *N. moschatus* and bush-buck *Tragelaphus scriptus* which are often found in forest but are not true forest-dependent species. *C. harveyi* appeared to be extremely abundant, followed by *N. moschatus,* both species captured in multiple camera trapping events. However encounter rates of *T. scriptus* (recorded only once through camera trapping although several signs were recorded) and *C. monticola* (visually observed and detected through sign but with no camera trapping events) were much lower. This distribution, diversity and relative abundances of the antelope guild appears to follow that of other Eastern Arc forests, (e.g. Udzungwas, Dinesen *et al.* 2000; Rovero & Marshall 2004, 2005; Rovero *et al.* 2005). This may be due to hunting pressure reducing numbers of the larger *T. scriptus*; more work

is required to assess niche separation and overlap in these sympatric forest antelopes. The species of red duiker, *C. harveyi*, has typical facial markings, but this morph is not as dark on the legs as the nearest population in the Udzungwas (photographed in annex 2a fig. 61a), raising the possibility that it might be a hybrid or intermediate with *C. natalensis* which is reported south of the Rufiji river (Kingdon 2001). This warrants further investigation to clarify the taxonomy as there are already controversies with the classing of *C. harveyi* as a separate species. Analysis of activity budgets revealed *N. moschatus* to be mainly diurnal, contrasting with previous studies finding *N. moschatus* to be primarily nocturnal in other areas of the Eastern Arc Mountains such as the Udzungwas (Rovero & Marshall 2004, 2005; Rovero *et al.* 2005). This could potentially be explained by the lesser hunting pressure found in Sali FR. It is worth noting that the survey did not record signs of the Tanzanian endemic and rare Abbott's duiker *Cephalophus spadix*, even though Sali FR represents a potentially suitable habitat for this species. However, the very low density and shyness of this species, as recorded elsewhere in the Eastern Arc such as the Udzungwa Mountains (Rovero *et al.* 2005; F. Rovero pers. comm.), means that recording the presence of this species is very difficult and requires intense camera trapping and survey work.

A variety of typical small forest carnivores were present in Sali. Camera traps revealed bushy-tailed mongoose *Bdeogale crassicauda puisa*, large spotted genet *Genetta maculata*, slender mongoose *Herpestes sanguinea;* audio recordings and visual observations were made of palm civet *Nandina binotata*; dung and visual observations were recorded of water mongoose *Atilax paludinosus robustus.* These species are also typically present in other Eastern Arc forests (e.g. Udzungwas, De Luca & Mpunga 2005). *B. c. puisa* is the sub-species of bushy-tailed mongoose present in this area (Schreiber *et al.* 1989), and was the most frequently photographed and most abundant small carnivore, as in the Udzungwas (De Luca & Mpunga 2005; F. Rovero pers. comm.), although it is not considered to be common (Kingdon 2001). Studies have found this species in wooded grassland (Kingdon 2001) as well as lowland and montane forest (De Luca & Mpunga 2005). The nocturnal activity budget recorded for *B. c. puisa* concurs with previous studies finding active peaks at 1900, 2300 and 0400hrs (De Luca & Mpunga 2005), with this study finding the species to be most active between 1900 and 0400hrs. Several camera trapping events were recorded of *G. maculata* between 1400-1050m asl, previous studies have also found it to occur up to 1470m asl (De Luca & Mpunga 2005). *A. p. robustus* is the sub-species of water mongoose present in East Africa (Kingdon 2001). This species was recorded through sign and sightings not camera traps, as it primarily occurs in the vicinity of watercourses (Kingdon 2001) and only some of the camera traps were placed to encompass these habitats. In previous studies in the Udzungwas this species was found to be common in a variety of habitats including montane forest (De Luca & Mpunga 2005). *H. sanguinea* and *N. binotata* are common and widespread species commonly found throughout East Africa and Eastern Arc forests (De Luca & Mpunga 2005; Perkin 2004; Kingdon 2001), with *N. binotata* primarily occurring in fragmented forests up to 2000m asl (Kingdon 2001). The difficulty of identifying small carnivores to species through sightings and dung meant that the primary method of identification was through camera trap photos. This means that there is still the possibility for additional species to be present.

Larger carnivores were recorded indirectly in Sali, including leopard *Panthera pardus*, hyaena *cf. Crocuta crocuta*, and the villagers reported sighting lion *P. leo.* The presence of these species, along with sightings and sign recorded in this study of buffalo *Syncerus caffer* and elephant *Loxodonta africana* indicate that Sali FR is still used as a migratory route between the Selous Game Reserve and Kilombero Valley floodplain. The high population levels of smaller fauna suggest that an adequate prey base is still present for many large carnivore species. These species are less affected by forest degradation but the results of the community questionnaires clearly indicate that numbers are declining, presumably due to hunting, encroachment and cultivation of parts of the migratory route. Interestingly, indigenous knowledge revealed that several species which were once found in the area are no longer present, such as wild dog *Lycaeon pictus* which apparently moved through the area 30 years ago. As an evidently important part of this migratory corridor, protection of Sali FR should increase and options for restoring corridor connectivity should be considered.

A forest-typical assemblage of rodents and insectivores were present, including high abundances of two near endemic species, the relict Eastern Arc near endemic lesser-pouched rat *Beamys hindei* and the African wood mouse *Hylomyscus arcimontensis.* A high abundance was also recorded for the soft-furred rat *Praomys delectorum*. These three species are typical of Eastern Arc montane forests and as the most frequently caught small mammals (Cordeiro *et al.* 2005; Stanley *et al.* 1998; Stanley *et al.*2005), their relative abundances indicate large populations. Grassland species such as the brush-furred mouse *Lophuromys flavopunctatus* were also present due to the variety of habitats in Sali including open wetland and grassland areas. However, a total of eight small mammal species appears to be low for an Eastern Arc forest (Cordeiro *et al.* 2005; Stanley *et al.* 1998; Stanley *et al.*2005). The sampling intensity employed to assess bat species was not sufficient to assess the diversity of species present as bats are notoriously difficult to sample in forest habitats and a significant period of time needs to be invested. Of the sengis, the chequered sengi *Rhynchocyon cirnei reichardi* appeared to be fairly abundant through camera trapping encounter rates (photographed in annex 2a fig. 61b). This species was also sighted on several occasions. This new record definitively establishes the presence of this species of sengi in the Mahenge Mountains, which was predicted from the current distribution patterns (Rathbun pers. comm.). No other species of sengi were confirmed although the near endemic black and rufous sengi *R. petersi,* may have been sighted on two occasions although these fleeting glimpses were not enough to verify its presence. At least one squirrel species assigned to the genus *Paraxerus* were present, with camera traps capturing sightings of Svynnerton's bush squirrel *Paraxerus vexillarius byatti,* while visual observations were also made of a red squirrel. In addition, the forest-dependent Lord Derby's anomalure *Anomalurus derbianus* was observed clearly, as was another anomalure that could not be identified to species level, as it appeared distinctly different to currently described species. Further research to identify this anomalure is encouraged as undescribed variations have been reported elsewhere in the Eastern Arc (F. Rovero pers. comm.).

Sali contained only two primate species, *Cercopithecus mitis cf. moloney* and *Galagoides granti* (photographed in annex 2a fig. 61c). The sub-species *C mitis cf. moloney* is found in the mountain region of southern Tanzania, Zambia and Malawi. The villagers claimed vervet monkeys *C. pygerythrus* were also present but these were only recorded outside the forest reserve on this survey. The widespread and adaptable but forest-dependent *C. mitis cf. moloney* occurred in low numbers in the forest but was recorded more frequently at the forest edge near to the village. This species is confined to evergreen forests and moist woodland. No black and white colobus *Colobus angolensis palliatus* were recorded in Sali FR; neither was this species mentioned by the villagers as historically being present in the forest; thus it is unlikely they were hunted to extinction. It is more likely that due to paleogeographical and evolutionary reasons colubus were never present in Sali FR. The galago assemblage of Sali FR is interesting, notably for species which were *not* encountered. *G. granti* is a coastal forest and moist woodland species; in Sali *G. granti* could be expected at the forest edges and riverine forest strips, but in the interior submontane forests *G. orinus* was expected. *G. orinus* is the typical Eastern Arc *Galagoides* in submontane and montane forests. Instead, only *G. granti* was definitively found to be present throughout Sali FR. This also represents a high-altitude record since this species is a typical lowland Coastal Forest form south of the Rufiji; but has been recorded in the Udzungwas at 1500 and 1800m asl as well as at 900m asl on the Rondo plateau (Butynski *et al.* in press). The relative abundance of *G. granti* also appeared to be fairly high. Further research may reveal *G. orinus* in Sali FR; as it was thought to be heard on two occasions at base-camp 2, although no recordings were made to verify this. If *G. orinus* does not occur in Sali FR this could be an example of ecological displacement where *G. granti* has adapted to the habitat of an ecologically similar species (*G. orinus*) which is absent; as the previous high altitude records of *G. granti* also did not record the presence of *G. orinus* (Butynski *et al.* in press). No *Otolemur* were encountered in Sali, which is interesting since *O. garnettii* may also be expected to occur in this habitat type. However, the nearest population of *O. garnettii* is on the Rufiji River in the Selous Game Reserve so perhaps it is not surprising that this species was not encountered in the Mahenge Mountains. Notably, it is interesting that tree hyrax *Dendrohyrax validus* was not recorded in this reserve, where good mature submontane forests would ordinarily support this species as in other Eastern Arc Mountains.

There is a typically low species richness of mammals in the Eastern Arc but there is a high proportion of forest-adapted, montane and endemic species (Kingdon & Howell 1993). The extent of suitable available habitat can be considered a major ecological factor influencing mammalian species richness and population densities; further influenced by the fragmented nature of the forests, often surrounded by cultivation and settlements (Kingdon & Howell 1993). Yet, despite the small size of Sali FR, a good species richness and abundance of widespread large mammals was present, and abundant populations were also recorded of the forest-dependent species *Cercopithecus mitis cf. moloney*, *Galagoides granti*, *Rhynochocyon cirnei reichardi* and *Cephalophus harveyi*. This is most likely due to the remote nature of the reserve meaning that there are minimal levels of human disturbance coupled with most of the reserve continuing to be forested.

Endemic Species and Range Extensions
Four near endemic species were recorded, Grant's galago *Galagoides granti*, the lesser pouched rat *Beamys hindei*, the African wood mouse *Hylomyscus arcimontensis*, and Svynnerton's bush squirrel *Paraxerus vexillarius byatti* (table 20). *Beamys hindei* was once regarded as one of the rarest rodents in Africa (Groombridge 1993) but it is now known to be more widespread (Burgess & Clarke 2000); this was reflected in our study which recorded high population levels in Sali FR. This species ranges throughout the Eastern Arc, Coastal Forests and Southern Rift; and represents a new record for Mahenge, also found in Mselezi FR. The newly described near endemic *H. arcimontensis* (Carleton & Stanley 2005) was documented as being locally abundant, and represents a new record for Mahenge, having been previously recorded in the Eastern Arc and Southern Rift. *G. granti* is a near endemic species to the Tanzania Coastal Forests occurring from the Rufiji River south into Mozambique as far as Inhambane and west inland as far as the lowland forests of Malawi (Butynski *et al.* in press); and was previously recorded in Mahenge Scarp FR. *P.vexillarius byatti* has been recorded in the Eastern Arc and Southern Rift.

A further twenty widespread mammal species represent new records for the Mahenge Mountains, of which six were also recorded in Mselezi FR.

Table 20: Ranges of Eastern Arc near endemic mammalian species previous to this study

Species	Range previous to this study
Eastern Arc Near Endemic	
Galagoides granti	E. Udzungwa, Coastal Forests (S of Rufiji R.), Mozambique, lowland 'coastal' forests of Malawi.
Beamys hindei (Mahenge new record)	South Pare, Usambaras, Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Udzungwa, Coastal Forests, Highlands, Southern Rift.
Hylomyscus arcimontensis (Mahenge new record)	South Pare, Usambaras, Nguu, Nguru, Uluguru, Ukaguru, Udzungwa, Southern Rift.
Paraxerus vexillarius byatti (Mahenge new record)	Usambaras, Nguru, Uluguru, Udzungwa, Southern Rift.

Avifauna

Fifty-nine bird species (in 30 families) were recorded in Sali FR. Significantly, almost half of these (24 species; 40.7%) are of conservation concern, due to endemism, threatened status or forest-dependency. With one endemic (1.7%) and five near endemics (8.5%), the total proportion of endemic birds present is 10.2%. Over a third of the total number of species (23 species; 40%) are strictly forest-dependent, suggesting that Sali hosts an important diversity of forest assemblage species. One species is considered to be at risk on the IUCN Red List (1.7%; listed as Vulnerable). Nine species are CITES listed.

Species Assemblages
The species richness of birds in Sali FR is significantly lower than for other areas of the Eastern Arc, which may be due to the much smaller size of the forest hosting a smaller species assemblage, as links between bird species richness and forest size have been observed by Mlingwa *et al.* (2000).

In addition, this is the first investigation of the bird fauna of this area and further studies will likely increase the species list. Despite the low species richness Sali FR holds at least part of an Eastern Arc montane bird assemblage with 16 montane bird species [as defined by Stuart *et al.* 1993; compared with the East Udzungwas (42), Usambaras (41), Ulugurus (41), Ngurus (31), Ukagurus (28)], but this number is likely to increase with more intensive bird surveys in the area. Mist netting capture rates indicate reasonably abundant population densities of those species that are present, with a recorded average of 162ind/10,000nmh in Sali FR. Breeding records were also documented for nine species, seven of which are considered to be of conservation concern (crowned hornbill *Tockus alboterminatus,* Shelley's greenbul *Andropadus masukuensis*, stripe-cheeked greenbul *A. milanjensis*, white-chested alethe *Alethe fuelleborni*, white-starred robin *Pogonocichla stellata,* Sharpe's akalat *Sheppardia sharpei*, red-faced crimson-wing *Cryptospiza reichenovii).*

Mlingwa *et al.* (2005) suggest that a relatively closed canopy with a shaded and dense understory tends to host a higher number of species than a more open canopy with a sparse understory. The closed canopy forest with areas of dense understory present in Sali FR may therefore explain the high proportion of forest-dependents with many typical submontane and montane forest species present; as vegetation structure may be more important than habitat continuity in determining the composition of bird communities (Mlingwa *et al.* 2000). However, this is countered by the fact that this vegetation structure makes obtaining a comprehensive and complete species list more difficult. The topographic variation present in Sali FR, with areas of forest, natural grassland, open wetland, and rock and cliff features creates an array of habitats enabling the reserve to harbour a range of species.

Endemic Species and Range Extensions

One Eastern Arc endemic, the Usambara eagle owl *Bubo vosseleri*, was recorded, representing a significant new record and range extension for the Mahenge Mountains (table 21). This threatened species has a restricted range and remaining tracts of its forest habitat are severely fragmented, being under great pressure outside protected areas. Most records of this species are from montane and submontane evergreen forest (800 – 1500m asl), although it has also been recorded in lowland evergreen forest down to 200m asl. It is presumed to be a canopy-dwelling species, which may be able to tolerate some human disturbance of forest structure. *B. vosseleri* is found in several of the Eastern Arc Mountains, including the Udzungwas adjacent to Mahenge; and may even be more widespread than previously believed (J. Kiure pers. comm.).

Table 21: Ranges of Eastern Arc endemic and near endemic avian species previous to this study

Species	Range previous to this study
Eastern Arc Endemic	
Bubo vosseleri (Mahenge new record)	Usambaras, Nguru, Uluguru, Rubeho, Udzungwa.
Eastern Arc Near Endemic	
Andropadus masukuensis	South Pare, Usambaras, Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Mahenge, Udzungwa, Southern Rift.
Andropadus milanjensis (Mahenge new record)	Taita, Pares, Usambaras, Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Udzungwa, Highlands, Southern Rift.
Batis mixta (Mahenge new record)	Pares, Usambaras, Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Udzungwa, Coastal Forests, Highlands, Southern Rift.
Sheppardia sharpei (Mahenge new record)	South Pare, Usambaras, Nguru, Uluguru, Rubeho, Udzungwa, Southern Rift.
Stactolaema olivacea (Mahenge new record)	Usambaras, Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Udzungwa, Coastal Forests, Southern Rift.

Five near endemics were also recorded, green barbet *Stactolaema olivacea*, *Andropadus masukuensis*, *A. milanjensis*, *Sheppardia sharpei*, and forest batis *Batis mixta*. Significantly, *A. masukuensis* was one of the most common species captured in mist nets at Work Unit 1, *S. sharpei* and *A. milanjensis* were common at Work Unit 2, and *B. mixta* was frequently recorded at both sites, indicating that Sali

FR harbours important populations of these endemic species. This is further supported by the breeding records obtained for *A. masukuensis, A. milanjensis,* and *S. sharpei*. Four of these endemic species represent new records and range extensions for Mahenge; all were also recorded in Mselezi FR. One restricted range species, *Alethe fuelleborni*, was also frequently recorded in Sali and breeding records were documented, while it is not endemic the restricted distribution means this species is also of interest.

A further 31 widespread avian species represent new records for the Mahenge Mountains, of which 12 of these new records were also recorded in Mselezi FR.

Additionally, a new species of owl was recently discovered in Nguru South, identified only by its call (J. Kiure pers. comm.). On several occasions a call resembling this was heard in Sali FR, although no recordings were obtainable to verify its presence. This would be an interesting opportunity to study and describe this species; and this finding also indicates that this species may be likely to be discovered in several more Eastern Arc sites.

Herpetofauna

Small fauna such as amphibians and reptiles are often considered to denote forest health due to their sensitivity to disturbance within the forest environment, particularly for endemic species (Spawls *et al.* 2002). Species richness and abundances, especially for those species of conservation concern, can be used to determine the condition of forests and to inform management requirements. Many forest-dependent and endemic species were recorded in Sali FR that require good forest conditions, indicating the healthy and undisturbed nature of the forest here. There are significant numbers of reptile and amphibian species (26 reptiles and 26 amphibians; e.g. compared with the much larger circa. 18,000ha Nguru South with 21 reptiles and 30 amphibians; Menegon *et al.* in prep) and high proportions of endemic species. This, combined with the potential four new species of amphibian and two new species of reptile shows this site to be of exceptional conservation importance.

Amphibians

Twenty-six amphibian species (in six families) were recorded in Sali FR, indicating high species richness and abundance for such a small forest reserve. Significantly, over two-thirds of these are of conservation concern (19 species; 73.1%), due to threatened status, endemism or forest-dependency. Up to four of these species may be new to science and strict endemics to the Mahenge Mountains (*Callulina sp. nov, Hoplophryne sp. nov, Nectophrynoides sp. nov 2, Probreviceps sp. nov*; photographed in annex 2a fig. 62); with an additional two species endemic to the Eastern Arc and fitting the description of as yet undescribed species recently found in other locations such as the Udzungwa Scarp (*Afrixalus sp. nov?, Nectophrynoides sp. nov 1*; M. Menegon pers. comm..). Three more species are Eastern Arc endemics, and eight are near endemics, bringing the total of endemics in Sali FR to 17 (65.4%). This is an impressive and significant proportion of endemic species, one of the highest to be found in any of the Eastern Arc forests (e.g. compared with 36 species of amphibians of which 53.6% were endemic in Udzungwa Scarp FR; Menegon & Salvidio 2005). Over half of all recorded amphibians are strictly forest-dependent (65.4%; 17 species). Seven species are considered to be at risk on the IUCN Red List (26.9%), of which six are threatened (Vulnerable or Endangered) and one is at lower risk (Near Threatened).

Species Assemblages

The amphibian fauna found in Sali FR, and likely to be in other montane forests in the Mahenge Mountains such as Muhulu, holds most affinities with the southern Udzungwa fauna. Sali FR has a particularly high proportion of amphibian endemics, and it is likely that there are more species to be discovered which certainly warrants further research. Additionally more information such as amphibian calls would be desirable to describe the new species found here. The species list should be fairly comprehensive as the survey was conducted during the start of the rains when many species' calling and mating behaviours made them more visible.

The species assemblage appears to be typical of pristine submontane forest, and particularly diverse because of the varied habitats. These include many water sources, both rocky and open wetlands, with surrounding dense vegetation and the moist humus layer providing a range of breeding habitats (Howell 1993). Many of the non-forest-dependent species recorded also prefer forested habitats, such as *Arthroleptis stenodactylus* and *A. xenodactyloides* that rely on the presence of damp soil and loose leaf mould to lay their eggs (Howell 1993). Juveniles were noted for most species, and high abundances were recorded for *Afrixalus sp. nov, Arthroleptis xenodactyloides, A. reichei, Arthroleptides yakusini, Leptopelis vermiculatus* and *Nectophrynoides tornieri*; of these the latter five species are of conservation concern due to their endemic status. This indicates that Sali FR supports significant breeding populations of these species.

New Species, Endemics and Range Extensions

Up to four species in Sali FR may be new to science, on the grounds of preliminary morphological and genetic analyses these specimens do not appear to fit any known species and further studies will confirm their taxonomical status.

Table 22: Ranges of Eastern Arc endemic and near endemic amphibian species previous to this study

Species	Range previous to this study
Mahenge Strict Endemic	
Callulina sp. nov (Mahenge new record)	
Hoplophryne sp. nov (Mahenge new record)	
Nectophrynoides sp. nov 2 (Mahenge new record)	
Probreviceps sp. nov (Mahenge new record)	
Eastern Arc Endemic	
Afrixalus sp. nov? (Mahenge new record)	Udzungwa?
Arthroleptides yakusini	Nguru, Uluguru, Udzungwa, Mahenge.
Leptopelis uluguruensis (Mahenge new record)	E. Usambara, Nguu, Nguru, Uluguru, Udzungwa.
Nectophrynoides sp. nov 1 (Mahenge new record)	Udzungwa?
Phrynobatrachus udzungwensis (Mahenge new record)	Nguu, Nguru, Uluguru, Udzungwa.
Eastern Arc Near Endemic	
Afrixalus uluguruensis complex	E. Usambara, Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Udzungwa, Mahenge, Coastal Forests.
Arthroleptis reichei (Mahenge new record)	Nguru, Uluguru, Udzungwa, Southern Rift.
Hyperolius punctilatus	Usambaras, Nguu, Nguru, Uluguru, Ukaguru, Malundwe, Udzungwa, Mahenge, Coastal Forests, Southern Rift.
Leptopelis vermiculatus	W. Usambara, E. Usambara, Nguu, Nguru, Udzungwa, Mahenge, Southern Rift.
Nectophrynoides tornieri	E. Usambara, Nguru, Uluguru, Udzungwa, Mahenge, Southern Rift.
Probreviceps cf rungwensis (Mahenge new record)	Udzungwa, Southern Rift.
Spelaeophryne methneri	Uluguru, Udzungwa, Mahenge, Coastal Forests, Southern Rift.

Within the genus *Nectophrynoides*, one species is believed to be new (*N. sp. nov 2)* and is likely to be a strict endemic to the Mahenge Mountain block, and another species (*N. sp. nov 1)* resembles specimens already taken from other locations but as yet undescribed (Udzungwa Scarp, M. Menegon pers. comm.). In addition, the third species within this genus, the near endemic *N. tornieri,* was

recorded at high abundance within Sali FR. This genus is considered an ancient Afrotemperate relict (Poynton 2003), but is currently poorly defined, and the forest-dependent species are associated with submontane and montane forest fragments in the Eastern Arc. The distribution is believed to reflect the long stability of the Eastern Arc forests combined with the fragmentation of the mountain blocks leading to long periods of isolation and speciation. *Nectophrynoides* may also be an indicator for reconstructing the biogeography of the Eastern Arc (Menegon *et al.* 2004).

The *Callulina sp. nov, Hoplophyrne sp. nov,* and *Probreviceps sp. nov* (latter two photographed in annex 2a fig. 62d, e, f) may also be new and are likely to be strict Mahenge endemics. This is because many of these species have become highly specialised to their mountain forest block, with little movement between fragmented forest patches, and new species have been discovered on several of the other Eastern Arc Mountains. The *Probreviceps sp. nov* resembles the *P. rungwensis* species found both in Mahenge in this survey and also in the southern Udzungwas, but lacking the elongated and hardened rostrum typical of that species. Interestingly, preliminary genetic analyses of the *Hoplophryne sp. nov* indicate this species is extremely divergent from other Eastern Arc *Hoplophryne* clades. The unidentified *Afrixalus sp nov?.* is likely to belong to the same undescribed taxon recently collected in the Udzungwa Scarp (Eastern Arc endemic; M. Menegon pers. comm.), based on morphology and bioacoustic data, and was present in high abundances. An additional species of *Hyperolius sp. (nov?)* is awaiting taxonomic assessment; it may potentially be new but *Hyperolius* is a variable and difficult genus to identify.

Other Eastern Arc endemics present were *Arthroleptides yakusini, Leptopelis uluguruensis* and *Phrynobatrachus udzungwensis*. Near endemics present were *Afrixalus uluguruensis* (complex), *Arthroleptis reichei, Hyperolius punctilatus, Leptopelis vermiculatus Nectophrynoides tornieri, Probreviceps cf rungwensis* and *Spelaeophryne methneri*. Notably, relative abundances of the endemics *A. yakusini, A. reichei,* and *L. vermiculatus* were high. Ten of the endemic species (four known endemics *A. reichei, L. uluguruensis, P. cf rungwensis* and *P. udzungwensis,* and all undescribed species) represent new records and range extensions for Mahenge. Table 22 shows the ranges of the endemic species previous to this study, and lists the new strict endemics.

Reptiles

Twenty-six reptile species (in nine families) were recorded in Sali FR, indicating a good species richness and abundance for such a small forest reserve. Seven species (26.9%) are of conservation concern due to endemism or forest-dependency. Two of these species (a forest gecko *Cnemaspis sp. nov,* and a chameleon *Kinyongia sp. nov?*; photographed in annex 2a fig. 62a, b) may be new to science. These new species may therefore be strict endemics to the Mahenge Mountains. One additional species is a strict Mahenge endemic, one is an Eastern Arc endemic and two more are near endemics, bringing the total of endemics in Sali FR to six (23.1%). Two species are listed on CITES Appendix II, and five species are forest-dependent (19.2%).

Species Assemblages

The reptile species assemblage appears to include those typical of pristine submontane forest, but there are also many species (particularly snakes) representative of lower and more open habitats, as specimens of these were sourced from villagers working in their farms at the forest edge. The new undescribed species deserve further investigation, and the species curve indicated this inventory was not yet complete.

Five species of chameleon were present, of which at least one is forest-dependent, the bearded pygmy chameleon *Rieppeleon brevicaudatus,* and likely *Kinyongia sp. nov?;* the pygmy chameleon *Rhampholeon beraduccii* is forest-dwelling but not dependent. Distributions follow typical Eastern Arc massifs. *R. brevicaudatus* is the most widespread pygmy chameleon species, found in the Coastal Forests and in the Eastern Arc up to 1300m (Spawls *et al.* 2002), replaced at higher altitude by montane specialised dwarf chameleons (Emmett 2004; Loader *et al.* 2003); in this case by *Rhampholeon beraduccii*. Only two skink species were recorded, Loveridge's limbless skink

Melanoseps loveridgei and Eastern striped skink *Trachylepis cf. striata*, however several more species can be expected to be present. A wide diversity of Colubridae species were present, several of which represent new records for Mahenge, although these were mostly collected from the forest edge and surrounding farms. Good abundances indicating reasonable population levels were present for several species of conservation concern, including the near endemic *R. brevicaudatus* as the most common reptile, as well as the new species *Cnemaspis sp. nov*, and the Mahenge strict endemic *R. beraduccii*.

New Species, Endemics and Range Extensions
The two new species are likely to be strict Mahenge endemics. The forest gecko *Cnemaspis sp. nov* (photographed in annex 2a fig. 62b) differs from both the Usambara forest gecko *C. africana* and Udzungwa forest gecko *C. uzungwae* (M. Menegon pers. comm. with A. Bauer). This species was also recorded in Mselezi FR. A single female specimen resembling *K. oxyrhinum* was collected (photographed in annex 2a fig. 62c), which fell out of a high tree; based on preliminary morphological and genetic analyses this could be a new species, however a male is needed to confirm the taxonomic status and fully describe this new species. Specialist techniques and further investigation would be useful to record other species which tend to live higher in the canopy. A species of dagger-toothed snake *Xyeledontophis sp.* was collected (photographed in annex 2a fig. 62a). This snake is particularly interesting, as this monotypic genus was recently described only a few years ago, known from the Uluguru endemic *X. uluguruensis* (Broadley & Wallach 2002), of which only a few specimens are held. The specimen obtained from Sali may be *X. uluguruensis*, representing a significant range extension for this Eastern Arc endemic, or it may be a new species within this genus, strictly endemic to Mahenge. The specimen is currently being compared to reference material for *X. uluguruensis.*

One additional strict endemic reptile was recorded, *Rhampholeon beraduccii*; a pygmy chameleon restricted to the Mahenge Mountains; recorded only within and around Sali FR and recently described (Mariaux & Tilbury 2006). The two near endemics were *Rieppeleon brevicaudatus* and Tornier's cat snake *Crotaphopeltis tornieri*. *R. brevicaudatus* has been recorded in the Eastern Arc and Coastal Forests while *C. tornieri* has been recorded in several Eastern Arc forests as well as the Southern Rift. Four of these endemics (including the possible two new species) represent new records, with *C. tornieri* and *Cnemaspis sp. nov* also being found in Mselezi FR.

The total of six endemics comprises a significant proportion of the reptilian fauna (23.1%), one of the highest to be found in any of the Eastern Arc forests (e.g. compared with 33 species of reptile in 7 families of which 21.7% were endemic in Udzungwa Scarp FR; Menegon & Salvidio 2005). Table 23 shows the ranges of the endemic species previous to this study.

Table 23: Ranges of Eastern Arc endemic and near endemic reptile species previous to this study

Species	**Range previous to this study**
Mahenge Strict Endemic	
Kinyongia sp. nov (Mahenge new record)	
Rhampholeon beraduccii	Mahenge.
Cnemaspis sp. nov (Mahenge new record)	
Eastern Arc Endemic	
Xyeledontophis sp. (Mahenge new record)	Uluguru?
Eastern Arc Near Endemic	
Crotaphopeltis tornieri (Mahenge new record)	Usambaras, Nguru, Uluguru, Rubeho, Udzungwa, Southern Rift.
Rieppeleon brevicaudatus	Shimba Hills, Usambaras, Uluguru, Nguru, Udzungwa, Mahenge, Coastal Forests.

The widespread species recorded as Whyte's water snake *Lycodonomorphus whytii* represents a new record and range extension to the north for this species. It has been previously recorded from Mt Rungwe and Songea in southern Tanzania, and may be more widespread near Lake Malawi, ranging south to Mozambique and northern South Africa. It has also been recorded in the Udzungwas (Moyer & Rasmussen 2001; Menegon & Salvidio 2005). This specimen was captured in a mist net suspended low over a stream, apparently when it consumed a large catfish caught in the net. It then proceeded to regurgitate the catfish once disentangled from the net. This fish-predating behaviour has never before been documented. A further nine widespread reptile species represent new records for the Mahenge Mountains, of which one of these new records was also recorded in Mselezi FR.

Herpetofaunal Communities

The submontane forest of Sali FR appears to support several herpetofaunal communities. Most samples showed that Sali FR has a different and more species rich submontane herpetofaunal assemblage than that in Mselezi FR. These Sali FR samples include forest-dependent and Eastern Arc near endemic indicator species such as *Leptopelis vermiculatus* and *Afrixalus uluguruensis* (complex). There is a clear division between samples from rocky stream habitats (semi-riverine forest) and forest habitats (undifferentiated submontane forest) indicating two separate water-associated and non-water-associated herpetofaunal communities.

Another community is indicated by a grouping containing Mselezi FR samples and some Sali FR samples, demonstrating a more widespread and lowland herpetofauna species assemblage which is shared with Mselezi FR, with species such as *Arthroleptis stenodactylus* and *A. xenodactyloides*.

Butterflies

N. OWEN & S. GOMBEER

Seventy-four butterfly species were recorded in Sali FR, indicating a good species richness and abundance; of all faunal species, butterflies made up the greatest proportion. Twenty-seven species (36.4%) are of conservation concern, due to endemism, conservation status and forest-dependency. Five (6.8%) species are endemic, with one Eastern Arc endemic and four near endemics recorded; 24 species (32.4%) are forest-dependent. Although no species are considered threatened by IUCN or listed on CITES, the African Butterfly Research Institute has assessed levels of threat to produce a measure of conservation status. Seven species are considered at risk, with one species listed as Vulnerable, two as Threatened and four as Near Threatened.

Species Richness and Assemblages

Butterfly species richness tends to be determined by forest area and the presence of dense and moisture rich vegetation (Kielland 2000); while the greatest proportion of forest species occurs at low to medium elevation (De Jong & Congdon 1993). These reasons explain the high species richness present in Sali, most of the forest reserve was at low elevation, combined with little disturbance meaning that much of the reserve continues to be forested, and the typical Eastern Arc climate maintains moisture levels. Also, the dense understory layers present in parts of the forest provide a shaded and moisture rich environment.

A diverse range of forest habitats were present, and many species were captured around water sources, particularly in the open wetland area which explains the diversity of both forest-dependent and non-forest-dependent species present.

The forest canopy supports a distinct butterfly community indicated by *Charaxes cithaeron*. Interestingly, the Sali FR canopy community does not appear to differ significantly from the Mselezi FR canopy community; although understory species community is significantly different from that of Mselezi FR; likely due to both altitudinal and habitat differences between the reserves (De Jong & Congdon 1993). Two understory butterfly communities can be distinguished in Sali FR, a distinct wetland community and a forest based community. The wetland community includes forest-dependant and forest visitor species such as *Eicochrysops Hippocrates*, which prefers swampy areas, riverine

thickets and forest margins (Kielland 1990). The forest based community was found to be present in both forested areas and near rocky streams; corresponding to the semi-riverine and undifferentiated submontane forest plant communities.

Endemics and Range Extensions

One Eastern Arc endemic species *Cymothoe aurivilli* and four near endemic species were recorded, *Bicyclus danckelmani*, *Neptis nina*, *Papilio pelodorus vesper, P. fuelleborni fuelleborni* (table 24). All the endemics represent new records for the Mahenge Mountains.

A further 42 widespread butterfly species represent new records for Mahenge, of which three were also recorded in Mselezi FR.

Table 24: Ranges of Eastern Arc endemic and near endemic butterfly species previous to this study

Species	**Range previous to this study**
Eastern Arc Endemic	
Cymothoe aurivilli (Mahenge new record)	Nguru, Nguu, Uluguru, Rubeho, Udzungwa.
Eastern Arc Near Endemic	
Neptis nina (Mahenge new record)	Usambaras, Kimboza, Uluguru, Nguu, Nguru, Mwanihana to Mufindi, Ukaguru, Ulanga District, Pugu Hills.
Bicyclus danckelmani (Mahenge new record)	Usambara, Nguru, Nguu, Kanga, Ukaguru, Rubeho, Uluguru, Muhulu, Mulundwe, Lulando, Mt Meru, Southern Highlands.
Papilio fuelleborni fuelleborni (Mahenge new record)	Usambara, Nguru, Nguu, Ukaguru, Rubeho, Uluguru, Udzungwa, Southern Highlands, Northern Malawi.
Papilio pelodurus vesper (Mahenge new record)	Usambara, Nguru, Nguu, Rubeho, Uluguru, Udzungwa, Southern Highlands, Malawi.

5.4.2 Vegetation of Sali FR

A. AHRENDS & V. WILKINS

150 different plant taxa were recorded in Sali FR, consisting of 118 tree species and 32 other plant life forms. Fifty-two tree species and 16 other life forms were new records for the Mahenge Mountains. This inventory is comprehensive in regard to tree species but a more complete survey is necessary for the other plant life forms present in the reserve; however this survey still sheds light on the vegetation structure and composition of Sali FR, which was previously virtually unknown.

A total of 18 species are of conservation concern, due to endemism or conservation status: 14 tree species and 4 species for other life forms. Eleven tree species are classed as endemics or near-endemics and three for other life forms; four tree species and four other life forms are classed as Potentially Threatened (Gereau & Luke 2003); and ten tree species are also present on the IUCN Red List. Of those species identified, 39 tree taxa were forest specialists, 16 were forest generalists and 3 were grassland/woodland species.

Table 25: Plant species recorded in Sali FR, categorised by forest specialists and those of conservation concern: endemic and threatened; new records for the Mahenge Mountains are shown in parentheses.

Life form	No. of Species	No. of Families	Endemic Species[a]	Potentially Threatened Species[b]	IUCN[c] (2006)	Forest Specialists[d]	Total Species of Conservation Concern[e]
Trees	118 (52)	44	11 (8)	4 (2)	10 (8)	39 (25)	14 (11)
Other life forms	32 (16)	21	3 (2)	4 (2)	0 (0)	1 (1)	4 (2)
Total	150 (68)	56	14 (10)	8 (4)	10 (8)	40 (26)	18 (13)
% of all species			9.3	5.3	6.7	26.7	12.0

[a]Including strict endemics (species thought to occur only in the Mahenge Mountains); Eastern Arc endemics (species found only in the Eastern Arc); and near endemics (species found in the Eastern Arc Mountains and adjacent locations such as Coastal Forests, Southern Rift, Highlands);

[b]Species considered to be Potentially Threatened and not yet evaluated by IUCN (Gereau & Luke 2003, revised 2006);

[c]Species recognised as threatened with extinction to varying degrees.(listed on the IUCN Red List as Endangered, Vulnerable, Near Threatened, Conservation Dependent only; excludes Data Deficient, Not Evaluated and Least Concern)

[d]Species dependent upon and associated with primary forest.

[e]Includes endemic species, Potentially Threatened species and IUCN Red Listed species; excludes forest-specialists;

Tree Species Assemblages

Most tree species present in the reserve were either montane or widespread in both lowland and montane areas; very few were predominantly lowland species, these were *Baphia semseiana?, Solanecio mannii, Drypetes natalensis var. natalensis* and *Garcinia huillensi*s. When compared to other Eastern Arc Mountain blocks Sali showed affinities with the Ngurus and the West and East Usambaras, sharing species that are predominantly widespread montane, some of which also occur at lower altitudes.

Tree species data were collected via vegetation plots and used to isolate vegetation classes; however this was very difficult for Sali FR, as vegetation changed along a continuum rather than being discretely grouped; therefore analyses that allow for a continuum may be a more appropriate than a classification system. Despite these difficulties, some groupings were isolated utilising appropriate analyses (Ahrends & Marchant 2006). *Undifferentiated (sub) montane forest* was typical of most plots surveyed, consisting of high quality primary forest, highlighting the undisturbed nature of Sali FR, reiterated by the very high tree species diversity in the reserve. Within the *undifferentiated (sub) montane forest* group there was variation in species domination with some plots dominated by *Parinari excelsa.* Previous research has found the occurrence of this species to be associated with low diversity in vegetation plots and it was suggested that this may be related to climatic fluctuations as *Parinari excelsa* is a widespread species occurring at mid to low altitudes and is more tolerant to water stress (Lovett 1996). Other *undifferentiated (sub) montane forest* plots were dominated by *Xymalos*

monospora; however the exact reasons for domination by either *Parinari excelsa* or *Xymalos monospora* within the reserve is still unclear, and is a topic that could be explored through further research. *Semi riverine/disturbed forest* contained plots with typical indicators of disturbance such as the regeneration of pioneer species, high shrub cover and disturbance resilient species but only one plot had any actual signs of disturbance; all the other plots were associated with water. The disturbance indicators within the plots could be directly related to the presence of streams, in that flooding within the plots could be a significant enough disturbance factor to trigger these indicators. During the seasonal rains, rainfall can occur in extremely high quantities causing small streams to swell into raging torrents. When streams are large and fast flowing with a seasonal variation in the water masses they carry, they can shape vegetation by creating large tree gaps and introducing an additional species disturbance factor, potentially carrying the seeds of widespread resilient species. Another possibility is that humans have in the past followed streams and rivers into the reserve, causing disturbance as they move through the forest, however there was no physical evidence to suggest human disturbance. Further research would need to be undertaken to clarify why water associated plots show indicators of disturbance.

Species of Conservation Concern

Of the 68 endemic tree species (Burgess *et al*. 2007) occurring in the Eastern Arc, eleven occur in Sali FR; of these one is the Mahenge endemic *Peddiea lanceolata*, nine are Eastern Arc endemics and one is a near endemic. Eight of these endemic tree species represent new records for the Mahenge Mountains, *Sibangea pleioneura, Alsodeiopsis schumannii, Vitex amaniensis?, Beilshmiedia kweo?, Baphia semseiana?, Craterispermum longipedunculatum?, Pavetta lynesii, Leptonychia usambarensis.*

Table 26: Ranges of Eastern Arc endemic and near endemic plant species previous to this study

Species	**Range previous to this study**
Mahenge Strict Endemic	
Peddiea lanceolata	Mahenge
Eastern Arc Endemic	
Allanblackia stuhlmannii	E. Usambara, Uluguru, Udzungwa.
Alsodeiopsis schumannii (Mahenge new record)	E. Usambara, Uluguru.
Anchomanes abbreviatus (Mahenge new record)	Eastern Arc
Baphia semseiana? (Mahenge new record)	Nguru, Udzungwa.
Beilschmiedia kweo? (Mahenge new record)	E. Usambara, Nguru, Udzungwa.
Craterispermum longipedunculatum? (Mahenge new record)	Eastern Arc
Impatiens confusa subsp. longicornu	Eastern Arc
Gravesia pulchra var. pulchra (Mahenge new record)	Eastern Arc
Pavetta lynesii (Mahenge new record)	Uluguru, Udzungwa.
Psychotria megalopus	Eastern Arc
Sibangea pleioneura (Mahenge new record)	Udzungwa.
Vitex amaniensis? (Mahenge new record)	E. Usambara, Uluguru, Udzungwa.
Eastern Arc Near Endemic	
Leptonychia usambarensis (Mahenge new record)	Coastal Forests, Eastern Arc, Northern.

Three endemics of other life forms were also recorded, all of these were herbaceous; two represent new records for the Mahenge Mountains. Details of the endemic plant taxa recorded in this study are in table 26.

All of the Eastern Arc endemic tree species are listed on the IUCN Red List, together with one widespread tree species *Morinda asteroscepa*. One endemic herbaceous species and the strict endemic *Peddiea lanceolata* are listed as Potentially Threatened along with two additional widespread tree species *Monodora globiflora* and *Cylicomorpha parviflora* (Gereau & Luke 2003). Of the conservation concern species recorded in Sali, the tree species *Sibangea pleioneura* is a range extension, previously recorded only in the Udzungwas.

Sali appears to be of great importance to species conservation with 16% of the endemic tree species that occur in the Eastern Arc, together with the presence of species such as *Sibangea pleioneura* previously thought to be restricted to the Udzungwas and *Peddiea lanceolata* a Mahenge endemic. With a total of 18 species of conservation concern, either Potentially Threatened, Red Listed or endemic; for its small size Sali holds numerous populations of many important botanical species and therefore should be considered a conservation priority.

Environmental Gradients and Human Disturbance

No single environmental factor was isolated as influencing vegetation, but rather a combination of factors of similar weight. The sharp gradients in environmental factors such as topography, climate and edaphic attributes are typical of the Eastern Arc Mountains; and have previously been noted as impacting on local species distribution (Lovett 1998c; Lovett *et al*. 2001), with the vegetation continuum reflecting the environmental continuum (Lovett 1996). The importance of human disturbance in shaping vegetation was also visible within disturbed plots, for example the presence of paths and clearances; characterised by an increase in open area and disturbance resilient species, as well as by the higher density of small trees and the regeneration of pioneers.

Altitude appeared to have a distinct effect on plot character, with higher altitude plots characterised by a better forest environment with a greater number of forest-dependent and montane species, a higher basal area and density of large trees, more regeneration of canopy species and lower shrub cover. Previous research has found similar relationships with botanical diversity, productivity and elevation. Lovett (1996; 1999) found forest tree species richness and diversity to increase with elevation; these changes were identified as being a function of productivity and disturbance. Human disturbance is generally inversely related to altitude and therefore lower altitudes are more prone to disturbance. Although the intensity of human disturbance is low in Sali the effects of natural disturbance should be considered as large mammals such as elephant and buffalo use Sali as a migratory route; this survey produced evidence that these animals continue to use the forest. Another possibility is the effect of previous human disturbance, and although no longer physically apparent, it is indicated by the reserve's vegetation structure. More research would clarify the reasons behind the increase in forest quality with altitude. It could be argued that higher altitude areas warrant increased protection due to their better forest environment however restricted range species occur at a range of altitudes (Lovett *et al*. 2001) and therefore conservation efforts are also needed at lower altitudes to counteract disturbance effects.

Regeneration

Analysis of the data collected suggested that canopy species were regenerating in the majority of plots in Work Unit 2 with *Alsodeiopsis schumannii, Xymalos monospora, Parinari excelsa* and *Newtonia buchananii* restocking in five plots and sub-canopy species restocking in the rest. The regeneration of canopy species seen in Work Unit 2 may be due to its location, further away from human settlements, therefore having a reduced probability of disturbance. Species diversity and equitability was also higher in Work Unit 2, possibly indicating a more pristine and undisturbed section of the forest, perhaps because Work Unit 2 was at a higher altitude.

5.4.3 Human Resource Use and Disturbance in Sali FR

V. WILKINS

Sali FR was pristine submontane forest, generally untouched as it is currently remote enough to hinder most illegal activities. The majority of human disturbance noted was hunting (snares) and fire damage, with little wood extraction, with systematic disturbance transects surveying an area of 80,000km^2.

Pole and Timber Extraction

There was a very low level of pole extraction with less than 1% of all poles surveyed being cut (six poles), the rest being either live or naturally dead. The six cut poles observed were in a range of locations across four different disturbance transects, suggesting opportunistic cutting rather than localised extraction. Additionally, there were no records of pole cutting through casual observations or on the mammal transects, indicating that no areas of high intensity pole cutting exist within the areas surveyed. No timber extraction was recorded in Sali; this suggests that there is no widespread or opportunistic timber extraction currently taking place in the reserve.

The low levels of wood extraction in Sali FR is probably due to the inaccessibility of the reserve; as there are wood sources closer and more accessible to the village. However, the disturbance methodology utilised surveys a wide area but may miss small and highly concentrated areas of extraction which could be occurring in some of the more accessible areas of the reserve. In the short-term, it appears that pole cutting is having no tangible negative effect on the reserve as yet. In the long-term, degradation of current wood sources by neighbouring villages may lead to wood extraction reaching the reserve. In addition, improved access to the reserve and to Sali village may facilitate the initiation of timber extraction. Therefore current pole sources need to be maintained and tree planting encouraged in and around the villages adjacent to the reserve. Access to the reserve should be kept to a minimum and awareness measures taken to stress locally the fact that timber production is illegal in the reserve.

Other disturbance

Fire Damage

Fire damage in Sali FR appears to be confined to the edge of the reserve. However, although only four fire damage incidents were witnessed these affected significantly large areas (photographed in annex 2a fig. 63b). Fire appeared to start at the edges of the reserve, particularly where grasslands were present, and spread into the forest; while the more inaccessible areas of the reserve are likely to be free from fire damage. Interviews revealed that fire damage is generally caused by accidental burning, spread from clearance fires for cultivation near the reserve edge; and the use of fire control methods needs to be encouraged in the villages adjacent to the reserve. There is also potential for cultivation to spread into the more accessible areas of the reserve, and so the boundaries of the reserve need to be monitored and enforced.

Hunting

Hunting using traps and snares appears to be the main illegal activity occurring in Sali FR. A total of 37 traps were recorded through disturbance transects and casual observations. Traps occurred on only four of the 16 disturbance and large mammal transects surveyed, suggesting that trapping is not widespread in the reserve. Instead, it appears to be intense and localised; occurring in those parts of the reserve close to the village, and along footpaths hence the high numbers recorded through casual observations. Of the traps found, 95% were wire (antelope) snares, with one ‘duiker fence’ and one buffalo *Syncerus caffer* rope snare, implying that the main target species are forest antelope. The low intensity of buffalo trapping is relative to the low number of buffalo utilising the reserve, as indicated by our surveys where *S. caffer* sightings and sign were infrequently recorded.

Consequently, hunting pressures may be having a negative effect on populations of forest antelope in the reserve, especially in those areas closest to the village. This was confirmed by community interviews where residents have witnessed declines in the four antelope species (red duiker *Cephalophus harveyi*, blue duiker *C. monticola*, suni *Neotragus moschatus*, bushbuck *Tragelephus scriptus*). The observed declines may be due to a decrease in numbers due to intense hunting pressure or possibly animals avoiding those areas of intense trapping. Corroboration comes from the faunal surveys which also revealed low numbers of *T. scriptus* and *C. monticola*.

5.4.4 Community Knowledge of Sali FR

V. WILKINS

Structured Interviews and Discussion

The community day was conducted at Sali village, a small village located on the southern edge of Sali FR; a range of information and opinions pertaining to the reserve were collected from the residents interviewed, including details of history, use and management. The residents interviewed represented a broad range of ages, although there was a lack of young people present, and even numbers of both sexes were interviewed to give a balanced perspective. The majority of people interviewed were farmers, accurately reflecting the employment ratio in the village. Most had lived in Sali for their entire life, providing the interviews with a good historical basis. Information was also collected during the community day discussion, involving individuals from the whole community, and was an opportunity for topics, opinions and questions that had not yet been raised to be discussed.

Status of Sali FR

The concept of the forest as a protected area was well known in Sali village and half of the residents consulted knew that Sali forest was a reserve. The remaining interviewees were people who lived further away from the reserve in surrounding hamlets, and they believed that Sali forest was simply the old colonial footpath to Mahenge. Most residents knew the purpose of the reserve was to protect water catchments, and some knew that the forest was preserved for future generations as well as habitat for wildlife. However some believed the forest was for the picking of *Phoenix reclinata* (Ukindu), a plant used to make woven floor mats. Although the majority of individuals questioned appeared to have a good awareness of the importance of the reserve, there was still be some confusion as to its purpose, therefore further environmental education at Sali should be encouraged.

Wildlife

People reported the presence of large populations of Sykes *Cercopithecus mitis cf. moloney* and vervet monkeys *C. pygerythrus*, leopard *Panthera pardus*, blue *Cephalophus monticola* and red duiker *C. harveyi*, baboons *Papio cynocephalus*, hyrax Procavidae *spp.* and galago Galagonidae *spp*. However, we found little evidence of *P. pardus* (fresh tracks on one occasion), and no evidence of Procavidae *spp., C. pygerythrus* or *P. cynocephalus* in the reserve; so this may be due to confusion with nearby forest reserves or areas surrounding the forest reserve. Bushpigs *Potamochoerus larvatus* and suni *Neotragus moschatus* were reported to be present but in low numbers, this was corroborated by survey work for *P. larvatus*, but *N. moschatus* appeared to be relatively abundant in the area, although their numbers may have decreased in recent years due to hunting pressure. People also reported seeing hyena Hyaenidae *spp.* and buffalo *Syncerus caffer* but very rarely, and both species were recorded at low levels in the forest reserve.

Cercopithecus mitis cf. moloney, C. pygerythrus, Potamochoerus larvatus, Neotragus moschatus, Cephalophus harveyi, C. monticola and Procavidae *spp.* are all regularly eaten at Sali village. Apparently, most of this bushmeat is from Sali FR, while some is bought from the nearby village of Ruaha, sourced from the Selous Game Reserve and surrounding areas. It was clear that the illegal nature as well as the damaging effects of hunting were generally not recognised, and that hunting for bushmeat was frequent and extensive. Prices for a piece of meat ranged from TSh1000 to 1500, sometimes as low as TSh500, indicating that bush meat is in regular circulation.

Changes in the Reserve

Changes in the reserve observed by the community included the disappearance of vegetation surrounding the forest caused by human encroachment, suggesting the community is aware of the negative effect they are having on their environment. Numbers of *Syncerus caffer, Neotragus moschatus, Cephalophus harveyi* and *C. monticola* have also decreased rapidly in the last 10 years, most likely due to hunting pressure confirmed by the high numbers of traps found that targeted these species. Hunting needs to be highlighted as the most predominant form of human disturbance currently affecting the reserve and targeted in relation to control and prosecution as well as community

education. Elephant *Loxodonta africana* sightings were also common from the 1930s to the 1970s, but not now; bones were documented within the forest during this survey, and large animal paths created by elephants and buffalo and used within the past year were noted in the northern grassland part of the reserve. This confirms the use of Sali FR as a migratory corridor between the Selous Game Reserve and the Kilombero Valley, but with encroachment and habitat fragmentation, coupled with reductions in elephant populations this appears to have dramatically reduced in recent years.

The climate around the reserve appears to have changed, with people reporting that the temperature in the area has been increasing, in conjunction with a reduction in rainfall. The reduction in forest cover near the village would result in a decrease in rainfall and a possible rise in temperature as the climate became drier. A rise in malaria incidents in recent years in the area was reported, but it is unknown if this could be related to the climate.

Activities in the Forest Reserve

Respondents stated that they obtained firewood and building material from their immediate surroundings, outside the forest reserve; confirmed by our disturbance data which indicated very little pole and timber cutting in the reserve. It was acknowledged by the interviewees that agriculture is the main activity causing fire damage in the reserve; although it was stressed that people do not intentionally burn the forest but they fail to control the fires they use to clear scrub. Additional potential causes of forest fires include the use of fires to flush out animals when hunting and discarded cigarettes. Most fires in the reserve appear to be unintentional, caused by the lack of fire control methods utilised. Measures to help reduce this potentially devastating problem include building awareness of the damage fire causes in the reserve and its effects on the plants and animals present; as well as education supplying the knowledge and tools needed to control fires.

No grazing of domestic animals was observed in the reserve during surveying; and the villagers stated that they only graze animals outside the reserve. Surprisingly, despite the close proximity of Sali village to the forest, there seemed to be no traditional beliefs related to the forest.

Forest Management

The management of the forest was the main issue discussed at the community day. There was a significant level of frustration present in the village, as they felt they were unable to fulfil their community management role due to a lack of resources. The expectation of the government regarding the involvement of the community in forest management is not facilitated by any financial or technical support; therefore this issue was of great local concern. The community believed that there are currently not enough resources in the form of equipment and training to allow the Environmental Committee to function effectively; and there are insufficient facilities, such as an easily accessible police station and reliable road network. Sali village is a long way from the police post and there is infrequent and irregular transport to allow illegal activities to be reported. It was also suggested that to speed and simplify prosecutions, communication between Sali and Ruaha should be improved, this would allow a greater number of illegal incidents to be reported and prosecutions made. In particular, applicable regulations should have been in place before management was granted to the community. Yet the lack of infrastructure is the main reason that Sali FR has remained pristine and untouched and this needs to be considered in parallel with the needs of the community.

Concerns were also voiced about the money that is being paid to the District as forest fees; the community felt that this money should be given to the village to help fund forest management. They also suggested that the government provide training and assist with farming activities, for example to help reduce burning incidents; one individual suggested subsidies for agricultural equipment such as tractors. The villagers were keen to receive more environmental education from the forest officers in order to raise awareness and education on a participatory approach to forest management. The community was enthusiastic to learn and build upon the community day and requested that a copy of the final report be sent to the village. It is apparent that the community wishes to help with management of the forest reserve, it was a well discussed topic with many opinions voiced. However without training, support and funding, the community remains unable to undertake this role.

5.5 CONCLUSIONS AND RECOMMENDATIONS FOR SALI FR

N. OWEN & V. WILKINS

Sali FR holds a high diversity and richness of species for its small size, with an impressive degree of endemism along with the discovery of several species new to science. The pristine nature of the forest is solely a result of the remoteness and inaccessibility of the reserve. This tiny isolated pocket of forest is a last refuge for many Mahenge endemics, fragmented enough for mountain block speciation to have occurred but also important as a migratory corridor between two areas noted as harbouring significant populations of large mammals. This rich diversity of fauna, particularly herpetofauna, and high proportion of endemics and forest-dependents, highlights Sali FR as an area of conservation importance and worthy of further research.

Sali FR hosts a total of 22 new records of vertebrate endemics including potentially six vertebrate species new to science (one lizard *Cnemaspis sp. nov*, one chameleon *Kinyongia sp. nov*.; four amphibians *Callulina sp. nov, Probreviceps sp. nov., Hoplophryne sp. nov., Nectophrynoides sp. nov 2*).

A high number of threatened and endemic species were recorded for all plant life forms with 18 species of conservation concern, which included 13% of EA tree endemics; and 11 new records for endemic plants. A collection was made of the tree species *Sibangea pleioneura*, only previously recorded in Udzungwa Mountains and also the Mahenge endemic *Peddiea lanceolata*. Other plant life forms were only collected opportunistically; however these still included four species of conservation concern but a more comprehensive survey of these life forms is needed in the future. Most tree species recorded were either montane or occurring in both lowland and montane environments with a high proportion of forest specialists. The most predominant plant community was *undifferentiated (sub) montane forest*, reinforcing the largely untouched nature of the reserve.

The results from survey work here have vastly improved the scientific knowledge of the Mahenge Mountains, and this significantly changes the position and conservation prioritisation of the Mahenge Mountains within the Eastern Arc hotspot, providing a concrete basis for further research and monitoring in this area.

The main human threat in the reserve is from hunting, with populations of forest antelopes potentially under stress from high hunting pressures. This is particularly important since the interviews reported that certain species have seen declines in recent years, most likely due to hunting pressures. Without any enforcement of the law this will continue unabated, and could lead to the dramatic reduction and extirpation of these species as the area of Sali FR is small. Pole and timber extraction in the reserve is currently negligible, however low altitude vegetation plots were of low vegetation quality that may have been caused by previous human disturbance. This may be a potential future issue which could be avoided through protecting and maintaining current local sources of poles and timbers as well as awareness raising. Fire damage within the reserve at the time of surveying was at a localised level, however, the destructive capacity of fire makes it a very serious issue that needs to be addressed. This can be achieved through enforcement of reserve boundaries and further education to highlight the danger of uncontrolled fires; as well as encouraging the use of fire control methods and alternative clearance methods for cultivation. Although people appreciate that the forest is a reserve that needs protecting, there is still some confusion over the purpose of the reserve, therefore environmental education is essential to raise awareness of the importance of catchment forest reserves.

It appears that the management and protection of the reserve by the local community is being suppressed by a lack of resources within the village and the local Forestry Office. Currently, no local livelihoods rely directly on the forest remaining in a pristine state, meaning there is little economic incentive for community participation. However there is a strong community will to protect and preserve the forest. Sali FR is currently primarily protected by its inaccessibility although disturbance is still occurring at low levels; yet in the future this may not be sufficient as human pressures continue to grow. Therefore local communities need additional support to help with management, better

communication facilities to aid prosecution, as well as training and awareness raising to increase understanding of the participatory management process. There may be some scope for limited and regulated eco-tourism as Sali FR is a last remaining fragment of pristine forest, with spectacular scenery, gigantic trees and opportunities to spot wildlife.

The capacity building component conducted by WWF-TPO (see section 7), produced Community Action Plans for forest management and facilitated community applications for CEPF funding for sustainable projects. This is an important first step in building the capacity of local communities to protect and conserve their forest reserve while enabling the parallel development of sustainable livelihoods as an economic incentive.

5.6 MANAGEMENT PRIORITIES FOR SALI FR

N. OWEN & V. WILKINS

The low levels of human disturbance present in Sali FR can be attributed to its remoteness from human populations rather than any active management plans currently in place. As demonstrated by the current high levels of illegal hunting within the reserve, more environmental education is necessary to prevent an increase in human resource use by the growing local populations, endangering both the environmental services provided by Sali FR and the rich biodiversity found therein. Some of the recommendations below reiterate those suggested by Lovett & Pócs (1993) in their assessment of the catchment forest reserves, as these were never implemented and continue to be important. The following recommendations can be achieved through action taken by the governmental Forestry and Beekeeping Division (FBD) in terms of enforcing governmental law. Interested NGOs and other grassroots organisations could provide environmental education and support to local communities through co-ordination and collaboration with local Environmental Committees.

1. **Boundary reassessment and clear demarcation of Sali FR** is required to remove ambiguities over boundary location and prevent encroachment.
2. **Achievable management plans** need to be developed and **adequate budgets allocated** for their implementation and for law enforcement, as well as for supporting the local community to enable implementation of the JFM schemes. WWF-TPO conducted a workshop as part of the capacity building component of this project, facilitating the preparation of management plans by the communities surrounding the reserve (appendix 11e). However this will need to be supported and maintained by Catchment Forestry Officers.
3. **Assist the Village Environmental Committees** to establish bylaws to address and act on conservation management issues. Support in the enforcing of bylaws and empowerment will be necessary to facilitate disciplinary measures to combat illegal exploitation (with an emphasis on poaching and the sale of bushmeat), such as introducing the use of fines. Financial support and professional training for the Environmental Committee should be a priority as without support or resources the committees are currently frustrated and ineffective.
4. **Patrols** should be conducted by Forest Officers in conjunction with the village Environmental Committees, and carried out on a regular basis to control illegal activities, particularly in relation to hunting as well as encouraging local people to report any illegal activities they witness. Financial support will be necessary to supply adequate equipment to the Environmental Committee.
5. **Support for the prosecution of illegal activities** through improved communication channels between the Environmental Committee and prosecuting authorities; as well establishing protocols for reporting illegal activities both within the village and externally.
6. **Improved liaisons** between the local Forestry Officer and Sali village. This would allow the communities to highlight problems, and the Forestry Officer to provide guidance and support; as well as being an opportunity to facilitate funding applications for community projects such as a tree nursery, new cottage industries etc. The Forestry Officer would have to be provided with adequate funds to ensure regular meetings.
7. **Provide alternative resources for sustainable use** through planting tree species in village areas that can be set aside for village use. Sustainable resource use and practices here must be encouraged. Planting could include quick growing tree species to meet demands for firewood and timber (Rodgers & Burgess 2000), and plant species commonly used for food and medicine. Sustainable hunting of locally abundant species could also be encouraged in these areas, with education to designate quotas and sustainable practices.
8. **Conduct environmental education and awareness raising** about the boundaries of the forest reserves; its importance for the protection of water sources, soil and biodiversity; and the negative effects of human disturbance, including practical advice on controlling activities that can cause damage, for example using firebreaks to limit fires, and addressing the impact of poaching. Education in schools is particularly important, targeting future generations as well as being a resource to apply schemes such as tree planting. Teachers should be encouraged to

use the forest and the natural environment in their lessons and to teach the importance of the forest and its resources, especially the traditional uses of forest plants.

9. **Investment in rural development** in the impoverished communities surrounding the forest reserves is necessary to establish essential services and infrastructures, and to help ensure effective and sustainable use of other natural resources in order to alleviate their dependence on the forest reserve. Alternative sources of income should be encouraged to deflect dependence away from the forest reserves. This could be achieved through cottage industries such as bee keeping, the growing of saleable crops and jewellery making.

6. MSELEZI FOREST RESERVE

6.1 STUDY SITE

N.OWEN

6.1.1 Site Summary (from Lovett & Pócs 1993)
Ulanga District, Morogoro Region
Location: 8º 46' – 8º 52' S 36º 43' – 36º 44' E
Year of Establishment: 1954
Declaration: GN216 of 30/7/54
Variation order: Initiated in 1982 (Jb 2071)
Border map: Jb 190 (1:24000) 1954; JB 2071 (1:25000) 1982
Topographical maps: 251/3
Gazetted area: originally 1904 acres (771 ha) (Jb190); now 2245 ha (Jb 2071)
Gazetted boundary length: originally 39km (Jb 190); now 25.6km (Jb 2071)

Mselezi FR is located on the central part of the Mahenge Mountains; 15-20km south of Mahenge (annex 1 fig. 59a), covering the Mselezi Valley. This information is taken from the assessment of the condition of the catchment forest reserves conducted by Lovett & Pócs (1993), except where new information was recorded in this project. Established in 1954, a variation order for the enlargement of the reserve was initiated in 1982, now including the valley bottom and the ridges on either side.

6.1.2 Topography
Mselezi FR covers the valley of Mselezi stream, stretching up the valley sides to the surrounding forested ridges. The inclusion of the valley bottom and Mselezi stream is a recent addition to the reserve. The main vegetation types are riverine lowland forest along the stream in the valley bottom, with semi-evergreen drier lowland forest on the slopes and ridge tops. The altitude ranges from 500-900m asl. The forest reserve supplies water to Mbingu, Chilomba and Mwaya villages. The soils are tropical rendzina on crystalline limestone rocks. Where deeper soil can develop, especially in the valley bottom and on gneiss and granulite baserocks, red and brown ferralitic soils occur.

6.1.3 Biodiversity
Lovett & Pócs (1993) considered the forests to be of the Eastern Arc type due to climate and altitude; and to be rich in endemic species, the Eastern Arc endemic *Dombeya amaniensis* was common in 1993.

6.1.4 Climate
Under the Indian Ocean climatic regime, the climate is oceanic with oceanic/continental temperatures. Rainfall is estimated at 1500mm per year. The dry season is June to October, with the long rains falling between February and May, and the short rains from November to January. The daytime temperature ranges from: 20˚C min (July) to 26˚C max (November).

6.1.5 Land Use
This catchment forest reserve permits no legal exploitation, but the boundary is unclear as there are no obvious beacons or trees planted, and the communities living inside the reserve appear unaware of the new variation order. The main road runs through the middle of the forest reserve, along the valley, making exploitation of the area extremely easy. There are settlements within the reserve, located along the road, established before the variation order, and so small scale cultivation is prevalent in the valley. Previous records of land use include encroachment for small-scale farming, damage to the reserve from logging and fire damage, and ruby mining. Lovett & Pócs (1993) recommended that the borders be clearly marked and planted but this had not been implemented by the time of our survey work.

6.1.6 Forest Reserve Management

Mselezi FR received Tanzanian Government-NORAD funding for the Joint Forest Management (JFM) scheme, which devolves reserve management to the local communities. The JFM contract is between Isongo village as managers of Mselezi FR and the FBD (Morogoro Office, January 2004). The government representatives, in the form of FBD along with the District Catchment Office and the District Forest Office, the District, Division and Ward Heads, have a number of duties to the JFM scheme. These include delivering environmental education to improve JFM implementation; providing alternative activities to reduce poverty; empowering the Environmental Committee and village to actively conserve and manage the forest reserve; through providing advice, supervision and task forces to patrol the reserve. On the part of the village, the Village Government is expected to supervise the JFM scheme on a local level, propose and accept relevant bylaws, and collaborate with relevant experts; while the villagers should participate fully in forest fire fighting, reporting those conducting illegal activities, and planting trees both inside and outside the reserve.

6.2 METHODOLOGY

N.OWEN

A total of two weeks was spent in Mselezi FR with survey work conducted from 25th November to 9th December 2005. The community day for Mpangayao hamlet and Isongo village was held on the 6th December 2005.

There was an extremely high level of disturbance in Mselezi FR and much of the forest was encroached and degraded. Considering this, one work unit was conducted as this was proportional to the remaining forest area (table 27). It was sited in the central section of the reserve as this was where the largest remaining area of forest was located, and this enabled the ridges and valley bottom to be sampled at a range of altitudes. However the zoological site was located in the vicinity of the basecamp and not within the work unit in this case, although in similar habitat (dry lowland forest and riverine forest); as there were no practical sites within the work unit (the area consisted of steep rocky slopes or houses and farmland).

A summary of the methods used and total survey effort employed is outlined in table 28. Annex 1 fig. 60a shows the location of the work unit, zoological site and basecamp within Mselezi FR.

Table 27: Work Unit details in Mselezi FR

Work Unit	Description of location	Zoological work	Grid ref Lat / Long	Grid ref UTM	Altitude (m asl)
1	Dry lowland forest with some riverine forest. Zoosite located in lowland/riverine forest in the north, near the road.	Zoological site 1	08 °47' 03.8" 036 °43' 00.41"	0248826 9028308	550
	Centre-Point located in lowland forest/secondary scrub in the centre of the reserve near the road with transects crossing valley settlements up to forested ridges 25/11/05 – 05/12/05	Centre-Point 1	08° 48' 47.9" 036° 43' 19.5"	0249435 9025022	550

Table 28: Methodology employed and summary of survey effort in Mselezi FR

Survey technique (and sampling unit)	Target	Total sampling effort
Vegetation		
Vegetation plot (50m x 20m; 12 per work unit)	Trees	12 vegetation plots
Regeneration plot (6m x 6m; 12 per work unit)	Trees	12 regeneration plots
Zoosite vegetation plot (10m x 50m; 3 per work unit)	Trees	3 vegetation plots
Zoosite regeneration plot (6m x 6m; 3 per work unit)	Trees	3 regeneration plots
Opportunistic observation/collection	All plant life forms	
Fauna		
Sherman traps (100 traps x 8 trap-nights per work unit)	Small mammals	800 trap-nights
Bucket pitfall traps (33 buckets x 8 trap-nights per work unit)	Reptiles, amphibians, rodents	264 trap-nights
Animal sign transects (4 transects x 1km per work unit)	Larger mammals	4 transects, 4km
Large mammal transects (4 transects x 3.5km per work unit)	Larger mammals	4 transects, 14km
Nocturnal mammal transects (2 transects x no. of hours per work unit)	Nocturnal mammals	10.3 hours
Large mammal and galago traps (opportunistically set)	Larger mammals and galagos	15 trap-nights
Bat mist net surveys (net-metre-hours)	Bats	276 net-metre-hours
Bird mist net surveys (net-metre-hours)	Birds	7,748 net-metre-hours
Bird randomised walks (12 observation hours per work unit)	Birds	12 observation hours
Visual encounter surveys (quadrats) (16 quadrats x 1 man-hour per work unit)	Reptiles, amphibians	16 man-hours
Visual encounter surveys (transects) (4 transects x 4 man-hours per work unit)	Reptiles, amphibians	16 man-hours
Acoustic nocturnal recordings (opportunistically conducted)	Amphibians, nocturnal mammals	
Canopy traps (6 traps x 8 trap-days per work unit)	Butterflies	48 trap-days
Sweep netting (2 man-hours x 8 days per work unit; 3 veg-plot man-hours per work unit)	Butterflies	19 man-hours
Opportunistic observation/collection	All animal taxa	
Human Resource Use and Disturbance		
Transects (4 transects x 1km per work unit)	Human disturbance	4 transects, 4km
Opportunistic observation	Human disturbance	
Community Knowledge		
Interviews	Local knowledge	15 interviews
Discussion	Local knowledge	

6.3 MSELEZI FR RESULTS

6.3.1 Fauna of Mselezi FR

Most faunal species have been taxonomically verified, however this is still pending for some species (primarily shrews); the following results have been compiled with both confirmed identifications as well as preliminary identifications for unverified species. Appendices 4 to 8 present faunal data.

Mammals

N. OWEN & A. PERKIN

A species inventory was compiled using data from sherman trapping, bat netting, bucket pitfall trapping, large mammal diurnal and nocturnal transects and opportunistic observations. In some cases, sightings and sign could only produce identifications to genus.

- *Species richness, diversity and composition*

Twenty-seven mammal species (with two taxa identified only to genera within which more species may be found) representing 16 families were recorded in this survey, (appendix 4a). Fourteen species represent new records for Mahenge, with eight of these new records also being found in Sali FR.

The presence of large mammals (species which cannot be sampled through sherman or bucket pitfall trapping such as sengis) was predominantly recorded through indirect observations of sign, although vocalisations and visual observations were also documented. Eighteen species in 12 families were recorded using a combination of 18km of diurnal transects (14km of direct observation transects and 4km of sign transects), 10.3 hours (8km) of nocturnal transects, and opportunistic observations. Sykes monkeys *Cercopithecus mitis cf. moloney* were the most frequently seen large mammal, with 26 sightings of groups over 14km of diurnal transects, and several more opportunistic observations, primarily around camp.

Approximately 14km of dedicated diurnal mammal transects were walked, recording visual, aural and sign (dung and tracks) sightings, although the only species which were seen or heard were *Cercopithecus mitis cf. moloney*, tree hyrax *Dendrohyrax validus* and bush hyrax *Heterohyrax cf. brucei*, and Svynnerton's bush squirrel *Paraxerus cf. vexillarius byatti*. This was supplemented by an additional 4km of sign-only transects, conducted along the human disturbance transects. Nine species (and two groups of species: small carnivores and hyrax Procavidae *spp.*) were recorded using this method. The mean encounter rate was primarily based on the number of sign (apart from *C. mitis cf. moloney* and *Paraxerus cf. vexillarius byatti* which were mostly seen and so encounter rate is given for groups and individuals respectively), and was calculated for each species as a measure of relative abundance (fig. 23). The most abundant species were *C. mitis cf. moloney* (0.84±0.99 groups/km), small duiker likely to be suni *Neotragus moschatus* (1.28±0.96 sign/km), and Procavidae *spp.* (0.72±0.62 sign/km). Procavidae evidence (both visual, aural and sign) has been grouped as analysis of vocalisations have now shown that there are two species. All small carnivore sign was grouped together as it could not always be reliably identified to species level, so the encounter rate gives a measure of overall small carnivore abundance. Appendix 4c summarises the diurnal transect data and encounter rates for Mselezi FR.

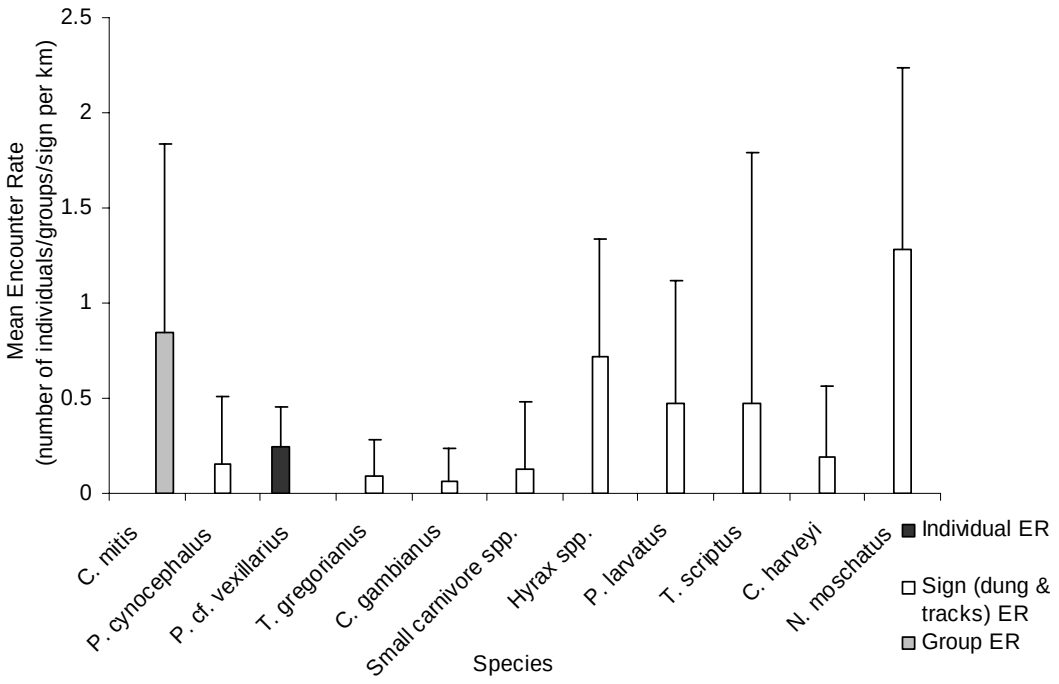

Figure 23: Encounter rates with associated standard deviations from large mammal transects in Mselezi FR

A total of 10 hours and 20 minutes of nocturnal transects (approximately 8km) over two survey nights yielded high-quality recordings and frequent vocal encounters for two species of galagos, Grant's galago *Galagoides granti* and the thick-tailed galago *Otolemur crassicaudatus*; and two species of hyrax *D. validus* and *Heterohyrax cf. brucei*, the latter species producing novel and interesting calls; encounter rates could not be produced for each species of hyrax as calls were not always clearly distinguishable. Relative abundance was calculated as the number of individuals encountered per hour of transect walked. Where possible, individuals were identified by their location so that repeated calls were not logged as a new individual. Procavidae *spp.* were the most abundant species (5.89±2.21ind/hour; fig. 24), followed by *O. crassicaudatus* (1.54±1.11ind/hour), and *G. granti* (1.38±0.23ind/hour). Appendix 4e summarises the nocturnal transect data and encounter rates for Mselezi FR.

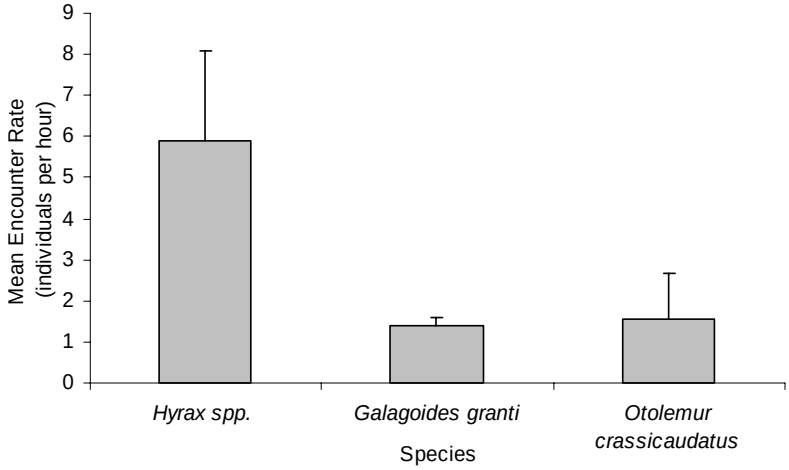

Figure 24: Encounter rates with associated standard deviations from nocturnal mammal transects in Mselezi FR

Otolemur crasicaudatus: Typical 'cry' calls which is the species advertising call and one series of 'squawks' were recorded (fig. 25).

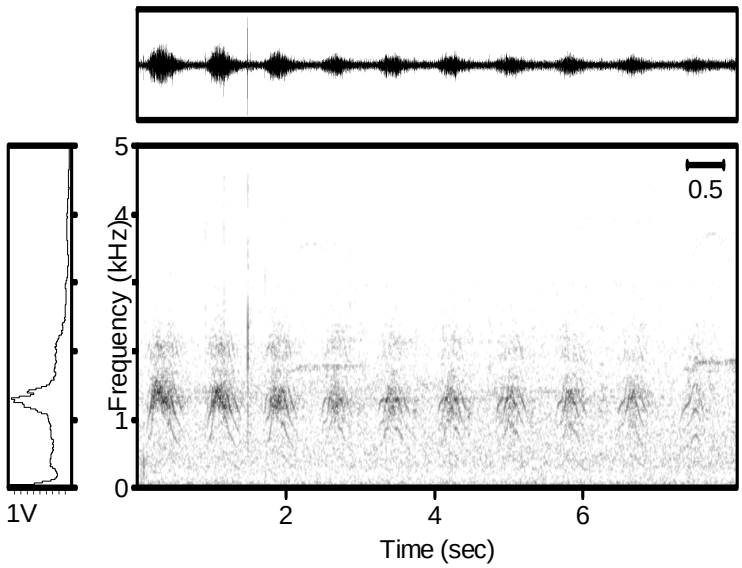

Figure 25: An example of the 'cry' advertising call of O. crassicaudatus from Mselezi FR.

Galagoides granti: The typical species advertising call, 'incremental calls', were mostly heard (fig. 26) but 'sweep screeches' both alone and mixed with yaps and other 'rapid yap and screech calls' were also recorded. These latter calls are alarm calls; containing very high frequency elements (up to 13KHz) and the different harmonies of the sweep screech units are evident (fig. 27).

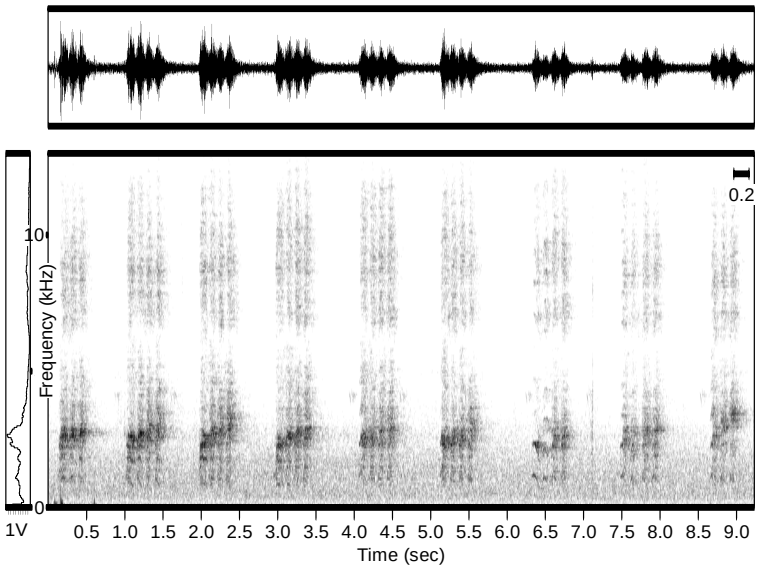

Figure 26: An example of a full 'incremental call' of G. granti from Mselezi FR.

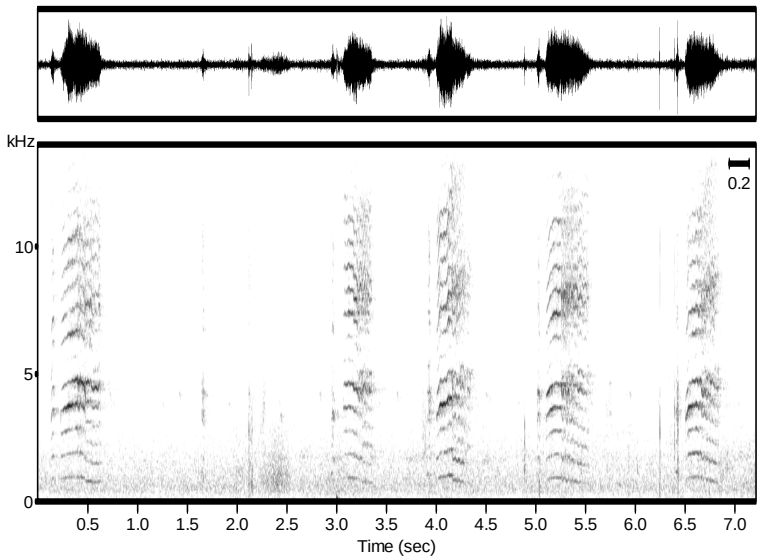

Figure 27: An example of 'yaps and sweep screeches', and alarm call of G. granti from Mselezi FR.

Dendrohyrax validus: Typical 'hacks' and 'hacks and ping pong' calls of *D. validus* were recorded in Mselezi FR (fig. 28). The call starts with a series of 'hacks' trailing into the 'ping pong' element seen towards the end. The regular spacing of each unit is a notable feature of this call.

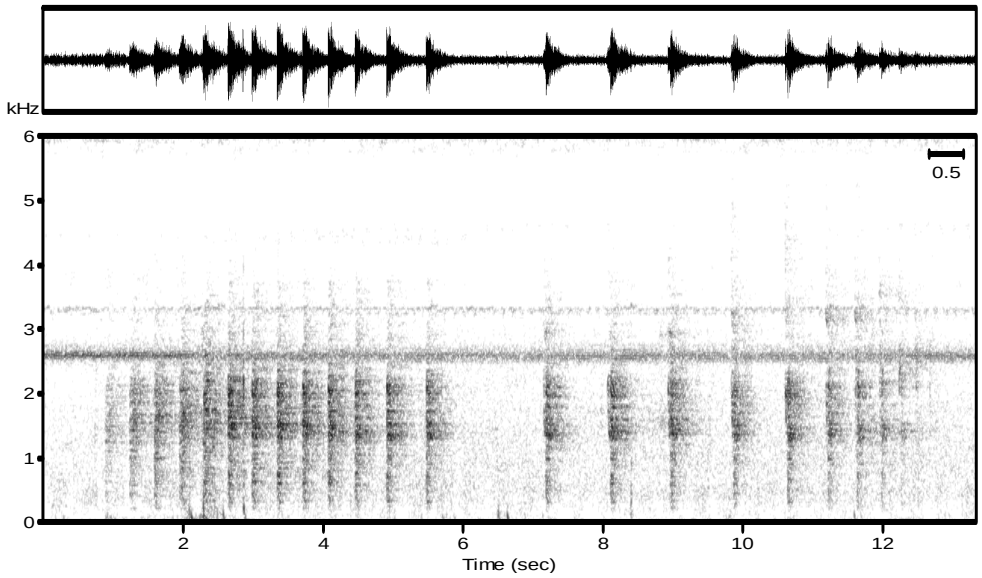

Figure 28: An example of 'hacks and ping pong' calls of D. validus recorded in Mselezi.

Heterohyrax cf. brucei: A second series of calls provisionally named here as: territorial calls similar to 'horse neighs' (fig. 29); 'whistles', 'hacks and wheezes', 'wheezes' and 'whistles' (fig. 30). The bush hyrax calls also appear to be of a higher frequency range (1370-13,000Hz) compared with the tree hyrax calls (60-550Hz). The frequency range of the whistle is 2000-7300Hz; the wheeze is 2000-12,000Hz.

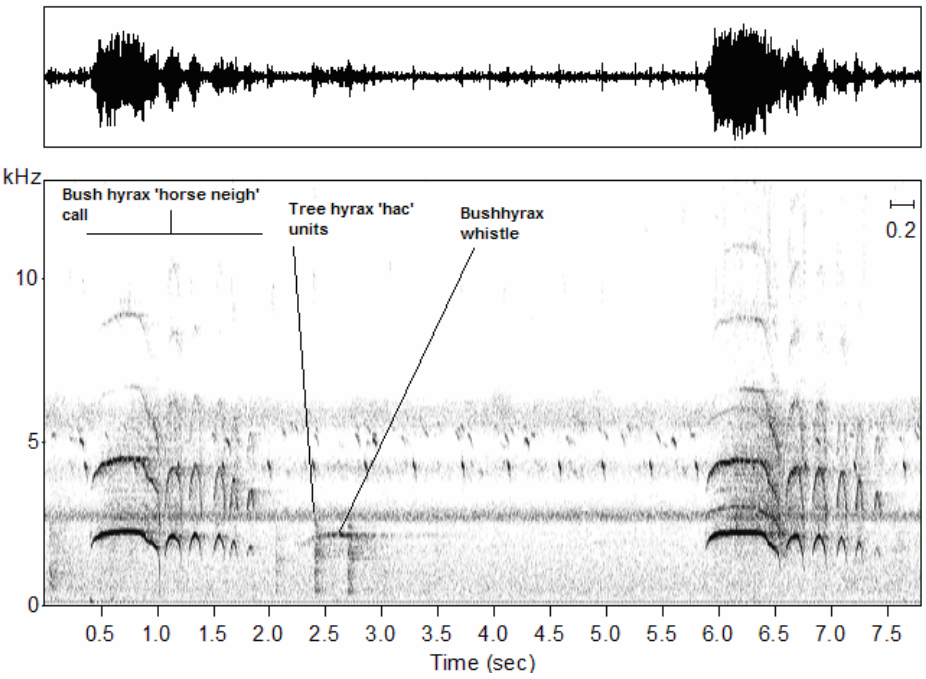

Figure 29: The 'horse neigh' territorial call of Heterohyrax cf. brucei. Another 'whistle' call can be seen in the background and the start of some typical 'hack' units of D. validus just after the first 'horse neigh' call.

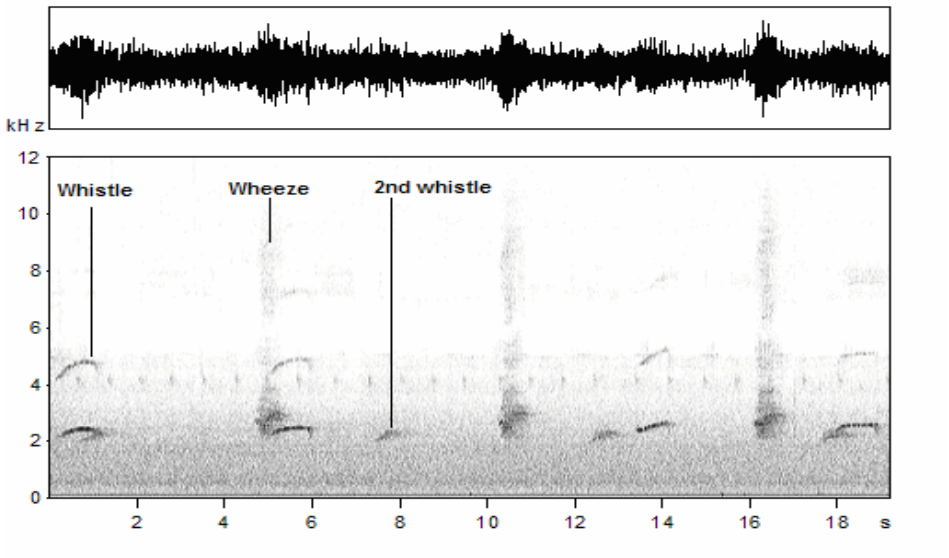

Figure 30: The 'wheeze' and 'whistle' call of Heterohyrax cf. brucei. It is not known if these two calls are being made by one animal. A second animal is starting to 'whistle'. Other marks on this graphic are background noise and insect calls.

For the small mammals five taxa (three confirmed to species and two confirmed to genus, with potentially more than one species recorded in each genus) in three families were recorded from a total of 22 captures. Fifteen captures (excluding three recaptures) were made over 800 sherman trapping nights; and four captures were made over 264 bucket pitfall trap-nights. Seven specimens were taken. The spiny mouse *Acomys spinosissimus* was most abundant at both sites, accounting for 73% of captures with a relative abundance of 1.38ind/100trap-nights (fig. 31). Other species included the lesser-pouched rat *Beamys hindei* (0.25ind/100trap-nights), the narrow footed woodland mouse *Grammomys sp*. (0.13ind/100trap-nights), and the brush-furred mouse *Lophuromys flavopunctatus* (0.13ind/100trap-nights). A potential two species of white-toothed shrews *Crocidura spp.* were recorded, out of four captures of which three specimens were taken. Appendix 4f summarises small mammal data obtained through sherman trapping, bucket pitfalls and opportunistic observations for Mselezi FR.

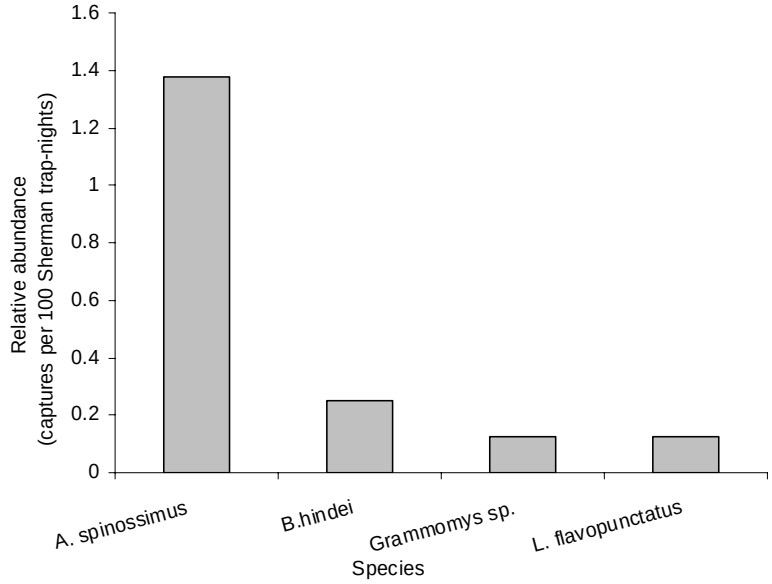

Figure 31: Relative abundance of small mammals produced from sherman trapping in Mselezi FR

Bat netting was conducted for a total of 276 net-metre-hours, yielding three species in two families out of six individuals caught: *Nycteris cf. hispida, Rhinolophus hildebranti* and *Rhinolophus cf. fumigatus*. An additional species, *Lissonycteris cf. angolensis* was an opportunistic early morning capture in a bird mist net. Five specimens were taken. Not enough captures were made to calculate any measures of relative abundance. Appendix 4g summarises bat data obtained through mist netting for Mselezi FR.

- *Endemism, conservation status, and forest dependence*

Of the 27 mammal species recorded, seven species in six families are of conservation concern (25.9%; full details of each species can be found in table 29): with four near endemics (14.8%; fig. 32), *Beamys hindei*, *Dendrohyrax validus, cf. Paraxerus vexillarius byatti*, *Galagoides granti*. Five species of conservation concern represent new records for Mahenge (including the former three near endemics); four of these species were also recorded in Sali FR.

Four species are considered to be at risk on the IUCN Red List (14.8%; including three near endemics; listed as Vulnerable, Near Threatened or Conservation Dependent), with three also being CITES listed. One species is listed as Data Deficient, and twenty are listed as Least Concern. Five species are forest-dependent (18.5%).

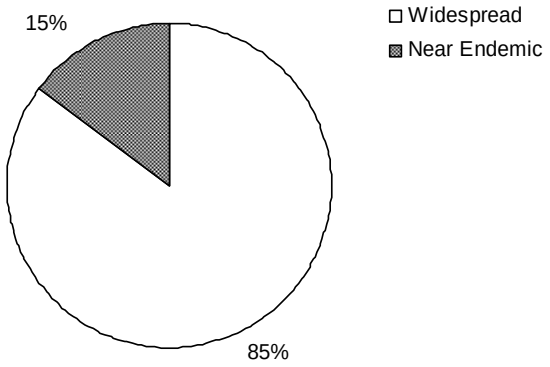

Figure 32: Mammal endemism in Mselezi FR

Table 29: Mammalian species of conservation concern (categorised by endemicity, forest-dependency and/or conservation status) in Mselezi FR

Species	Common Name	Range	Habitat	IUCN (2006)	CITES (2006)	Previous Mahenge Records
CERCOPITHECIDAE						
Cercopithecus mitis cf. moloney Wolf 1822	Sykes monkey	W	FF	LC	II	Mahenge Scarp; Nambiga
GALAGONIDAE						
Galagoides granti Thomas & Wroughton 1907	Mozambique galago	NE – EA, CF	FF	DD	-	Mahenge Scarp
MURIDAE						
Beamys hindei Thomas 1909	Lesser pouched rat	NE – EA, CF, SR, H	F	NT	-	New Record† (Nawenge; Mahenge Scarp; Nambiga)
SCIURIDAE						
Paraxerus vexillarius byatti Kershaw 1923	Svynnerton's bush squirrel	NE – EA, SR	FF	VU	-	New Record
HYRACOIDEA						
Dendrohyrax validus True 1820	Tree hyrax	NE – EA, CF, H	FF	VU	-	New Record† (Mahenge Scarp)
BOVIDAE						
Cephalophus harveyi Thomas 1893	Red duiker	W	FF	CD	-	New Record
Neotragus moschatus Van Duben 1847	Suni	W	F	CD	-	New Record

†These records (*Beamys hindei*, *Dendrohyrax validus)* from Frontier Tanzania's previous work have not been included in peer-reviewed literature (Burgess *et al.* 2007), and have therefore been considered unverified for Mahenge. This survey presents the first confirmed records of these species for the Mahenge Mountains.

Key to Results Species Tables:

Range: SE = Strict Endemic, confined to the Mahenge Mountain block, E = Endemic, range restricted to the Eastern Arc Mountains, NE = Near endemic, range restricted to the Eastern Arc Mountains and at least one other African ecoregion (CF = Coastal Forests; SR = Southern Rift; H = Kilimanjaro, Meru and/or Kenya Highlands; W = Widespread;

Habitat: FF = forest-dependent, F = forest dwelling, f = forest visitor, O = non-forest species;

IUCN (2006) Status: VU = Vulnerable, EN = Endangered, NT = Near Threatened, CD = Conservation Dependent, LC = Least Concern, NE = Not Evaluated;

CITES (2006) Status: Appendices I, II, or III;

Avifauna

N. OWEN & J.KIURE

- *Species richness, composition and diversity*

A total of 109 bird species in 38 families were recorded in Mselezi FR (appendix 5a). Sixty-three species represent new records for Mahenge, with fifteen of these new records also being found in Sali FR. Appendix 5b lists details of avian survey sites and survey effort.

A total of 7,748 net-metre-hours yielded a total of 23 species from 73 individuals (9.4ind/1000net-metre-hours; appendix 5c). A total of 12 man-hours of randomised walks increased the species inventory by another 86 species. Thirty-seven DNA samples and eight specimens were taken for both Mselezi and Sali forest reserves (appendix 5d). Breeding records were made for five of these species (appendix 5e). Behavioural observations are described in appendix 5f.

Overall species diversity was good with species evenly distributed (Shannon Wiener; H=2.73, J=0.87). The most abundant species captured through mist netting was the little greenbul *Andropadus virens* (1.8ind/1000nmh) and Peter's twinspot *Hypargos niveoguttatus* (1.4ind/1000nmh; fig. 33), with other more common species being the olive sunbird *Nectarinia olivacea* (0.8ind/1000nmh), the grey-olive greenbul *Phyllastrephus cerviniventris* (0.6ind/1000nmh), and the collared sunbird *Anthreptes collaris* (0.6ind/1000nmh).

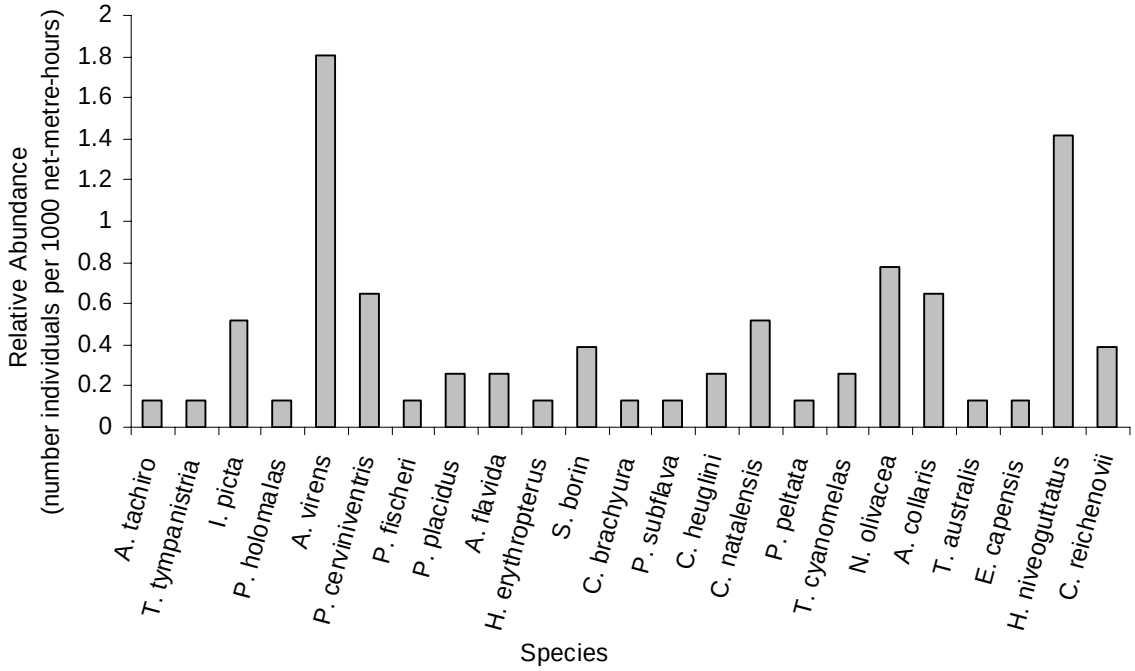

Figure 33: Relative abundance of birds produced from mist netting in Mselezi FR

- *Endemism, conservation status, and forest dependence*

Of the 109 avian species recorded, 16 species in 10 families are of conservation concern (14.7%; full details of each species can be found in table 30). Nine of these species of conservation concern represent new records for Mahenge (including three near endemics)*;* with six of these new records also recorded in Sali FR. Breeding records were made for five species, four of which are of conservation concern.

Four of these species are near endemics (3.7%; fig. 34), found in the Eastern Arc, Coastal Forests and/or Southern Rift: Shelley's greenbul *Andropadus masukuensis*, stripe-cheeked greenbul *A. milanjensis*, forest batis *Batis mixta*, and green barbet *Stactolaema olivacea*. The latter three represent new records for Mahenge and all were also found in Sali FR.

Two species are considered to be at risk on the IUCN Red List (1.9%; listed as Near Threatened or Conservation Dependent) with 25 also being CITES listed. Two species have not yet been evaluated by IUCN, and 105 are listed as Least Concern. Fourteen species are classed as forest-dependent (12.8%), including three near endemics.

Table 30: Avian species of conservation concern (categorised by endemicity, forest-dependency and/or conservation status) in Mselezi FR

Species	Common Name	Range	Habitat	IUCN (2006)	CITES (2006)	Previous Mahenge Records
ACCIPITRIDAE						
Circaetus fasciolatus Kaup 1850	Southern banded snake-eagle	W	FF	NT	II	New Record
Stephanoaetus coronatus[#] Linnaeus 1766	African crowned eagle	W	FF	LC	II	Mahenge Scarp
MUSOPHAGIDAE						
Tauraco livingstonii Gray 1864	Livingstone's turaco	W	FF	LC	II	Nawenge; Mahenge Scarp
CUCULIDAE						
Chrysococcyx cupreus Shaw 1792	African emerald cuckoo	W	FF	LC	-	New Record
CORACIIDAE						
Coracias garrulous Linnaeus 1758	European roller	W	O	NT	-	New Record
BUCETORIDAE						
Bycanistes brevis Friedmann 1929	Silvery-cheeked hornbill	W	FF	LC	-	Nawenge; Mahenge Scarp
Bycanistes bucinator[#] Temminck 1824	Trumpeter hornbill	W	FF	LC	-	Mahenge Scarp
Tockus alboterminatus Büttikofer 1889	Crowned hornbill	W	FF	LC	-	Nawenge; Mahenge Scarp
RAMPHASTIDAE						
Stactolaema olivacea Shelley 1880	Green barbet	NE – EA, CF, SR	F	LC	-	New Record[†] (Nawenge; Mahenge Scarp)
PYCNONOTIDAE						
Andropadus masukuensis Shelley 1897	Shelley's greenbul	NE – EA, SR	FF	LC	-	Mahenge
Andropadus milanjensis Shelley 1894	Stripe-cheeked greenbul	NE – EA, H, SR	FF	LC	-	New Record
Phyllastrephus placidus[#] Sharpe 1882	Placids's greenbul	W	FF	LC	-	New Record
MUSCICAPIDAE						
Cossypha natalensis[#] Smith 1840	Red-capped robin-chat	W	FF	LC	-	New Record
PLATYSTEIRIDAE						
Batis mixta Shelley 1889	Forest batis	NE – EA, CF, H	FF	LC	-	New Record
DICRURIDAE						
Dicrurus ludwigii Smith 1834	Square-tailed drongo	W	FF	LC	-	Mahenge Scarp
ESTRILDIDAE						
Cryptospiza reichenovii Hartlaub 1874	Red-faced crimsonwing	W	FF	LC	-	New Record

[†]These records (*Stactolaema olivacea)* from Frontier Tanzania's previous work have not been included in peer-reviewed literature (Burgess *et al.* 2007), and have therefore been considered unverified for Mahenge. This survey presents the first confirmed records of these species for the Mahenge Mountains.

[#]Opportunistic breeding records were documented for these birds. For further details, see appendix 5e.

For Key to Results Species Tables see Mammal Table Key

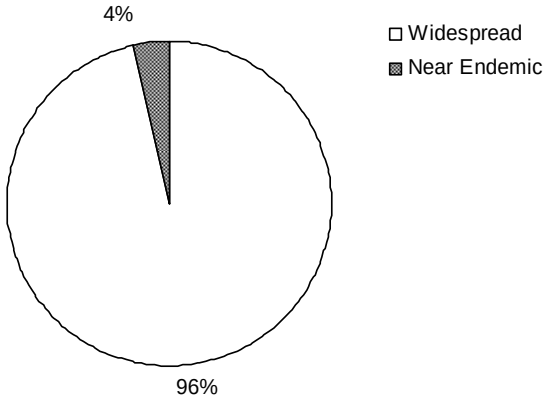

Figure 34: Avian endemism in Mselezi FR

Herpetofauna

N. OWEN & S. GOMBEER

A species inventory was compiled using data from bucket pitfall trapping, visual encounter surveys (VES), and opportunistic observations and collections.

Amphibians

- *Species richness, diversity and composition*

Nine amphibian species (with three taxa identified only to genus, one genus *Arthroleptis* may hold more than one species) representing five families were recorded in this survey (appendix 6a).

A total of 281 individuals were encountered: 186 captures were made over 264 bucket pitfall nights, 92 captures over 32 man-hours of visual encounter surveys, and 3 casual observations (appendix 6b). Of these, 20 specimens were taken. Plotting the species accumulation over time indicates that the curve has only just begun to reach an asymptote, demonstrating that this estimate of species richness may be on the low side (fig. 35).

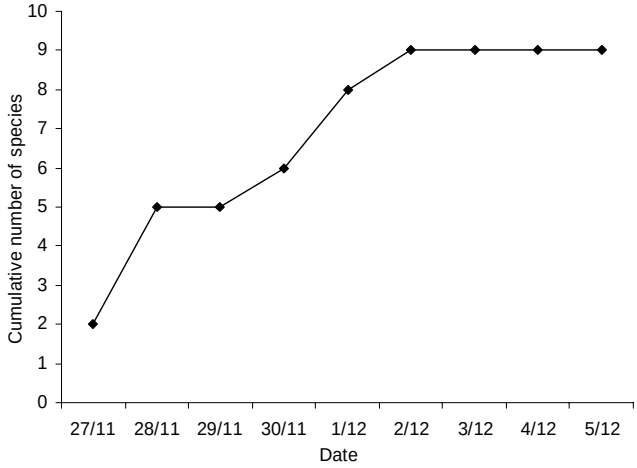

Figure 35: Amphibian species accumulation over time for Mselezi FR.

Species diversity was found to be low, with species being unevenly distributed (Shannon Weiner; H = 0.93, J = 0.42).

Only two species were caught using both bucket pitfalls and visual encounter surveys; visual encounter surveys caught an additional four species, and the pitfall traps caught an additional two species, indicating that both these methods are important to survey as wide a range of species as possible.

Relative abundance of each species was calculated per 100 VES man-hours and/or per 100 bucket pitfall trap-nights, depending on the species targeted by each method. *Arthroleptis xenodactyloides* had a significantly higher relative abundance than all other species (fig. 36) on both visual encounter surveys (206ind/100 man-hours) and in bucket pitfall traps (43ind/100 trap-nights).

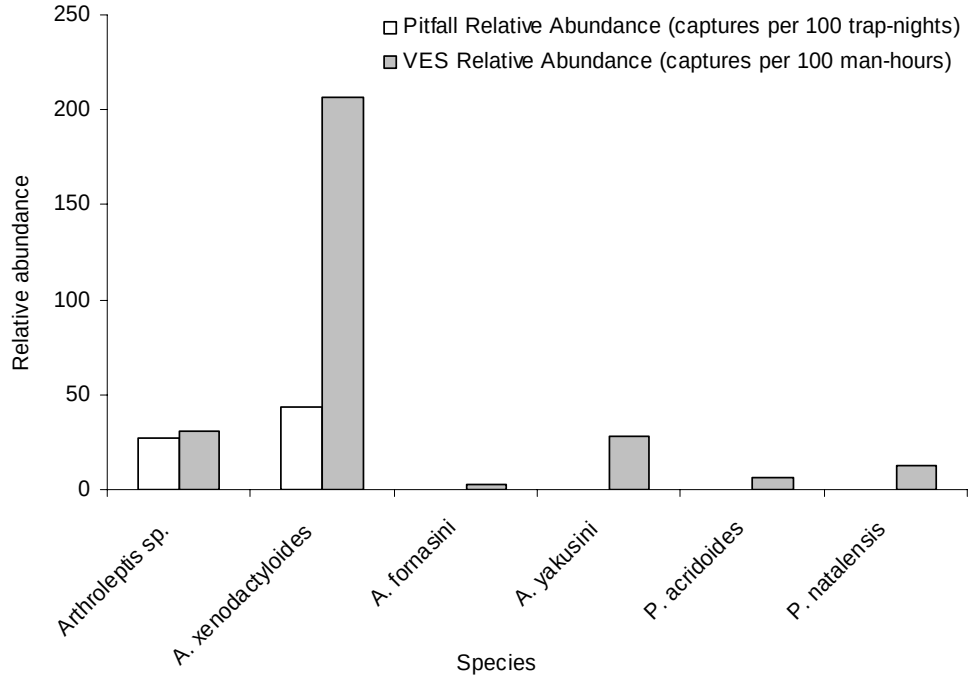

Figure 36: Relative abundance of amphibians caught in bucket pitfall traps and on VES in Mselezi FR

- *Endemism, conservation status, and forest dependence*

Of the nine amphibian species recorded in Mselezi FR, three species in three families are of interest (33.3%; full details of each species can be found in table 31), with a total of two (22.2%) endemic to the region (fig. 37).

Arthroleptides yakusini is an endemic (11.1%), recorded only in the Eastern Arc. One near endemic was also recorded (11.1%), *Spelaeophryne methneri* found in the Eastern Arc, Coastal Forests and the Southern Rift.

Two endemic species are considered to be at risk, listed on the IUCN Red List (22.2%), one Endangered and one Near Threatened. Eight species are listed as Least Concern. One endemic species is forest-dependent, with an additional widespread species *Stephopaedes loveridgei*, also being forest-dependent (22.2%).

Table 31: Amphibian species of conservation concern (categorised by endemicity, forest-dependency and/or conservation status) in Mselezi FR

Species	Common Name	Range	Habitat	IUCN (2006)	CITES (2006)	Previous Mahenge Records
BUFONIDAE						
Stephopaedes loveridgei Poynton 1991	Loveridge's toad	W	FF	LC	-	Sali; Nambiga; Mahenge Scarp
MICROHYLIDAE						
Spelaeophryne methneri Ahl 1924	Scarlet snouted frog	NE – EA, CF, SR	F	LC	-	Sali; Nambiga; Nawenge
RANIDAE						
Arthroleptides yakusini Channing *et al.* 2002	Southern torrent frog	E – Nguru, Uluguru, Mahenge, Udzungwa	FF	EN	-	Sali

For Key to Results Species Tables see Mammal Table Key

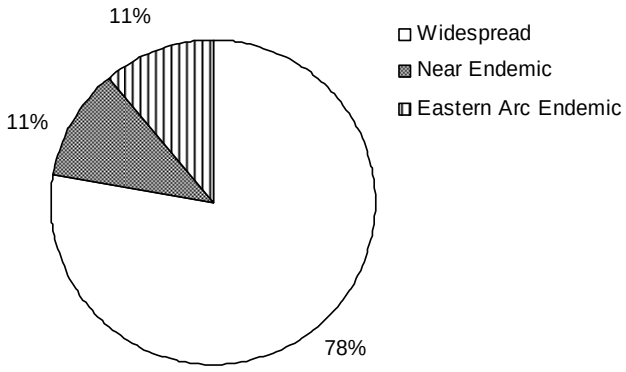

Figure 37: Amphibian endemism in Mselezi FR

Reptiles

- *Species richness, diversity and composition*

Eight reptile species representing six families were recorded in this survey (appendix 7a). Four species represent new records for Mahenge, with two of these also found in Sali FR.

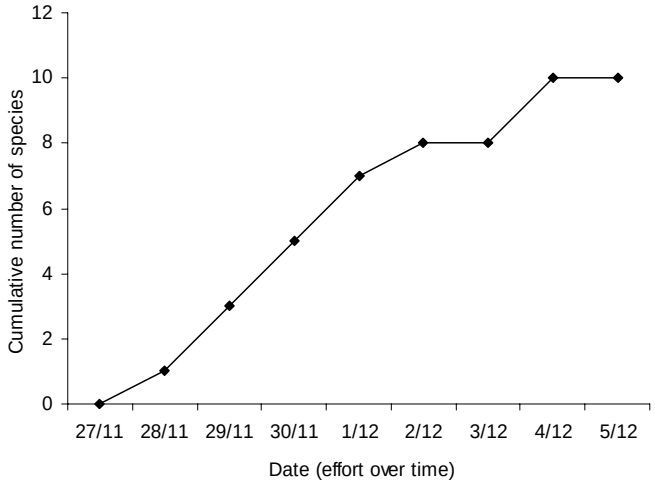

Figure 38: Reptile species accumulation over time for Mselezi FR

A total of 24 individuals were encountered: 3 captures were made over 264 bucket pitfall nights, 18 captures over 32 man-hours of visual encounter surveys, and 3 casual observations (appendix 7b). Of these, 5 specimens were taken. This count of species richness appears to be an underestimation as the species accumulation curve is still showing an upward trend (fig. 38).

Species diversity was found to be on the low side with species being fairly evenly distributed (Shannon Weiner; H = 1.57, J = 0.76). Relative abundance of each species was calculated per 100 VES man-hours and/or per 100 bucket pitfall trap-nights, depending on the species targeted by each method. The only species caught by both bucket pitfalls and VES was *Cnemaspis sp. nov* (12.5ind/100man-hours and 0.76ind/100trap-nights respectively). For bucket pitfalls, only a few individuals of two species were captured, *Cnemaspis sp. nov* and *Melanoseps loveridgei* (0.38ind/100trap-nights). For VES, four species were captured (fig. 39), with *Rieppeleon brevicaudatus* being most abundant (34.38ind/100man-hours), and a couple captures of *Cnemaspis sp. nov, Thelotornis cf. mossambicanus* and *Mabuya sp.*

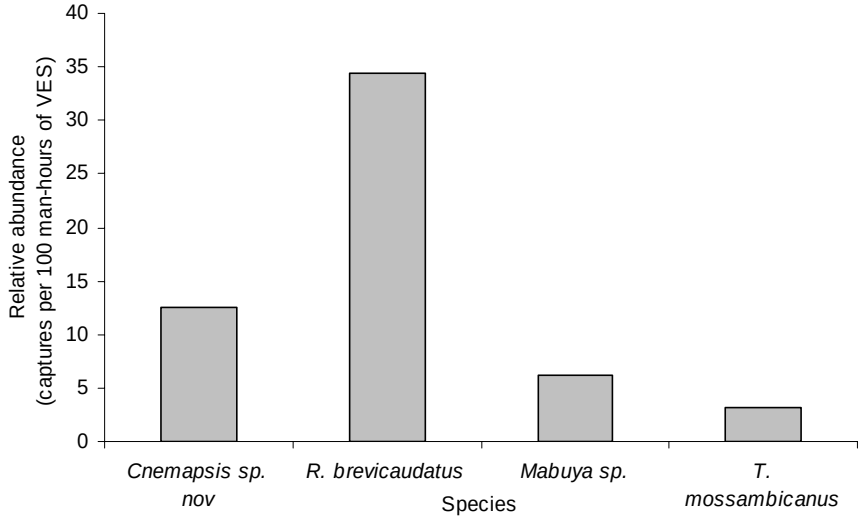

Figure 39: Relative abundance of reptiles caught on VES in Mselezi FR

- *Endemism, conservation status, and forest dependence*

Of the eight reptile species recorded in Mselezi FR, two species in two families are of interest (25%; full details of each species can be found in table 32).

On the basis of preliminary morphological and genetic analysis, one is a new species, *Cnemaspis sp. nov* which is likely to be a strict endemic (M.Menegon pers. comm.; 12.5% strict endemics; fig. 40) to the Mahenge Mountain block. This species represents a new record for Mahenge, also recorded in Sali FR; and is also the only forest-dependent reptile found in Mselezi (12.5%). One species (12.5%) is near endemic, *Rieppeleon brevicaudatus*, found in the Eastern Arc and Coastal Forests. Additionally, one species is listed on CITES, *Varanus niloticus.*

Table 32: Reptile species of conservation concern (categorised by endemicity, forest-dependency and/or conservation status) in Mselezi FR

Species	Range	Habitat	IUCN (2006)	CITES (2006)	Previous Mahenge Records
GEKKONIDAE					
Cnemaspis sp. nov	SE?	FF?			New Record
CHAMAELEONIDAE					
Rieppeleon brevicaudatus Matschie 1892	NE – EA, CF	F	NE	-	Sali; Nawenge; Mahenge Scarp

For Key to Results Species Tables see Mammal Table Key

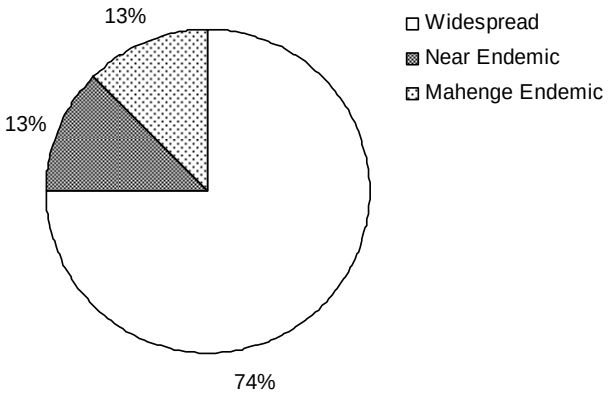

Figure 40: Reptile endemism in Mselezi FR

Herpetofaunal Communities

TWINSPAN analysis was conducted using the VES transect and VES quadrat data combined. Analysis using species abundances showed no obvious clustering in relation to habitat, capture method or forest reserve whereas analysis using presence-absence produced some separation into different communities (see appendix 7c for diagrammatic output). The samples divided into a set of samples solely from Sali FR; and a set primarily made up of samples from Mselezi FR with some from Sali FR, indicated by *A. xenodactyloides*.

Butterflies

S. GOMBEER

- *Species richness, composition and diversity*

Thirty species of butterflies, representing eight families were recorded in Mselezi FR (appendix 8a). Ten species represent new records for Mahenge, with four of these new records also being found in Sali FR.

A total of 66 captures were made, from 48 canopy trapping days and 19 sweep net-hours as well as opportunistic collections. Of these, 33 specimens were taken. Appendix 8b summarises the butterfly data obtained through canopy traps, sweep netting and opportunistic collections in Mselezi FR. The species accumulation curve for Mselezi FR (fig. 41) is still showing an upward trend therefore this is an underestimation of species richness.

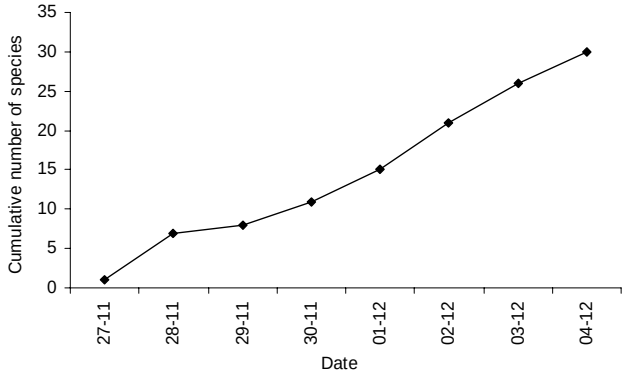

Figure 41: Butterfly species accumulation over time for Mselezi FR

Species diversity was found to be fair with species being evenly distributed (Shannon Weiner; H = 2.83, J = 0.57).

Relative abundance of each species was calculated per 100 sweep-netting man-hours and/or per 100 canopy trap-days, depending on the species targeted by each method (table 33). The most abundant butterfly found in canopy-traps was *Bicyclus safitza*, accounting for 40% of captures. The most abundant butterfly caught by sweep-netting was *Oboronia beuronica*, accounting for 24% of captures.

TWINSPAN analysis was conducted using the sweep netting and canopy trapping data combined; analyses utilised the abundances of species and presence-absence data (see appendix 8c for diagrammatic output).

Both analyses produce a separation of communities through canopy trapping and through sweep netting; indicated by *Charaxes cithaeron*. The forest canopy thus supports a different community to the understory species sampled using sweep nets; demonstrating that the use of canopy traps is a valuable technique to obtain a more complete representation of the butterfly community.

Mselezi FR appears to have a significantly distinct understory species community from Sali FR although only one butterfly community is indicated, with the indicator species being *Amauris niavius*.

Table 33: The ten most abundant butterfly species found in Mselezi FR, with relative abundances by canopy trapping (number of individuals per 100 canopy trap-days) and/or sweep netting (number of individuals per 100 sweep net man-hours)

Family	Species	Relative abundance (per 100 sweep net man-hours)	Relative abundance (per 100 canopy trap-days)
Nymphalidae	*Bicyclus safitza*	0.09	0.29
Lycaenidae	*Oboronia beuronica*	0.27	0.00
Nymphalidae	*Amauris niavius*	0.23	0.00
Nymphalidae	*Bicyclus campus*	0.00	0.08
Nymphalidae	*Bicyclus tanzanicus*	0.00	0.06
Nymphalidae	*Charaxes cithaeron*	0.00	0.06
Nymphalidae	*Eurytela dryope*	0.05	0.02
Nymphalidae	*Henotesia perspicua*	0.05	0.02
Pieridae	*Eurema senegalensis*	0.05	0.00
Nymphalidae	*Byblia anvatara*	0.00	0.04

- *Endemism, conservation status, and forest dependence*

Of the 30 species recorded in Mselezi FR, a total of eight are of conservation concern (26.7%); full details of each species can be found in (table 34), with one near-endemic *Bicyclus simulacris* (3%; fig. 42). Of these species of conservation concern, this endemic represents a new record for Mahenge, also being recorded in Sali FR.

Six species (20%) are forest-dependent, including the near-endemic *Bicyclus simulacris*. Of the species recorded in Mselezi FR, four species are considered to be at risk according to the African Butterfly Research Institute (Collins & Bampton 2007). *Bicyclus simulacris* is considered Threatened and *Euphaedra orientalis, Alaena picata* and *Oboronia beuronica* are listed as Near Threatened.

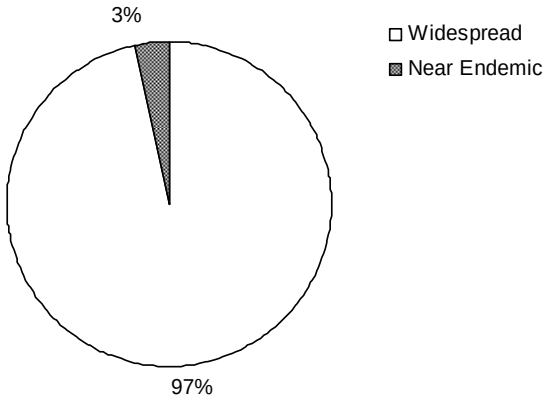

Figure 42: Butterfly endemism in Mselezi FR

Table 34: Butterfly species of conservation concern (categorised by endemicity, forest-dependency and/or conservation status) in Mselezi FR

Species	Range	Habitat	IUCN (2006)	CITES (2006)	Conservation status (ABRI 2007)	Previous Mahenge Records
DANAIDAE						
Amauris niavus Linnaeus 1758	W	FF	-	-	LC	Mahenge Scarp (Nambiga)
NYMPHALIDAE						
Charaxes cithaeron Felder 1885	W	FF	-	-	LC	Mahenge Scarp; Nawenge; (Nambiga)
Euphaedra orientalis Rothschild 1898	W	FF	-	-	NT	Mahenge Scarp
Euxanthe wakefieldi Ward 1873	W	FF	-	-	LC	Mahenge Scarp
SATYRIDAE						
Bicyclus simulacris Kielland 1990	NE – EA & SR	FF	-	-	T	NR
PAPILIONIDAE						
Graphium policenes Cramer 1775	W	FF	-	-	LC	NR; (Nambiga)
LYCAENIDAE						
Alaena picata Sharpe 1896	W	F	-	-	NT	NR
Oboronia beuronica Karsch 1895	W	F	-	-	NT	NR

For Key to Results Species Tables see Mammal Table Key
Conservation Status (ABRI 2007): V = Vulnerable, T = Threatened, NT = Near Threatened, LC = 'Least Concern', NE = Not Evaluated;

6.3.2 Vegetation of Mselezi FR

A. AHRENDS & V. WILKINS

Vegetation data were collected utilising 15 vegetation and regeneration plots within the systematic work unit, as well as opportunistic collections. Systematic surveying concentrated on tree species as the dominant life form in the forest reserve and a comprehensive species list was achieved; however other life forms were only collected opportunistically and due to time and survey effort constraints, these species lists are incomplete. Appendix 9 presents plant data.

- *Species richness, composition and diversity*

Using the latest identifications, a total of 95 different plant species in 34 families were recorded in Mselezi FR (appendix 9a). Eleven species were recorded in both Sali and Mselezi FR. In the field 33 plant taxa were identified to species and a further 62 plants were collected as specimens (6 of which had already been collected in Sali); of which 32 have been identified to date and 30 specimens still have incomplete identifications. Thirty-four species represent new records for the Mahenge Mountains.

Trees

A collection of 50 specimens and 32 field records of 78 different tree species in 25 families were obtained in Mselezi FR. Specimens for some species had already been collected in Sali. In the field plant taxa were identified to 32 species and a further 46 plant species were collected as specimens during the surveys; of which 21 have been identified to date and 25 specimens still have incomplete identifications. Of those tree species identified, 9 were forest specialists, 27 forest generalists and 10 were grassland/woodland species (Ahrends *et al.* 2006); 27 tree species represent new records for the Mahenge Mountains.

Overall tree species diversity was excellent with species evenly distributed (Shannon Wiener; H = 3.66, J = 0.89). The most abundant species recorded in Mselezi FR was *Milletia sp*. (identification unconfirmed), followed by the Vulnerable near endemic *Lettowianthus stellatus*; *Harrisonia abyssinica* and *Englerophytum sp*. were also relatively abundant in the reserve.

Other plant life forms

For other life forms 18 specimens of 17 species in 12 families were recorded: 6 shrubs and 11 herbaceous plants. In the field one plant species was identified and a further 17 plant species were collected as specimens; of which 9 have been identified to date and 8 specimens still have incomplete identifications. Seven of the species recorded represent new records for the Mahenge Mountains.

- *Endemism, conservation status and forest dependence*

A total of seven plant species are of conservation concern, due to endemism or conservation status (full details of each species can be found in table 35), four of which are new records for the Mahenge Mountains. Six species are classed as endemics or near endemics, one species is classed as Potentially Threatened (Gereau & Luke 2003), and five species are classified as Vulnerable on the IUCN Red List. Of the plant species recorded in the reserve nine tree species and one herbaceous plant are forest specialists.

Trees

Five tree species are of conservation concern, due to endemism or conservation status. Four species are classed as endemics or near-endemics, two near-endemics and two EA endemics (fig. 43). No species are classed as Potentially Threatened, and four species are presented as Vulnerable on the IUCN Red List. Three of these tree species are new records for the Mahenge Mountains.

Other plant life forms

For other life forms two species were found to be of conservation concern, due to endemism or conservation status. Two species were classed as endemics, one species is classed as Potentially Threatened, and one species is listed as Vulnerable on the IUCN Red List. The herbaceous plant *Anchomanes abbreviatus* is a new record for the Mahenge Mountains.

Table 35: Plant species of conservation concern (categorised by endemicity and/or conservation status) in Mselezi FR

Family	Species	Author	Local Name	Life Form	Habit	Endemic Status	Threatened Status	Previous Mahenge Records
Annonaceae	*Lettowianthus stellatus*	Diels	Mlengalenga	T	fg	NE	VU	Mahenge Scarp
Araceae	*Anchomanes abbreviatus*	Engl.	Unknown	H	-	E	PT	New Record
Bombaceae	*Bombax rhodognaphalon*	K.Schum.	Msufi pori	T	fg	NE	-	Mselezi; Nawenge
Lamiaceae	*Prema schliebenii*	Werderm.	Mkoko	T	g/w	-	VU	New Record
Lauraceae	*Beilschmiedia kweo?*	(Mildbr.) Robyns & R.Wilczek	Unknown	T	fs	E	VU	New Record
Rubiaceae	*Pavetta lynesii*	Bridson	Unknown	T	-	E	VU	New Record
Sterculiaceae	*Dombeya amaniensis*	Engl.	Luvuwangala	S	-	E	VU	Mselezi; Mahenge Scarp

Key to Plant Results Table
Life Form: T = Tree, S = Shrub, H = Herb;
Habit: fs = forest specialist, fg = forest generalist, g/w = predominantly woodland and grassland species;
Endemic Status: SE = Strict Endemic, confined to the Mahenge Mountain block, E = Endemic, range restricted to the Eastern Arc Mountains, NE = Near-endemic, range restricted to the Eastern Arc Mountains and at least one other African ecoregion;
Threatened Status: VU = Vulnerable (IUCN 2006) PT = Potentially Threatened (Gereau & Luke 2003, revised 2006);

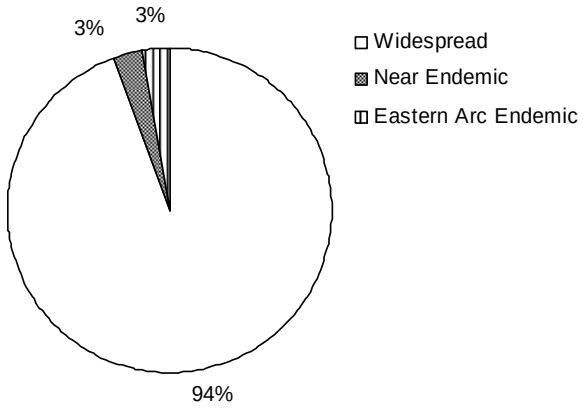

Figure 43: Tree endemism in Mselezi FR

- *Tree Communities and Vegetation Structure*

Mselezi vegetation plots were noticeably variable in both tree species composition and vegetation structure making vegetation grouping difficult, therefore a combination of grouping techniques were utilised. The tree community groups identified as occurring in Mselezi FR are displayed in table 36.

Table 36: Mselezi FR vegetation associations

Vegetation Association	Characteristic Species	Vegetation Structure	Regeneration	Site Characteristics	Robustness	Wider Applicability across the Eastern Arc
dry open canopy woodland on dry rocky underground in an edaphically restrained climax state	*Bombax rhodognaphalon, Sterculia appendiculata, Drypetes reticulata*	tree density low; average dbh high; canopy low; canopy, shrub and ground cover low	scarce	rocky outcrops, middle part of non-east-facing slopes, potentially affected by water run-off effect	robust (identified as an isolated group by the TWINSPAN, phyto-sociological and vegetation structure analyses)	The established groups were subject to spatial autocorrelations. Their wider applicability is therefore doubtful. Furthermore, Mselezi presents a transitional vegetation type between the lowland coastal forest vegetation and the Eastern Arc vegetation. This particular combination might not be found elsewhere.
dense closed-canopy woodland on east-facing (moisture receiving) steep and rocky slopes	*Sorindeia madagascariensis, Trilepisium madagascariensis, Ficus sur*	high canopy; high canopy coverage	canopy species	rocky outcrops, east-facing slopes	robust (identified as an isolated group by the TWINSPAN, phyto-sociological and vegetation structure analyses)	
disturbed variation of the above vegetation type	in addition to the above: *Trema orientalis Hoslundia opposita*	high canopy; medium canopy cover, high shrub cover; few trees >20 cm dbh		as above, but disturbances (fire, mining, timber cutting) present	relatively robust (identified as an isolated group by the TWINSPAN and phyto-sociological analyses)	
grassland (with sparse tree recruitment)	*Annona senegalensis, Piliostigma thonningii, Xeroderris stuhlmannii*	tree density low; average dbh high; canopy cover low, ground and shrub cover high	woodland species	reasons for grassland development unknown (potentially edaphical savannah or former disturbance)	relatively robust (identified as an isolated group by the TWINSPAN and phyto-sociological analyses)	
open lowland woodland in a transitional stage	*Turraea holstii, Lettowianthus stellatus, Pericopsis angolensis*	tree density low; average dbh high; canopy cover low, ground and shrub cover high	forest species	reasons for woodland development unknown (potentially formerly disturbed)	relatively robust (identified as an isolated group by the TWINSPAN and phyto-sociological analyses)	
semi-riverine forest	*Vitex doniana, Markhamia zanzibarica, Pteleopsis myrtifolia*	tree density high; basal area high; high canopy; medium canopy cover	canopy species	sectioned by stream	relatively robust (identified as an isolated group by the TWINSPAN and phyto-sociological analyses)	
previously cultivated with pioneer species regeneration		-	pioneering species		robust	
cultivated		-				

- *Environmental Gradients*

Analysing relationships between environmental gradients and the plant species present demonstrated that land use and disturbance are the dominant factors shaping the vegetation. Analysis also showed that vegetation plots with rocky outcrops, a steeper slope inclination and higher altitudes exhibited more forest type characteristics.

- *Regeneration*

Vegetation plots that had been cleared for agriculture had pioneers regenerating. Vegetation plots that had been cleared a long time ago were regenerating with tree species; however no forest-dependent species were observed within the regeneration plots.

For more information and greater detail regarding the botanical data analysis for Mselezi FR please refer to the BREAM Consultant Report by Ahrends *et al.* (2006).

6.3.3 Human Resource Use and Disturbance in Mselezi FR

V. WILKINS

A total of 4km of disturbance transects were conducted, covering an area of 40,000m^2 (4ha) of the total 2245ha of Mselezi FR. Each transect was divided into twenty 50m sections; giving a total of eighty 50m sections. A road runs through the reserve with settlements located along it, ten meters either side of the road is legally available for farms and buildings; however these infringe into the reserve in many places. Annex 2b fig. 64a shows a view of the reserve including the road, cultivation is clearly visible more than ten metres from the road. GPS points were obtained for several disturbance activities; major disturbance activities are mapped in annex 1 fig. 60b.

Pole Extraction

Displayed in figure 44 and table 37 are the percentages and total number of pole extractions, live and naturally dead poles (appendix 10b). A total of 2,045 poles were surveyed in the reserve with 44% being cut poles; of these 15% were old cut and 29% were fresh cut. Just under half of all poles were live, at 46%, whereas naturally dead poles contributed to only 10% of the total.

Table 37: Pole extraction in Mselezi FR

	Total poles surveyed	Live poles	Naturally dead poles	Fresh cut poles	Old cut poles	Total cut poles
Numbers	2045	705	151	438	232	670
% of total		46	10	29	15	44

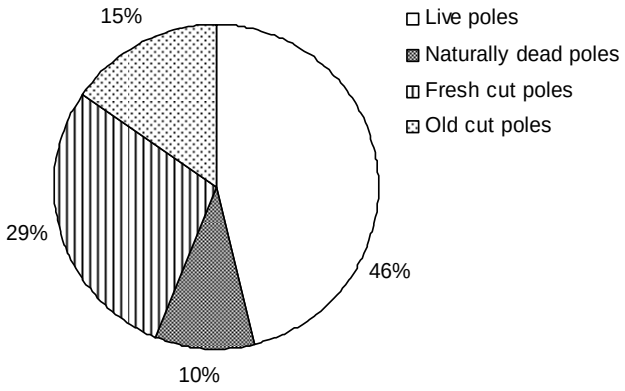

Figure 44: Proportions of naturally dead, live, fresh cut and old cut poles in Mselezi FR

Timber Extraction

Displayed in figure 45 and table 38 are the percentages and total number of timber extractions, and numbers of live and naturally dead timbers (appendix 10b). Of the 615 timbers surveyed in the reserve the highest proportion were live timbers representing 67%, followed by 21% of cut timbers: 6% of these were old cut and 15% were fresh cut.

Table 38: Timber extraction in Mselezi FR

	Total timbers surveyed	Live timbers	Naturally dead timbers	Fresh cut timbers	Old cut timbers	Total cut timbers
Numbers	615	410	110	34	61	95
% of total		67	18	6	10	16

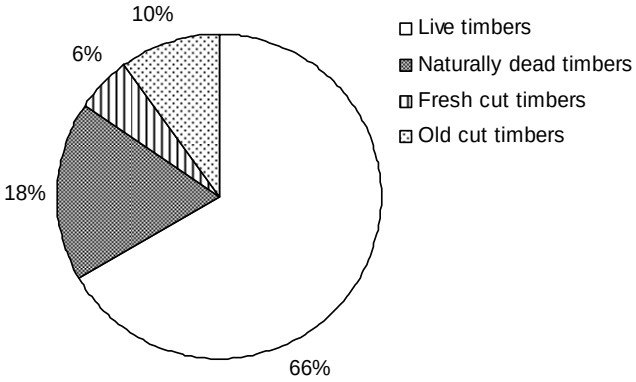

Figure 45: Proportions of naturally dead, live, fresh cut and old cut timbers in Mselezi FR

Distribution of pole and timber extraction throughout the reserve

The extraction of poles and timbers is not evenly distributed between transects (table 39), particularly in the case of recent fresh cut poles where there is a significant difference in distribution between transects, suggesting intense localised extraction (ANOVA; poles: χ^2 = 351.05, df = 3, p < 0.000; timbers: χ^2 = 132.41, df = 3, p < 0.0001). High levels of fresh cut poles and timbers were present on disturbance transects 2 (east) and 4 (west); with slightly higher numbers on the east transect. High levels of old cut poles and timbers were present on disturbance transect 3 (south). This indicates that localised extraction has moved from the south of the reserve to the east and west.

Table 39: Assessment of poles and timbers by disturbance transect in Mselezi FR

Transect ID	Live poles	Naturally dead poles	Old cut poles	Fresh cut poles	Live timbers	Naturally dead timbers	Old cut timbers	Fresh cut timbers
DT1 N	207	28	6	1	175	40	9	1
DT2 E	287	93	92	375	96	41	1	21
DT3 S	116	15	97	1	47	4	36	3
DT4 W	95	15	37	61	92	25	15	9
Total	705	151	232	438	410	110	61	34

Distribution of pole and timber extraction by altitude

The numbers of fresh cut timbers significantly increased with altitude (Pearson's Product Moment Correlation; F = 42.86, df = 27, p <0.0001; fig. 46). However no other categories of poles or timbers showed a relationship with altitude.

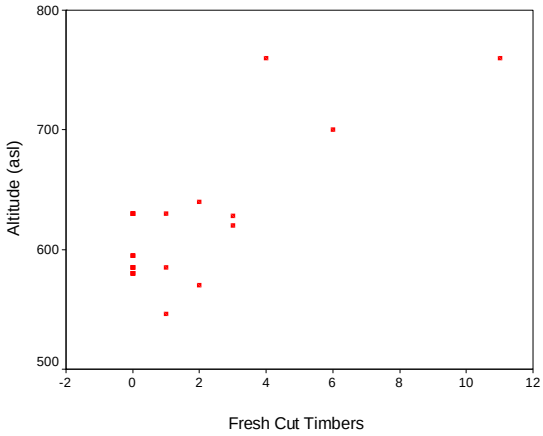

Figure 46: Relationship between numbers of fresh cut timbers and altitude

Distribution of pole and timber extraction by slope and vegetation cover

There was no relationship found between any categories of poles and timbers relative to slope; or relative to vegetation cover for the shrub layer, ground layer and canopy cover.

Pitsawing sites

A total of 23 pitsaw sites were found in the reserve during surveying (table 40); six were found on the disturbance transects; with one present on transects 1 (north) and 3 (south), and four on transect 4 (west). Nine were documented through casual observations and eight were recorded on large mammal transects number 1 (north-east), 3 (south-west) and 4 (north-west). Of the 23 pitsaw sites observed 8 were new and currently in use, and 15 were old, classified as over six months since last use (table 41). One hidden store of planks produced from pitsawing sites were also found within the reserve (photographed in annex 2b fig. 64b).

Table 40: Disturbance classified by type and occurrence in Mselezi FR

Disturbance Type	Total number of incidences	% of 50m sections on Disturbance Transects	Location
Pitsawing	23	7.5	Disturbance transects DT1 N; DT3 S; DT4 W; Large mammal transects LT1 NE; LT3 SW; LT4 NW; Casual;
Cultivation	30	15	Disturbance Transect DT3 S; DT4 W; Large Mammal Transects LT1 NE, LT3 SW; LT4 NW;
Fire Damage	40	36	Disturbance Transects DT1 N, DT2 E, DT3 S, DT4 W; Large Mammal Transects LT1 NE, LT4 NW;
Hunting	21	3	Disturbance transects DT1 N; DT3 S; DT4 W; Large mammal transects LT1 NE; LT2 SE; LT3 SW; Casual;
Mining	3	1	Disturbance Transect DT4 W; Large Mammal Transect LT3 SW;
Settlements	4	3	Disturbance Transect DT3 S; Large Mammal Transects LT3 SW, LT4 NW;
Footpaths	15	6	Disturbance Transects DT1 N, DT4 W; All Large Mammal Transects; Casual;

Table 41: Pitsaw sites classified by tree species in Mselezi FR

Species	Kiswahili name	Number of Pitsaws	Use of Wood
Khaya sp.	Mkangazi	5	Furniture and buildings
Pterocarpus latifolius	Mninga maji	1	Doors and furniture
Milicia excelsa	Mvule	2	Building material for houses
Albizia sp.		1	
Afzelia quanzensis		1	
Unknown sp.		13	

Other Disturbance

Additional forms of disturbance recorded in Mselezi FR included cultivation, fire damage, hunting, mining, settlements and footpaths (table 40). These are detailed below.

Cultivation

Of the eighty 50m sections, 12 (15%) had been cultivated on disturbance transects 3 (south) and 4 (west). Cultivation observed included paddy fields, banana trees and sugar cane as well as mixed cultivation, generally found close to homes. Eighteen incidents of cultivation were also seen on the large mammal transects LT1 (north-east), LT3 (south-west) and LT4 (north-west).

Fire Damage

In Mselezi FR, 29 (36%) out of the eighty 50m sections surveyed during the disturbance transects had been burnt, with fire damage recorded on all four disturbance transects. Eleven fire damage incidents were observed on the large mammal transects 1 (north-east) and 4 (north-west); an example is photographed in annex 2b fig. 64c.

Hunting

A total of 21 traps were found, recorded on disturbance and large mammal transects as well as through casual observations (table 42; a 'crush' trap is shown in annex 2b fig. 64d). Traps were relatively infrequent along the disturbance transects with a total of only four traps (three hyrax Procavidae *spp.* traps and one cane rat *Thryonomys sp.* trap) recorded in an area of 40,000m^2. Two traps were present on disturbance transect 1 (north) and one trap each on transects 3 (south) and 4 (west). On the large mammal transects thirteen traps were recorded in total, four on transect 1 (north-east), four on transect 2 (south-east), and three on transect 3 (south-west); in addition four casual observations of traps were made.

Table 42: Animal traps classified by type and occurrence in Mselezi FR

Trap Type	Number observed		Location
	New (<6months)	Old (>6months)	
Hyrax	1	2	Disturbance transects DT1 N; DT3 S; DT4 W;
Cane Rat	1	1	Disturbance transect DT4 W; Large mammal transect LT2 SE;
Snares	9	0	Large mammal transects LT1 NE; LT2 SE; LT3 SW; Casual;
Crush trap	2	2	Large mammal LT3 SW; Casual;
Duiker	2	1	Large mammal transects LT1 NE; LT3 SW; Casual;

Mining

Three ruby mines were observed in the reserve, one old mine at the top of the western ridge on disturbance transect 4 (west); and two records of ruby mines on large mammal transect 3 (south-west); one mine had been excavated using dynamite.

Settlements

Settlements away from the road and Mpangayao hamlet were recorded. Two buildings were present in two (3%) of the eighty 50m sections on disturbance transect 3 (south). On large mammal transect 3 (south-west) a bed under a rock was found with signs of an old fire, and on large mammal transect 4 (north-west) the remnants of an old building with latrine and overgrown farmland was found.

Footpaths

It was observed that 5 (6%) out of the eighty 50m sections surveyed had human footpaths; these were recorded on transects 1 (north) and 4 (west). In addition, two footpaths were recorded through casual observations and six human paths were recorded on all four large mammal transects.

Distribution of disturbance in relation to altitude

In Mselezi FR the occurrence of different types of human disturbance was related to altitude with a significant difference between the disturbance types by altitude (ANOVA; $F = 2.561$, $df = 21$, $p = 0.004$; fig. 47). Cultivation and settlements were concentrated at low altitudes, below 600m asl. Pitsawing sites and animal traps were generally found at slightly higher altitudes, above 550m but below 650m asl. Other forms of disturbance ranged to slightly higher altitudes, such as human paths, up to 700m asl. Fire damage was found at all altitudes in the reserve from 585 - 800m asl and this was the form of disturbance that impacted the most at higher altitudes.

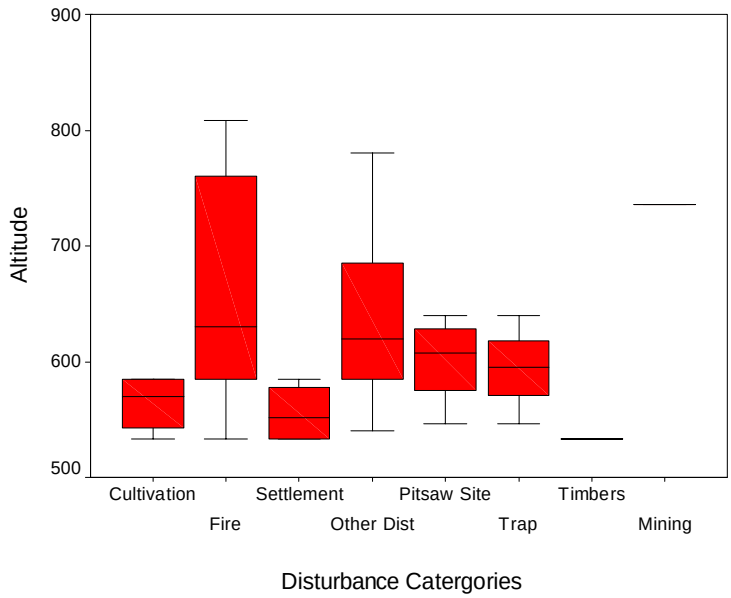

Figure 47: Disturbance relative to altitude in Mselezi FR

Distribution of disturbance in relation to slope

The occurrence of different disturbance types was also related to degree of slope. Disturbance types by slope were significantly different (Kruskal Wallis; χ^2= 16.99, df = 6, p = 0.009; fig. 48). Settlements, traps and cultivation were restricted to slopes below 10 degrees, whereas fire damage occurred on slopes up to 20 degrees. Pitsawing and mining appeared to be restricted to steeper slopes of 15 –30 degrees. Other forms of disturbance such as human paths tended to occur on steeper slopes.

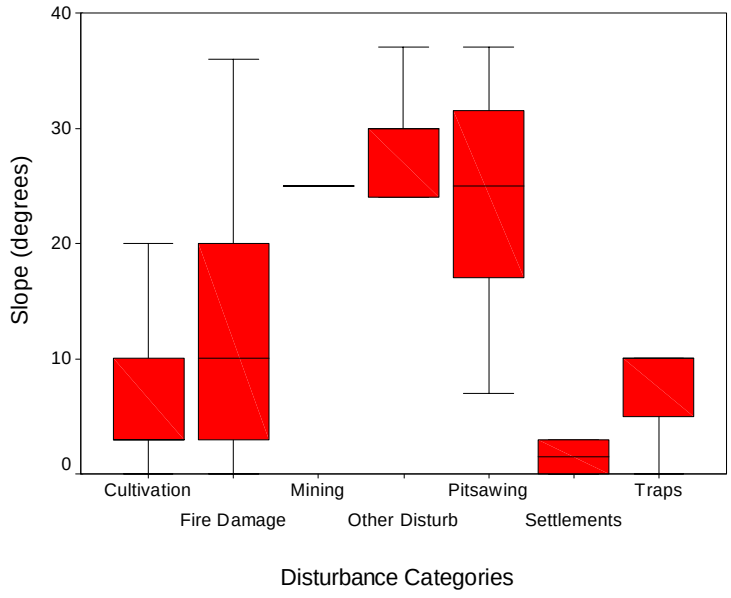

Figure 48: Disturbance relative to slope in Mselezi FR

6.3.4 Community Knowledge of Mselezi FR

A. MACHA & V. WILKINS

The community day for Mselezi FR took place on the 6th December 2005. Villagers were invited from two settlements, Mpangayao hamlet and Isongo village. Mpangayao hamlet is located at the centre of Mselezi FR, spread out along the road that runs through the reserve. Mpangayao hamlet is a small settlement with a church and a school. The Environmental Committee for Mselezi FR is based in Isongo, a village on the edge of the reserve. On the community day 73 members of the local community were present, from both Mpangayao hamlet and Isongo village (appendix 11b). This included: the Forest Officer, Village Executive Officer of Isongo, Chairman of Isongo, Environmental Committee Chairman, Border Chairman, Border Secretary, Chairman of Mpangayao Hamlet, District Catchment Manager and 10 members of the Isongo Village Environmental Committee. Appendix 11a summarises the structured interview questionnaire.

Structured Interviews
Structured interviews were conducted over two evenings in the week prior to the community day. Fifteen village residents were interviewed.

1. Personal Details
Of the residents interviewed most (40%) were between the ages of 50-70 and 20-35, with a small number in the age brackets >70 and 36-49. The majority of people interviewed (80%) had lived in the village for over ten years and the rest had been resident for less than three years. Slightly more males (53%) were interviewed relative to females (47%); 67% of residents interviewed were farmers and the remaining were public servants.

2. What do you know about Mselezi FR?
60% of the respondents knew that the forest is a reserve**,** 20% did not know anything about Mselezi FR but were aware of Muhulu FR; however these people lived at Isongo village, on the edge of Mselezi FR.

3. Why is the forest reserved?
80% of the respondents had an idea of what the forest reserved for, with 67% believing it was reserved for water catchments. The rest of the interviewees thought that the forest was for timber production as well as providing habitat for animals associated with the forest.

4. Are there any animals living in the forest?
Sykes monkeys *Cercopithecus mitis*, blue duiker *Cephalophus monticola* and red duiker *C. harveyi*, baboons *Papio cynocephalus*, two species of hyrax Procavidae *spp.*, and galago Galagonidae *spp.* were all stated as being found in the forest in large numbers, with bushpigs *Potamochoerus larvatus* and suni *Neotragus moschatus* also present but less abundant. Vervet monkeys *Cercopithecus pygerythrus* and buffalo *Syncerus caffer* were said to be present but very rarely seen.

5. How has the forest changed over the past 10, 20, and 30 years?
Interviewees responded that burning of the forest has degraded the natural resources to the point that there is no habitat for the animals. Loss of the forest has had the following results: 40% commented on the reduction in the availability of timber; vegetation in and around the forest has disappeared; and buffalo, bushpig, red and blue duiker have all decreased in the last 10 years.

6. What climatic changes have you become aware of?
People had noticed a rise in temperature, also changes in rainfall as well as an increase in the number of malarial incidents.

7. What type of meat do you eat?
Sykes, vervets, bushpig, red and blue duiker and hyrax are all regularly eaten in the village. Most bush meat is obtained from the forest; however some people buy it from the Selous Game Reserve. The price for a piece of meat ranges from TSh1000 to 2000 and can go down to TSh500 per piece.

8. Where do you go to get firewood from?
About 85% of the respondents sourced firewood from the lowland area, where they believe they are allowed to cultivate. The other interviewees obtained firewood from Muhulu FR.

9. Why do you think people burn the forest?
Respondents believed agriculture is the main reason for burning the forest, but most is unintentional, occurring when people fail to control fires that are started when clearing scrub around their farms. Some people occasionally burn scrub to catch animals and these fires can also get out of control.

10. Where do you source your building materials from?
95% said they sourced building materials from the forest reserve.

11. What traditions do you have related to the forest reserve?
The forest is used in both traditional beliefs as well as for traditional medicine. Traditions relating to the forest include utilising seed-pods from the Mbuyu tree as a musical instrument. These traditional beliefs are well respected by local people.

12. What are your views on the utilization of the forest reserve with respect to its conservation?
Replies centred on the following issues: enough resources and regulations should be in place before the management contract is granted to the local community; environmental education should be conducted to raise awareness; and the Environmental Committee should live near the forest

13. Do you plant trees? If yes, what types of tree do you plants?
Responses show that most people do not plant trees, except in the form of fruit trees on their farms.

14. Do you keep livestock? Where do they get food?
The villagers said that they do not keep animals that could harm the forest, and if they do graze animals it is only around their farm.

15. Do you have an Environmental Committee in your village? Is it useful?
An Environmental Committee is present, and the villagers agreed that having the Committee was positive for the community but they stated that it is not empowered with the equipment and resources needed to function effectively.

Community Discussion
During the discussion residents were encouraged to give their opinions and to ask questions in relation to the presentation and the interviews, and to raise any extra issues that they felt should be discussed. The discussion was lively and a good proportion of the people present made active contributions.

Topics Raised:
1. The advantages of participatory forest management are unclear. If the village government manages the forest, why are fee payments and entrance permissions executed in Dar es Salaam or Mahenge? How are the residents and/or forest managers meant to benefit from the said fees?
2. The forest boundary is not known to people living within the forest reserve
3. Is the reserve meant to be divided into four parts for: biodiversity, water catchment, human settlement and forest reserve?
4. It was claimed that indigenous people allow immigrants to harvest forest resources, it was stressed that villagers need to make it known to village leaders which residents are

collaborating with immigrants and harvesting the natural resources. The indigenous people should think of the next generation and so must protect the natural resources from poachers.

5. Fires are started to clear land for farming activities, people cannot control them and so they spread into forest. Often children get the blame and the people responsible get away without reprimand. If children are accused, it is a kind of corruption which prevents any action against the perpetrators.
6. The community warned that in less than 10 years there will not be a Mselezi FR, as there are currently so many pitsaw sites in the forest, indicating a high level of illegal timber harvesting. The issues of forest burning, hunting and the growing population of the village are all threatening the entire ecosystem.
7. Could it be possible to allow people to cultivate, mine and hunt in the FR under license?
8. Village leaders should be responsible for the laws and dealing with law violators.
9. The following improvements for environment/forest management were suggested:
    a. Local people should report those who harvest natural resources illegally.
    b. The Environmental Committee should work hand in hand with the other villagers.
    c. People in the village should elect to the Committee those who are capable of performing the pledged tasks and carrying them out on behalf of the village
10. Unity is power; the whole village should work together for a better natural environment in Mselezi FR.

6.4 MSELEZI FR DISCUSSION

6.4.1 Fauna of Mselezi FR

N. OWEN & A. PERKIN

One hundred and eighty-three faunal species in 73 families were recorded in Mselezi FR (table 43), of which 153 were vertebrate species (in 65 families), and 30 butterfly species (in 8 families). Of the vertebrates, the majority were birds; with 109 (71.2%) birds, 8 (5.2%) reptiles and 9 (5.9%) amphibians, and 27 (17.6%) mammals.

Table 43: Faunal species recorded in Mselezi FR categorised by widespread species and those of conservation concern: endemic, threatened and forest-dependent; new records for the Mahenge Mountains are shown in parentheses.

Taxa	No. of families	No. of species[a]	Wide-spread species	Strict Mahenge endemics[b]	Eastern Arc endemics[c]	Eastern Arc near endemics[d]	IUCN[e] (2006)	CITES[f] (2006)	Forest-dependent species[g]	Total number of species of conservation concern[h]
Mammals	16	27 (14)	23 (11)	0	0	4 (3)	4	3	5	7 (5)
Birds[i]	38	109 (63)	105 (60)	0	0	4 (3)	2	25	14	16 (9)
Amphibians	5	9 (0)	7 (0)	0	1 (0)	1 (0)	1	0	2	3 (0)
Reptiles[j]	6	8 (4)	6(3)	1(1) [k]	0	1 (0)	0	1	1	2 (1)
Butterflies	8	30 (10)	29 (9)	0	0	1 (1)	0	0	6	8 (4)
Vertebrate Total	65	153 (82)	141 (74)	1 (1)	1 (0)	10 (7)	7	29	22	28 (16)
% total of vertebrate species			92.2	0.7	0.7	6.5	4.6	19.0	14.4	18.3
All taxa total	73	183 (92)	170 (83)	1 (1)	1 (0)	11 (8)	7	29	28	36 (20)
% total of all species			92.9	0.5	0.5	6.0	3.8	15.8	15.3	19.7

[a]Includes all verifiable opportunistic observations as well as those from systematic methodologies.

[b]Species thought to occur only in the Mahenge Mountains.

[c]Species found only in the Eastern Arc.

[d]Species found in the Eastern Arc Mountains and adjacent locations such as Coastal Forests, Southern Rift, Highlands;

[e]Species recognised as threatened with extinction to varying degrees.(listed on the IUCN Red List as Endangered, Vulnerable, Near Threatened, Conservation Dependent only; excludes Data Deficient, Not Evaluated and Least Concern)

[f]Species recognised as threatened with extinction and so with varying restrictions on trade.

[g]Species dependent upon and associated with primary forest.

[h]Includes endemic species, IUCN Red Listed species, forest-dependent species; excludes CITIES listed species;

[i]Includes birds seen at the forest edge.

[j]Includes reptiles caught at the forest edge.

[k]One of these species appears to be new to science

Summaries of vertebrate species according to endemism, forest-dependency and conservation status can be found in Section 8: The Mahenge Mountains. Within the vertebrate species, the number of endemics made up 7.8% (12 species), a low proportion of the total number of species. The endemics are divided as follows (fig. 49): one (0.7%) is strictly endemic to the Mahenge Mountains, one (0.7%) is endemic to the Eastern Arc Mountains, with ten (6.5%) near endemics, found in the Eastern Arc and adjacent eco-regions. Of these species, ten near endemics and one strict Mahenge endemic were also recorded in Sali FR.

Of all vertebrate endemic species, seven represent new records for the Mahenge Mountains (one strict Mahenge endemic, six near endemics), of which one appears to be new to science (the strict Mahenge endemic) based on preliminary morphological and genetic analyses. Six of these new records were also recorded in Sali FR (five near endemics and one strict Mahenge endemic).

A small proportion of vertebrate species are considered to be at risk (4.6%; 7 species), recognised by IUCN: two are threatened (Endangered and Vulnerable) with five at lower risk (Near Threatened or Conservation Dependent). A further eight are listed as Not Evaluated or Data Deficient (5.2%), with 133 listed as Least Concern (86.9%). Twenty-nine species are listed on CITES. The number of species recognised to be at risk may increase with further research and re-classification.

In Mselezi FR the species assemblage was much less indicative of submontane forest, and was more appropriate for the dry woodland and anthropogenically altered vegetation typical of that reserve. This is corroborated by the low proportion of forest-dependent vertebrate species recorded (22 species; 14.4%); with a similar proporation of faunal species overall being forest-dependent (28 species; 15.3%).

Taking into account endemism, threatened status and forest-dependency for all taxa studied, a fifth of species are of conservation concern (36 species; 19.7%), with a slightly smaller proportion of vertebrate species of conservation concern (28 species; 18.3%).

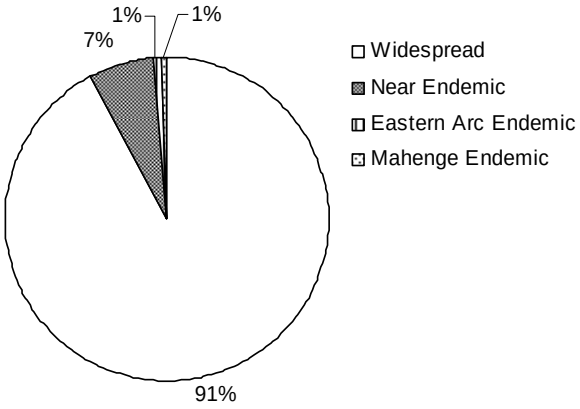

Figure 49: Vertebrate endemism in Mselezi FR

Mammals

Twenty-seven mammal species (in 16 families) were recorded in Mselezi FR: five small mammal species, four bat species, and eighteen species of large mammals. A fifth of these species (7 species; 22.2%) are of conservation concern, due to endemism, threatened status or forest-dependency. Four near endemic species were recorded (14.8%); five (18.5%) species are classed as forest-dependent. Four species are considered to be at risk on the IUCN Red List (14.8%) listed as Vulnerable, Near Threatened or Conservation Dependent. Three species are CITES listed. Notably, the first known record of an association between two hyrax Procavidae species (tree *Dendrohyrax validus* and bush hyrax *Heterohyrax cf. brucei*) was documented in Mselezi.

Species Richness and Assemblages
Mselezi FR had reasonable diversity but generally low abundances with respect to mammal species, less than other priority areas in the Eastern Arc. This is likely due to the fragmented and heavily degraded nature of this forest reserve, with very little forest remaining. However, of particular interest is the fact that larger mammals make up the greatest proportion of mammal species. The most abundant species recorded were Sykes monkey *Cercopithecus mitis, D. validus, H. cf. brucei,* and suni *Neotragus moschatus.*

Mselezi FR is the first confirmed record of an association between *D. validus* and *H. cf. brucei* (Hoeck 1982; H. Hoeck pers. comm.). Many of the *D. validus* calls recorded matched other calls of this species from the population clade in the Udzungwas, Rubeho and Uluguru Mountains. They differ from the northern Eastern Arc, Pemban and Unguja vocalisation ‘clades’ of *D. validus* (A. Perkin

unpubl. data; Roberts 2000). A second species of hyrax, *H. cf. brucei*, was also recorded, based on vocalisations identified by the hyrax expert Hendrik Hoeck (pers. comm.). This was also corroborated by indigenous knowledge as the villagers claimed two different types of hyrax were present. Male hyraxes make territorial calls named here as the 'horse neigh'. This is most likely to be the yellow spotted bush hyrax *Heterohyrax cf. brucei* based on distribution descriptions (Kingdon 1997; Wilson & Reeder 1993); however there are 25 described subspecies and it is premature at this stage to ascribe subspecies status. This is the first known locality where these two species of hyrax are known to associate together. In the Serengeti, rock hyrax *Provocaria* and *Heterohyrax* associate to the extent that they share the same sleeping sites and even cooperatively care for their young (Hoeck 1982a; 1982b). This *Heterohyrax* population is likely to be restricted to Mselezi FR due to its requirements for safe denning sites such as caves produced by the limestone rock formations; and the vegetation present in Mselezi includes typical food plants such as *Acacia* and *Allophylus. Heterohyrax* has not been recorded in the surrounding lowland coastal forests and woodlands (A. Perkin unpubl. data; T. Butynski pers. comm.). However a species of hyrax provisionally identified as *Dendrohyrax validus* was reported and heard in Mahenge Scarp FR and in adjacent miombo woodland (Frontier 2004b); if this is actually *Heterohyrax* this raises the contradictory possibility of a potential wider distribution. Further research is needed to assess the extent of the association with Mselezi hyrax populations. These species may also associate in parts of the Udzungwa Mountains in rocky outcrops surrounded by forest (D. Moyer pers. comm.). Further data in the form of vocalisation recordings, genital morphology (hyrax penile morphology is known to be diagnostic at a genus level at least; Coetzee 1966; Hoeck 1978, 1982b), pelage and skull morphology is required to confirm the identity of this hyrax species and return visits by researchers to Mselezi are therefore encouraged.

Several antelope species were present, detected primarily through sign: small duiker species likely to be *Neotragus moschatus,* red duiker *Cephalophus harveyi*, and bushbuck *Tragelaphus scriptus.* Carnivores recorded were restricted to slender mongoose *Herpestes sanguinea,* African palm civet *Nandinia binotata,* and genet *Genetta sp.* The species *H. sanguinea* and *N. binotata* are common and widespread, found throughout East Africa and Eastern Arc forests (Kingdon 2001; De Luca & Mpunga 2005), with *N. binotata* primarily occurring in fragmented forests up to 2000m asl (Kingdon 2001). More typical open habitat species were present in Mselezi FR than in Sali FR, such as the spiny mouse *Acomys spinosissimus.* The relict Eastern Arc near endemic lesser-pouched rat *Beamys hindei* was also present. There was generally a low diversity and abundance of many groups of species compared to other Eastern Arc forests, including rodents and insectivores (Corderio *et al.* 2005*;* Doggart *et al.* 2005, 2006; Stanley *et al.* 1998; Stanley *et al.* 2005), forest antelopes and carnivores (De Luca & Mpunga 2005; Dinesen *et al.* 2000; Rovero & Marshall 2004, 2005; Rovero *et al.* 2005), probably because of the greater hunting pressure and degraded forest. The sampling intensity employed to record bat species was not sufficient to assess the diversity of species present as bats are notoriously difficult to sample in forest habitats and a significant period of time needs to be invested in this method.

Five primate species were present, *Papio cynocephalus, Cercopithecus mitis cf. moloney, C. pygerythrus, Galagoides granti* and *Otolemur crassicaudatus*. The species *P. cynocephalus* and *C. pygerythrus* typically occur in open bushland and woodland habitats as well as the edges of lowland forests; and were to be expected in Mselezi FR as most of the tree species present were classed as either lowland or lowland/montane species. These species are highly adaptable and often found in farmland areas where they are a major crop pest. *O. crassicaudatus* is typically a woodland species widespread in Southern and East Africa. The presence of *P. cynocephalus, C. pygerythrus* and *O. crassicaudatus* are an indicator of dry lowland forest surrounded by dry woodland, grassland rocky areas and bushland in a populated landscape. *C. mitis cf. moloney* is an adaptable species confined to evergreen forests and moist woodland. *G. granti* is a coastal forest and moist woodland species. Mselezi FR may form a refuge for these primate species where surrounding habitats are being disturbed by anthropogenic activity.

The low proportion of forest-dependent species and the presence of those species adaptable to human pressures such as *Potamochoerus larvatus, Cercopithecus pygerythrus* and *Papio cynocephalus* reflect the level of human encroachment in this forest reserve, in conjunction with the lack of high quality forest habitat. This is also in line with the generally low richness of mammalian species in the Eastern Arc; which may be influenced by the fragmented nature of the forests, often surrounded by cultivation and settlements, and the mobility and extensive home ranges of many mammals (Kingdon & Howell 1993). The lack of suitable habitat available can be considered a major ecological factor influencing mammalian species richness and population densities in Mselezi FR.

Endemic Species, New Species and Range Extensions
Three near endemic species were recorded in Mselezi FR, Grant's galago *Galagoides granti*, lesser pouched rat *Beamys hindei*, tree hyrax *Dendrohyrax validus* and *cf. Paraxerus vexillarius byatti* (table 44); the latter three represent new records for the Mahenge Mountains. *B. hindei* was once regarded as one of the rarest rodents in Africa (Groombridge 1993) but it is now known to be more widespread (Burgess & Clarke 2000) it was also recorded in Sali FR during this study. Extremely low abundances were recorded in Mselezi FR as there was little forest habitat remaining. This species ranges throughout the Eastern Arc, Coastal Forests and Southern Rift. *D. validus* with their distinctive hack and ping pong calls were present in Mselezi, which is particularly interesting because this species was not found in Sali FR; although it is found through much of the Eastern Arc as well as Coastal Forests and Highlands. *G. granti* is a near endemic species to the Tanzania Coastal Forests occurring from the Rufiji River south into Mozambique as far as Inhambane and west inland as far as the lowland forests of Malawi (Butynski *et al.* in press). This species has been recorded up to 1900m in the Udzungwa Mountains and 900m asl in the Rondo Plateau (Butynski *et al*. in press); and was previously recorded in Mahenge Scarp FR. *P.vexillarius byatti* has been recorded in the Eastern Arc and Southern Rift.

A further eleven widespread mammal species represent new records for the Mahenge Mountains, of which six were also recorded in Sali FR.

Table 44: Ranges of Eastern Arc near endemic mammal species previous to this study.

Species	Range previous to this study
Eastern Arc Near Endemic	
Galagoides granti	E. Udzungwa, Coastal Forests of Tanzania (S of Rufiji R.), Mozambique, lowland 'coastal' forests of Malawi.
Beamys hindei (Mahenge new record)	South Pare, Usambaras, Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Udzungwa, Coastal Forests, Highlands, Southern Rift.
Dendrohyrax validus (Mahenge new record)	Taita, Pares, Usambaras, Nguu, Nguru, Uluguru, Rubeho, Udzungwa, Pemba & Unjuga islands, Coastal Forests, Highlands.
Paraxerus vexillarius byatti (Mahenge new record)	Usambaras, Nguru, Uluguru, Udzungwa, Southern Rift.

Avifauna

One hundred and nine bird species in 38 families were recorded in Mselezi FR. A small proportion of these (15 species; 14.7%) are of conservation concern, due to endemism, threatened status or forest-dependency. Only four species are near endemics (3.7%), and there is a low proportion of forest-dependent species (14 species; 12.8%). Two species are considered to be at risk on the IUCN Red List (1.8%; listed as Near Threatened or Conservation Dependent). Twenty-five species are CITES listed.

Species Richness and Assemblages
The species richness of birds in Mselezi compares favourably with other areas of the Eastern Arc, particularly when considering the small size of this reserve. However, the species assemblage in this area is typical of the dry open canopy woodland and anthropogenically altered vegetation present, and not the afromontane forests of the Eastern Arc, as there were few forest-dependent species and only three montane species in Mselezi. This makes it difficult to compare sites based on species richness alone. The lack of closed canopy forest with dense understory may explain the low proportion of

forest-dependents, as vegetation structure may be more important than habitat continuity in determining the composition of bird communities (Mlingwa *et al.* 2000). Despite the high species richness, mist netting capture rates indicate smaller populations present in Mselezi compared with Sali FR, with an average of only 94ind/10,000nmh. Breeding records were also documented for five species indicating reproducing populations, African crowned eagle *Stephanoaetus coronatus,* trumpeter hornbill *Bycanistes bucinator,* Placid's greenbul *Phyllastrephus placidus,* red-capped robin-chat *Cossypha natalensis;* all of which are considered to be of conservation concern.

Endemic Species and Range Extensions
Four near endemic species were recorded (table 45), found in the Eastern Arc, Coastal Forests and/or Southern Rift. These are Shelley's greenbul *Andropadus masukuensis*, stripe-cheeked greenbul *Andropadus milanjensis,* forest batis *Batis mixta,* and green barbet *Stactolaema olivacea*. The latter three represent new records for Mahenge, also recorded in Sali FR. Relative abundances of these species in Mselezi FR were generally much lower than in Sali FR, where they were frequently mist netted.

A further 60 widespread avian species represent new records for the Mahenge Mountains, of which 12 were also recorded in Sali FR.

Table 45: Ranges of Eastern Arc near endemic avian species previous to this study

Species	Range
Eastern Arc Near Endemic	
Andropadus masukuensis	South Pare, Usambaras, Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Mahenge, Udzungwa, Southern Rift.
Andropadus milanjensis (Mahenge new record)	Taita, Pares, Usambaras, Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Udzungwa, Highlands, Southern Rift.
Batis mixta (Mahenge new record)	Pares, Usambaras, Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Udzungwa, Coastal Forests, Highlands, Southern Rift.
Stactolaema olivacea (Mahenge new record)	Usambaras, Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Udzungwa, Coastal Forests, Southern Rift.

Herpetofauna

Small fauna such as amphibians and reptiles are often considered to denote forest health due to their sensitivity to disturbance within the forest environment, particularly for endemic species (Spawls *et al.* 2002). Species richness and abundances, especially for those species of conservation concern, can be used to determine the condition of forests and to inform management requirements. Low abundances and species richness of forest-dependent and endemic species were recorded in Mselezi FR, reflecting the degraded nature of the forest here. However, a new species of forest gecko, *Cnemaspis sp. nov*, was found in Mselezi FR (as well as Sali FR), indicating that Mselezi FR should still be considered of conservation importance.

Amphibians

Nine amphibian species (in five families) were recorded in Mselezi FR, indicating a generally low level of species richness. Of these, a third are of conservation concern (three species; 33.3%), due to threatened status, endemism or forest-dependency. Two species (22.2%) are endemic to the region, and one of these is considered to be at risk (11.1%), listed on the IUCN Red List as Endangered. Two species (22.2%) are forest-dependent.

Species Richness and Assemblages
In general, species richness of amphibians in Mselezi FR was low, probably as the area is extremely dry and rocky, thus not particularly good habitat for this taxa. Despite this, the endemic species that were found here are typically forest-dependent, suggesting that the forest was once pristine and likely

to have supported many more forest-dependent species. The species assemblage was dominated by *Arthroleptis xenodactyloides, which* was present in the greatest abundances.

Endemic Species and Range Extensions
One endemic species was recorded, *A. yakusini*, but at low abundances. An additional near endemic species was also present, *Spelaeophryne methneri*, again at low abundance (table 46).

Table 46: Ranges of Eastern Arc endemic and near endemic amphibian species previous to this study

Species	Range previous to this study
Eastern Arc Endemic	
Arthroleptides yakusini	Nguru, Uluguru, Udzungwa, Mahenge.
Eastern Arc Near Endemic	
Spelaeophryne methneri	Uluguru, Mahenge, Udzungwa, Coastal Forests, Southern Rift.

Reptiles

Mselezi FR had a low diversity and species richness of reptiles with only eight species (in six families) recorded. Two of these species (25%) are of conservation concern due to endemism and forest-dependency. Both these species are endemics; one species (a forest gecko *Cnemaspis sp. nov*) is likely to be new to science, on the grounds of preliminary morphological and genetic analyses. This new species may be a strict endemic to the Mahenge Mountains; is likely to be forest-dependent (12.5%) and was also found in Sali FR. One other species is near endemic. One widespread species is listed on CITES.

Species Assemblages and Richness
The reptile species are generally indicative of the dry woodland and open areas found in the reserve, for example the Nile monitor lizard *Varanus niloticus* was seen on several occasions. There appeared to be more skink and other lizard species here than in Sali FR and more research would be worthwhile to improve the species inventory. Many typical Coastal Forest species were present, such as the pygmy chameleon *Rieppeleon brevicaudatus,* also found at low altitude in the Eastern Arc forests (Menegon & Salvidio 2005; Menegon *et al.* in prep).

New Species, Endemics and Range Extensions
The forest gecko *Cnemaspis sp. nov* is believed to be a new species, differing from both the Usambara forest gecko *C. africana* and Udzungwa forest gecko *C. uzungwae* (M. Menegon pers comm. with A. Bauer). This new record for Mahenge was also recorded in Sali FR.

One species is near endemic, *Rieppeleon brevicaudatus,* found in the Eastern Arc and Coastal Forests (table 47). This species appeared to be particularly abundant in Mselezi FR.

A further three widespread reptile species represent new records for the Mahenge Mountains, of which one was also recorded in Sali FR.

Table 47: Ranges of Eastern Arc endemic and near endemic reptile species previous to this study

Species	Range previous to this study
Mahenge Endemic	
Cnemaspis sp. nov (Mahenge new record)	
Eastern Arc Near Endemic	
Rieppeleon brevicaudatus	Shimba Hills, Usambaras, Ulugurus, Ngurus, Udzungwas, Mahenge, Coastal Forests.

Herpetofaunal Communities

Mselezi hosts a more widespread and predominately lowland herpetofauna species assemblage, distinctly different to the submontane forest community of Sali FR although some species are shared, such as *A. xenodactyloides*.

Butterflies

N. OWEN & S. GOMBEER

Thirty butterfly species were recorded in Mselezi FR, indicating a fairly low species richness and abundance; of all faunal species, butterflies made up the greatest proportion. Over a quarter of the species recorded (26.7%; 8 species) are of conservation concern, due to endemism, conservation status and forest-dependency. One near-endemic (3%) was recorded and six species (19.4%) are forest-dependent. Although no species are considered threatened by IUCN or listed on CITES, the African Butterfly Research Institute (Collins & Bampton 2007) has assessed levels of threat to produce a measure of conservation status. Four species are considered at risk, one species is listed as Threatened and three as Near Threatened.

Species Richness and Assemblages

Butterfly species richness tends to be determined by forest area and the presence of dense and moisture rich vegetation (Kielland 2000); while the greatest proportion of forest species occurs at low to medium elevation (De Jong & Congdon 1993). The low species richness in Mselezi is likely due to the open and dry woodland and rocky habitat present throughout most of Mselezi. This has been exacerbated by fire and other clearance methods, which have led to the development of dry scrub in many areas.

The forest canopy thus supports a different community to the understory species, indicated by *Charaxes cithaeron.* Interestingly, the Mselezi FR canopy community does not appear to differ significantly from the Sali FR canopy community, the forest canopy in Mselezi FR must be intact enough to continue to support this community. This is probably linked to vegetation structure rather than the species that make up particular plant communities.

Mselezi FR appears to have a significantly distinct understory species community from Sali FR; likely due to both altitudinal and habitat differences between the reserves (De Jong & Congdon. 1993). Despite the large number of plant communities identified only one butterfly community is indicated, likely corresponding to dry woodland indicating that the remaining habitat in Mselezi FR is fairly uniform. The forest-dependent *Amauris niavius* is an indicator species for the Mselezi FR community, again illustrating that the forests of Mselezi are still important habitats despite the levels of degradation present.

Endemics and Range Extensions

One near endemic was recorded, *Bicyclus simulacris* found in the Eastern Arc, Southern Highlands and Northern Malawi; and a new record for the Mahenge Mountains (table 48).

A further seven widespread butterfly species represent new records for the Mahenge Mountains.

Table 48: Ranges of Eastern Arc endemic and near endemic butterfly species previous to this study

Species	Range
Eastern Arc Near Endemic	
Bicyclus simulacris (Mahenge new record)	Uluguru, Udzungwa, Rubeho, Southern Highlands, Northern Malawi.

6.4.2 Vegetation of Mselezi FR

A. AHRENDS & V. WILKINS

A total of 95 plant taxa were recorded in Mselezi FR, including 78 tree species and 17 other floral life forms (table 49). Twenty-seven tree species represent new records for the Mahenge mountains and seven for other life forms. This inventory is comprehensive in regard to tree species but a more complete survey is necessary for the other floral life forms present in the reserve; however this survey still sheds light on the vegetation structure and composition of Mselezi FR, which was previously virtually unknown.

A total of five tree species are of conservation concern, due to endemism or conservation status, and two species for other life forms. Four tree species are classed as endemics or near-endemics and one species for other life forms. One herbaceous plant species is classed as Potentially Threatened (Gereau & Luke 2003); and four tree species are listed as Vulnerable on the IUCN Red List together with one shrub species. Of those tree species identified, 9 tree taxa are forest specialists, 28 are forest generalists and 9 are grassland/woodland species.

Table 49: Plant species recorded in Mselezi FR, categorised by forest specialists and those of conservation concern: endemic and threatened; new records for the Mahenge Mountains are shown in parentheses.

Life form	No. of Families	No. of Species	Endemic Species[a]	Potentially Threatened Species[b]	IUCN[c] (2006)	Forest Specialists[d]	Total Species of Conservation Concern[e]
Trees	25	78 (27)	4 (2)	0 (0)	4 (3)	9 (5)	5 (3)
Other plant life forms	12	17 (7)	2 (1)	1 (1)	1 (0)	1 (1)	2 (1)
Total	34	95(34)	6 (3)	1 (1)	5 (3)	10 (6)	7 (4)
% of all species			6	1	5	11	7

[a]Including strict endemics (species thought to occur only in the Mahenge Mountains); Eastern Arc endemics (species found only in the Eastern Arc); and near endemics (species found in the Eastern Arc Mountains and adjacent locations such as Coastal Forests, Southern Rift, Highlands);

[b]Species considered to be Potentially Threatened and not yet evaluated by IUCN (Gereau & Luke 2003, revised 2006);

[c]Species recognised as threatened with extinction to varying degrees.(listed on the IUCN Red List as Endangered, Vulnerable, Near Threatened, Conservation Dependent only; excludes Data Deficient, Not Evaluated and Least Concern)

[d]Species dependent upon and associated with primary forest.

[e]Includes endemic species, Potentially Threatened species and IUCN Red Listed species; excludes forest-specialists;

Species Richness & Assemblages

All but one plant taxon recorded in the reserve were either exclusively lowland or occurred in both lowland and montane areas, this was to be expected to due the low altitudinal position of Mselezi FR. The single montane species that was found was *Zanthoxylum lepieurii* and was present in a higher altitude plot (730m asl). Most tree species recorded were forest generalists with a few forest-dependents, open area and fire resistant species. These results were indicative of the high frequency of human disturbance present in the reserve shifting the vegetation type towards open area and forest generalists; also there were natural constraints such as the rocky ground present throughout most of the reserve. However despite the disturbed nature of this reserve, there was good species diversity and evenness, perhaps due to the variety of habitat types and fragmentation caused by disturbance.

The plant communities identified at Mselezi FR concisely illustrate the diverse nature of the forest reserve. *Dry open canopy woodland* characterises its lowland nature and the geological constraints posed upon it. *Dense closed canopy woodland* is characteristic of the east facing slopes in Mselezi FR supporting more moisture dependent vegetation communities, as they directly benefit from the moisture laden south-eastern trade winds that prevail during the dry season. Some plots of this woodland also portrayed indicators of former disturbance such as a strongly developed shrub layer; the canopy and regeneration was dominated by non-forest-dependent species, with the prominent presence

of species thought to be comparatively disturbance resistant, *Trema orientalis* and *Hoslundia opposita,* at sites affected by fire, mining and timber cutting. The *semi-riverine forest* grows along the Mselezi river that runs through the centre of the reserve. *Grassland* with sparse tree recruitment is a direct product of tree loss, possibly abandoned farms or older burnt land, most common at low altitude due to the intensity of cultivation. Both *open lowland woodland* in a transitional stage, and *previously cultivated with pioneer species regeneration,* clearly illustrates the human effects on the reserve. The reserve has a floristic affinity to the lowland Coastal Forests partly due to its disturbed nature as well as environmental factors such as altitude and climate.

Species of Conservation Concern

Of the 68 endemic tree species present in the Eastern Arc (Burgess *et al*. 2007), four were recorded in Mselezi; two are Eastern Arc endemics and two are near-endemics. Two tree species, *Beilschmiedia kweo?* and *Pavetta lynesii*, represent new records for the Mahenge Mountains. Of the Eastern Arc endemics *Beilschmiedia kweo?* has been recorded in four other mountain blocks and *Pavetta lynesii* has been recorded in two; therefore no Mahenge endemic species occurred in Mselezi. Other endemic plant life forms that were recorded included the herbaceous species *Anchomanes abbreviatus*, which is a new record for Mahenge; and one shrub species *Dombeya amaniensis*. Details of the endemic plant taxa recorded in this study are in table 50. Four of the endemics were also IUCN Red Listed as Vulnerable, as well as one widespread species *Prema schliebenii* (also a new record for Mahenge). One Potentially Threatened species was present, the herbaceous plant species *Anchomanes abbreviatus*, another new record for the Mahenge Mountains. This gives a total of seven species of conservation concern recorded in Mselezi FR, five of which represent new records for the Mahenge Mountains.

Table 50: Ranges of Eastern Arc endemic and near endemic plant species previous to this study

Species	**Range previous to this study**
Eastern Arc Endemic	
Beilschmiedia kweo? (Mahenge new record)	E. Usambara, Nguru, Udzungwa.
Pavetta lynesii (Mahenge new record)	Uluguru, Udzungwa.
Anchomanes abbreviatus (Mahenge new record)	Eastern Arc
Dombeya amaniensis	Eastern Arc
Eastern Arc Near Endemic	
Bombax rhodognaphalon	Coastal Forests, Eastern Arc, Lake Nyasa, E. & S.E. tropical Africa.
Lettowianthus stellatus	Coastal Forests, Eastern Arc.

Environmental Gradients and Human Disturbance

Plots occurring at higher altitude, with steep slopes and the presence of rocky outcrops were characterised by more typical forest type vegetation; it is likely that the environmental attributes of the plots make them less attractive to humans and consequently these plots experience no or lower levels of disturbance. It also appeared that the type of human disturbance is related to altitude. Therefore those disturbance types occurring at lower altitudes, such as cultivation and settlements, appear to have a greater impact on the vegetation than disturbance occurring at high altitudes. This may be due to nature of the disturbances at lower altitudes, which are much more intense and permanent in their effects than those at higher altitudes, which allow regeneration. Agricultural encroachment (including fires from clearance for cultivation) was the most dominant form of disturbance recorded and occurs at low altitudes. The very nature of this disturbance, total clearance associated with the introduction of an edge effect and increased risk of fire significantly impacts on the reserve's vegetation. Pitsawing was also very prevalent, mainly occurring at mid altitudes, which as results show restricts high quality forest to higher altitudes.

Conservation Importance of Mselezi FR

The scarcity of primary forest and the great variability in species composition and vegetation structure are both presumably related to the high level and variety of human disturbance in Mselezi FR. Human disturbance has shaped the vegetation, with the highest quality forest only found in those areas least attractive to humans. Any remaining forest within the reserve is highly fragmented due to the effects of fire damage, cultivation and pitsawing. Despite its fragmented nature and the high level of disturbance, Mselezi should not be dismissed as having no conservation importance as fragmented reserves often harbour restricted range species (Lovett *et al*. 2001). Previous research has also highlighted that it is important to conserve forests at a range of altitudes in order to protect restricted range species; as such species generally occur at a range of elevations but are often restricted to only a few altitudinal bands at a few sites in a few forests (Lovett *et al*. 2001). As low altitude Eastern Arc forest Mselezi is an important part of the Mahenge Mountain block. The second most abundant tree species recorded in Mselezi FR was the Vulnerable near endemic *Lettowianthus stellatus,* a predominantly lowland and open area pioneer species; Mselezi FR forms an ecosystem bridge for this species to higher altitude forest. This highlights that despite the high level of disturbance the reserve is still important for conservation of threatened and endemic tree species; as well as for the development of dynamic conservation management plans in the face of climate change.

Mselezi is also of scientific interest as the area might constitute a transitional stage between the lowland Coastal Forests and the montane Eastern Arc forests, indicating an ecological continuum between the two areas. This interesting ecological concept has profound implications for the understanding and management of the Eastern Arc; as well as helping to determine the borderline between the montane and coastal forests and potentially contributing to understanding the effects of global warming on the Eastern Arc; and therefore forest reserves such as Mselezi warrant further investigation.

Stable regeneration was recorded in some of the vegetation plots, however no forest-dependent species were found to be regenerating in any plots within the reserve. This does not bode well for the future recovery of Mselezi FR to high quality secondary forest; however such a result may be an artefact of insufficient data or an indication that secondary forest re-growth is a long and potentially limited process. Some plots lacked any kind of regeneration, although this may just have been an artefact of restrained climatic static due to the rocky nature of some of the plots. The transitional rocky open woodland plots showed regeneration, this may be an indication of previous disturbance in these plots initiating regeneration. Only a more long-term and robust survey could establish Mselezi FR's potential for regeneration, and this would be an ideal location for long-term research to establish whether forest regeneration is at all possible for Eastern Arc forests.

6.4.3 Human Resource Use and Disturbance in Mselezi FR

V. WILKINS

Mselezi FR is a mix between dense closed canopy woodland and dry open woodland due to the environmental variability in the reserve. However much of the woodland mix is now severely degraded and disturbed. Clearance and fire damage has left large areas of dry scrub and thickets and the village bordering the road that runs through the reserve encroaches into the forest. Many people appear to be unaware of the reserve boundaries, the number of settlements along the road has increased, and illegal activities are rife, including traps, fire damage, pole and timber extraction major forms of disturbance (pitsaw sites, mining and timber stores) are mapped in annex 1 fig. 60b).

Pole and timber extraction

There was a high level of pole extraction recorded in Mselezi FR, almost half (44%) of all poles surveyed were cut. Relative to location, pole extraction was very high on the eastern transect whereas on the north and south transects cutting was relatively low, suggesting localised cutting. The percentage of fresh cut poles was double that of old cut poles, indicating a recent increase in the intensity of pole extraction. Although there may be some regeneration of poles occurring, an increase in extraction will not be sustainable and degradation will continue.

The number of timbers extracted is low in comparison to poles, but still significant with just under a quarter (21%) of all timbers surveyed being cut. The number of old cut timbers is higher than fresh cut timbers suggesting timber extraction within the reserve may be decreasing, probably due to depletion of the target species. A total of six species were identified as being targeted for abstraction, *Pterocarpus latifolius* (Mninga maji), *Millettia excelsa* (Mvule), *Albizia sp.*, *Afzelia quanzensis*, *Unknown sp.*, with the main species being *Khaya sp*. (Mkangazi). The cutting of these species suggests that the timber is being exported out of the local community, as they are generally used for furniture and building materials. A total of 23 pitsaw sites were observed, clustered in the north and west of the reserve, reinforcing the evidence for a high level of timber exploitation. A positive correlation between fresh cut timbers, pitsawing sites and altitude indicates that timber extraction is being forced to higher altitudes as targeted species have been depleted at lower altitudes. These levels of extraction are causing severe degradation in the reserve. One large hidden store of planks was also discovered in the reserve, indicating that pitsawing is an ongoing and lucrative business (photographed in annex 2b fig. 64b). Pitsaw sites and timber stores are mapped in annex 1 fig. 60b.

Other disturbance

Cultivation

Cultivation was relatively intense in the reserve with 15% of the eighty 50m disturbance sections having cultivation present, this was generally localised to lower altitudes on gentle slopes. Cultivation was typically mixed, providing only produce to the local community. However the high level of cultivation in the reserve has seriously degraded the forest on the valley floor and has the potential to spread further into the reserve (a view of Mselezi FR including the road shows that cultivation has extended beyond the ten metre boundary; annex 2b fig. 64a). Therefore cultivation needs to be monitored relative to the reserve boundaries and bylaws enforced to prevent further encroachment.

Fire Damage

Fire damage was the most frequent and widespread human disturbance in the reserve, occurring on all disturbance transects, in 36% of the eighty 50m sections surveyed and at all altitudes (an example is shown in annex 2b fig. 64c). This was probably a combination of uncontrolled clearance fires for cultivation and purposeful fires to flush out animals and clear land for cultivation. It was found that fire damage occurred mostly on less steep slopes, suggesting a degree of protection from burning in steeper areas of the reserve. Fire damage causes widescale destruction and degradation in the reserve, and efforts should be made to raise awareness of this issue and provide alternatives and control methods (e.g. fire breaks) for the local community.

Hunting

Trapping was widespread in the reserve, occurring on every disturbance transect and on some of the large mammal transects, as well as through casual observations. Several different types of traps were being utilised in order to catch a variety of faunal species. The main species targeted are forest antelopes, cane rats *Thryonomys spp.*, hyrax Procavidae *spp.* and bushpig *Potamochoerus larvatus*. However, traps were not as abundant as could be expected relative to human presence, possibly due to low densities of target species caused by previous hunting pressures and a significant loss of habitat. This is confirmed by the data collected on mammal species in the reserve, as abundances of most hunted species appear to be relatively low. In addition, during the community interviews, suni *Neotragus moschatus*, bushpig *P. larvatus*, red duiker *Cephalophus harveyi* and blue duiker *C. monticola* were all reported as having declined in number in the area. Procavidae *spp.* were the exception, both reported and recorded as having high abundances; perhaps these species are better adapted to habitat changes and disturbance effects. If many of these declining species continue to be hunted along with degradation of their habitat, populations will be dramatically reduced and perhaps even extirpated in the reserve. Therefore the bylaws relating to hunting need to be stringently enforced in order to protect hunted species within the reserve.

Mining

Legal ruby mining was occurring outside the reserve near the western boundary, however mining has started to encroach into the reserve with three mines found within the western section of the reserve above 700m asl. This situation needs to be monitored in order to ensure no further mining activities take place, as it could potentially cause serious damage, destroying vegetation and creating barren infertile areas at high altitude. Mines are mapped in annex 1 fig. 60b.

Settlements and Footpaths

There were a number of footpaths running through the reserve, indicating widespread human use. Settlements and footpaths were generally present at low altitudes, although there was evidence of a camp at higher altitude. Settlements are legally permitted up to 10m on either side of the road, but there was a significant degree of confusion over the location of the reserve boundary and settlements have spread further into the reserve. Expansion will need to be monitored and awareness raised on the location of the reserve boundary relative to Isongo Village and Mpangayao Hamlet.

6.4.4 Community Knowledge of Mselezi FR

V. WILKINS

Structured Interviews and Discussion

A representative sample of community opinions and knowledge pertaining to Mselezi FR were collected from Mpanganyao hamlet and Isongo village. Several middle-aged residents were surveyed, providing a good historical overview of the forest. An even number both of males and females were interviewed; from a range of occupations with the majority being farmers. Most interviewees had lived in the village for many years giving a broad overview of changes over time; however there were also a few short-term residents to give a more objective view. It can be concluded that the information collected from Mpanganyao and Isongo gives a balance of opinions for the communities living directly adjacent to the reserve.

Status of Mselezi FR

The questionnaire demonstrated that most villagers were aware that the forest was a reserve and most knew this was related to water catchment, however very few appreciated its importance for the conservation of plants and animals. Some interviewees even thought the purpose of the reserve was for timber production. It is apparent that awareness needs to be raised about the importance of the forest reserve and the benefits to the community. It also needs to be stressed that timber production is strictly prohibited in the reserve as this is unclear to many residents especially those at the edge of the reserve in Isongo village.

Wildlife

The community had noticed that Sykes monkeys *Cercopithecus mitis*, blue duiker *Cephalophus monticola* and red duiker *C. harveyi*, baboons *Papio cynocephalus*, two species of hyrax Procavidae *spp.* and galago Galagonidae *spp.* were all present in the reserve in large numbers, and apart from *C. monticola* this correlated with our survey results. Bushpigs *Potamochoerus larvatus* and suni *Neotragus moschatus* were said to be present but less abundant which again confirmed our findings. Buffalo *Syncerus caffer* were also said to be present in the reserve but infrequently sighted; and no signs were recorded of this species during our surveys.

It was freely admitted that hunting was carried out in the forest reserve and most of the local bushmeat is obtained from the forest although some does come from the Selous Game Reserve. Species targeted for meat include *Cercopithecus mitis, C. pygerythrus*, *Potamochoerus larvatus*, Procavidae *spp.* and *Cephalophus spp*. Three of these species have been recognised to be in decline in the forest by the community, *C. harveyi*, *C. monticola* and *P. larvatus*. It is likely that hunting pressures together with forest degradation has led to the decline of these species; whereas the lack of decline in populations of monkey and hyrax may be because they are less dependent on pristine forest habitat. Prices for a piece of meat ranged from TSh1000 to 1500, sometimes as low as TSh500, indicating that bush meat is not a rare commodity and is in regular circulation. The fact that hunting is generally not viewed as an illegal activity and the low price for bush meat suggests that illegal hunting in the reserve is both frequent and abundant.

Forest Degradation

Residents responded that the loss of timber would be the greatest effect the loss of the forest would have on them as both individuals and as a community, despite timber extraction being illegal. Therefore greater awareness is needed in relation to the other benefits of conserving the forest, and again the laws associated with the reserve clarified.

Questioning on the burning of the forest revealed that this was caused mainly by scrub clearance fires becoming out of control, which suggests that insufficient control measures are being utilised by villagers in order to prevent the fires from spreading beyond their farms. Fires were also said to be caused by people flushing animals for hunting, and on the borders of the reserve uncontrolled fires can quickly spread into the forest. Most villagers acknowledged the negative effect burning has on the

forest, however it was claimed that local children are often blamed for the fires and so those responsible are not prosecuted. More information needs to be available in regard to the dangers and effects of uncontrolled fires together with instructions on how fires can be controlled, such as the use of fire breaks.

Changes in the Reserve

Some people did acknowledge that there had been a loss in vegetation in and around the forest, so the visible effect of human disturbance has been recognised by the community. Climatic changes have also been noticed, with a general increase in temperature and decrease in rainfall. This is most likely contributed to by the loss of the forest, creating a more open and dry habitat. A rise in malaria incidents was also reported, and this may also be related to a change in the local climate.

Activities in the Forest Reserve

Most residents stated their firewood was sourced from the lowland area outside the forest reserve, probably due to easy accessibility and the abundance of appropriate firewood in this area. However, there was some confusion over the boundary of the reserve and so some unintentional exploitation takes place within the reserve. Some interviewees also stated that they also sourced firewood from the nearby Muhulu FR indicating that the overall importance of forest reserves is not fully appreciated locally.

Most people interviewed consider the forest reserve as a source of building material and this was emphasised by a large store of timber planks found near settlements in the centre of the village. Pitsawing sites were also very frequent in the reserve with 19 pitsaws recorded during our surveys. During the community discussion a comment was made that immigrants were the main people harvesting forest resources and villagers were allowing this to happen and so losing an important resource. The resident who made this comment asked her fellow community members to make it known to village leaders the residents who were collaborating with immigrants in harvesting the natural resources. The community should be supported in reinforcing the illegal nature of logging to discourage this activity.

People were generally aware of the damage grazing animals can have on the forest, and claimed that they only graze animals around their farm. This was supported by our data as no evidence of grazing was apparent in the forest reserve. It was also suggested by one resident that people should be allowed to conduct activities such as cultivation, mining and hunting in the forest reserve under license.

The forest was locally important to the community because of their traditional beliefs and the use of forest resources in traditional medicines, such activities are well respected by local people and generally sustainable. Any environmental education or awareness raising measures should stress the importance of these traditions and encourage the community to celebrate them.

Forest Management

There are obvious concerns regarding the lack of support given to the Environmental Committee members in the reserve and the lack of available resources (equipment and training) as continually stated by many members of the community. The community also wanted environmental education to be carried out more regularly in order to raise awareness and to help the community to understand and manage the reserve.

There was a lot of confusion relating to implementing the Joint Forest Management scheme, especially as without support and funding the community felt that participatory management was impossible; and the villagers claimed they could not see the advantages of this type of management. A common complaint was that if the forest is managed by village Environmental Committee, why were fees charged by the government rather than by local offices or the community; and how are the residents and forest managers around the forest to benefit from the forest fees. People had their own ideas on how management of the forest could be improved: such as villagers reporting the illegal harvesting of natural resources from the forest, and also that the Environmental Committee should work hand in

hand with other villages to exchange ideas. It was also thought that the village should elect people who are capable to perform the pledged tasks on behalf of the village.

Most people interviewed did not plant trees, apart from fruit trees close to their house or in their farm, however this is unsurprising as there is currently no incentive or support to do so. It should be encouraged, especially for timber species, deflecting pressure from the forest reserve through supplying an alternative source of resources.

A common and alarming problem was that the forest boundary is generally unknown to the people living adjacent to Mselezi FR, and it is evident that clear documentation together with awareness raising exercises need to be employed to solve this issue. This is a particular problem due to the border change implemented in 1982, which then designated the reserve to include the central portion with the road and settlements, not solely the ridges. Most of the community appears to be unaware of this variation order, and still follow the old reserve boundaries.

6.5 CONCLUSIONS AND RECOMMENDATIONS FOR MSELEZI FR

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Mselezi FR is severely degraded and under serious threat from human disturbance, the high frequency of activities can be judged from the map in annex 1 fig. 60b. The view of Mselezi FR in annex 2b fig. 64a shows the cultivation infringement into the reserve from the road; it also shows the scrub and degraded forest present throughout the reserve. This has impacted negatively on the wildlife present in the forest, with generally low species richness across many taxa. Despite this, several Eastern Arc endemics and near endemics are still present and any conservation measures should focus on these. Additionally, the results of research into the hyrax population at this site have shown the presence of both tree hyrax *Dendrohyrax validus* (Eastern Arc near endemic; the only known record of this species in the Mahenge Mountains) and bush hyrax *Heterohyrax cf. brucei*; making Mselezi FR the first known locality where these two species associate closely. The large numbers of hyrax present in Mselezi FR means that this is a good opportunity to conduct research into this little known taxa. Results from survey work here have also improved the scientific knowledge of the Mahenge Mountains, with a total of six new vertebrate endemic records, five of which were also found in Sali, including the new species of gecko *Cnemaspis sp. nov;* but one of which was only found in Mselezi: the tree hyrax *D. validus.*

Mselezi FR consists of highly disturbed and fragmented mixed woodland, with the two dominant plant communities being dense closed canopy woodland and dry open canopy woodland, interspersed by anthropogenically altered vegetation. All remaining dense closed canopy woodland was confined to areas of high altitude, steep slopes and rocky outcrops. Most tree species found in the reserve occur in lowland areas with some lowland/montane species present, and very few were forest-specialist. Despite its lowland nature and the high level of current and previous disturbance, Mselezi FR showed a high level of plant diversity and hosts seven plant taxa of conservation concern including the near endemic *Lettowianthus stellatus*, which was the second most abundant tree species present in the reserve. Mselezi is also of interest as a transitional area between the Coastal Forests and montane Eastern Arc, further research in the reserve may help clarify the relationship between the two areas. Analysis showed the highest quality forest to be occurring at high altitudes and therefore conservation efforts should concentrate on preserving these areas.

In addition to increased protection for the existing forest in Mselezi FR, habitat rehabilitation schemes such as facilitating tree growth in secondary and regenerating areas would be important; the planting of indigenous species should be integral to this. Forest expansion could be possible for Mselezi FR, but current forest expansion schemes (such as that established in 1976 in Nawenge FR, another Eastern Arc forest reserve in the Mahenge Mountains) include plantations of fast-growing exotics (*Eucalyptus-Grevillea* plantation in Nawenge) with set-aside areas for the regeneration of native tree species. The need to meet Government targets has meant that the exotic plantations have received the bulk of funding and land allocation for rapid enhancement of water catchment value. This has considerable implications for biodiversity conservation, as exotics may outcompete native species, simplify community structure, reduce species diversity and consequently fail to support a diverse fauna assemblage, particularly the unique ecosystem found in the Eastern Arc. Forest expansion should therefore only be considered if characteristic species from pristine areas of the reserve are used in order to achieve both the preservation of catchment value as well as biodiversity.

Clearance to establish sites for cultivation within the forest reserve continues to be a significant problem despite incurring fines of up to TSh20,000 for expansion beyond permitted boundaries, due to increased resource demand, a tradition of shifting cultivation and poor law enforcement. Catchment Forest have begun the advocacy of a sustainable static rotational system of agriculture but there is a lack of funding to deliver this scheme or subsidise materials for communities. A more widespread implementation of this scheme may help to reduce deforestation through clearance for cultivation.

Human disturbance in Mselezi FR is intense and widespread, the most severe problems being fire damage, cultivation, hunting and pole and timber extraction. Fire damage is the biggest threat throughout the reserve, and has led to fragmentation and loss of much of the forest. Without fire control and prevention methods, a continuation of this trend could see fire destroy the forest reserve. Although hunting was found to be relatively low this is probably due to a decrease in the abundance of target species from a combination of previous hunting and loss of habitat; making hunting less productive. Continued hunting threatens to drive many species to extinction. Hunting was generally viewed as an acceptable activity and the community freely admitted its occurrence. Timber production is currently extremely intensive with a timber store found during field work, supplying an external market aided by local people. Target timber species *Pterocarpus latifolius*, *Millettia excelsa*, *Albizia sp.*, *Afzelia quanzensis* and *Khaya sp*. have already been depleted at lower altitudes, inducing timber extraction to climb to progressively higher areas of the forest. Efforts need to be made to highlight the importance of the forest to the local community, emphasise the illegal nature of these activities, and provide an understanding of the effects that human disturbance is currently having on the reserve. The community needs encouragement to report illegal activities occurring in the reserve. Alternatives also need to be provided so people can sustain themselves without using forest products. The confusion within the community about the location of the reserve boundaries arises from the initial establishment of the reserve in 1954, which excluded the valley floor. A recent variation included the whole area in 1982. Many of the villagers do not realise there has been a change in forest boundaries and continue to utilise the area, unaware that they are infringing more and more into the forest reserve. Without awareness raising of these issues, Mselezi FR is likely to be lost in the near future, a sentiment echoed by many of the villagers.

The apparent lack of support and funding provided to the Environmental Committee is currently preventing any kind of effective management and protection of the forest reserve. The community is aware of the degradation of the forest reserve but feels that without support it is unable to stop the destruction. The community requested more environmental education and awareness raising in order to allow them to understand and manage the forest better. People in the community do want to see the forest preserved but feel that they do not have the resources or expertise to allow it to happen. The community was aware that after ten years there will be little remaining forest in Mselezi FR, and it was acknowledged by the local community that illegal timber extraction, fire damage, hunting, and the growing population of the village are all contributing to the loss of the forest. The community felt that people should think of the next generation and so should be protecting their natural resources. A poignant sentiment expressed by the villagers was that “unity is power; we should work together for a better natural environment at Mselezi FR”.

6.6 MANAGEMENT PRIORITIES FOR MSELEZI FR

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The high levels of human disturbance and forest degradation present throughout Mselezi FR indicates that immediate and effective action needs to be taken to conserve the environmental services (water sources, soil protection and natural resources) of the forest as well as the vegetation and fauna found therein.

Of note is the Joint Forest Management contract between Isongo village, managers of Mselezi FR and the FBD. The government representatives have a number of duties to the JFM scheme. These include delivering environmental education to improve JFM implementation; providing alternative activities to reduce poverty; empowering the Environmental Committee and village to actively conserve and manage the forest reserve; through providing advice, supervision and task forces to patrol the reserve. According to the community, and as evidenced by the state of the forest, little has been done on either side to achieve the aims of sustainable forest reserve management. On the part of the village, the Village Government is expected to supervise the JFM scheme on a local level, propose and accept relevant bylaws, and collaborate with relevant experts; while the villagers should participate fully in forest fire fighting, reporting those conducting illegal activities, and plant trees both inside and outside the reserve. However it is difficult to expect this to be achieved without external support, and in fact there has been little contributed towards these activities. JFM is designed to ensure environmental good practice and is advocated as a more time and cost-efficient method of preventing illegal exploitation within forest reserves, but in this case the scheme does not appear to have achieved any measure of success.

There is significant potential for Mselezi to be the basis for a pilot forest regeneration project as part of the JFM scheme. This would be rewarding both from a scientific perspective analysing the ability of the Eastern Arc forests to regenerate; as well as successful from a socio-economic perspective encouraging the community to actively preserve and manage their natural resources.

Some of the recommendations below reiterate those suggested by Lovett & Pócs (1993) in their assessment of the catchment forest reserves, as these were never implemented and continue to be important. The following recommendations can be achieved through action taken by FBD in terms of enforcing governmental law, and interested NGOs and other grassroots organisations that could provide environmental education and support to local communities through co-ordination and collaboration with local Environmental Committees.

1. **Boundary reassessment and clear demarcation of Mselezi FR** is required to remove ambiguities over boundary location and prevent encroachment. This is particularly important considering the variation order initiated on Mselezi FR, of which local communities are unaware. At present, the boundaries perceived by residents are very different to those defined on land cover and land use maps, and not all forest officers are aware of these discontinuities. A priority should be defining the boundaries close to villages surrounding the reserves, particularly at Mpangayao hamlet.
2. **Resettlement of people located within Mselezi FR** may be necessary in conjunction with the first recommendation to fully enforce reserve boundaries. However, suitable compensation will need to be paid to these people and an alternative home provided for this to be an acceptable solution. Should resettlement not be an option, human expansion in Mpanganyao hamlet must be monitored by FBD to ensure settlements and cultivation do not expand past permitted areas into the forest reserve, and that current cultivation within the reserve is curtailed.
3. **Achievable management plans** need to be developed and **adequate budgets allocated** for their implementation and for law enforcement, as well as for supporting the local community to enable implementation of the JFM schemes. WWF-TPO conducted a workshop as part of the capacity building component of this project, facilitating the preparation of management

plans by the communities surrounding the reserve (appendix 11e). However this will need to be supported and maintained by Catchment Forestry Officers.

4. **Assist the Village Environmental Committees** to establish bylaws to address and act on conservation management issues. Support in the enforcing of bylaws and empowerment will be necessary to facilitate disciplinary measures to combat illegal exploitation, such as introducing the use of fines. Financial support and professional training for the Environmental Committee should be a priority as without support or resources the committees are currently frustrated and ineffective.
5. **Patrols** should be conducted by Forest Officers in conjunction with the village Environmental Committees, and carried out on a regular basis to control illegal activities, particularly in relation to hunting as well as encouraging local people to report any illegal activities they witness. Financial support will be necessary to supply adequate equipment to the Environmental Committee.
6. **Support for the prosecution of illegal activities** through improved communication channels between the Environmental Committee and prosecuting authorities; as well establishing protocols for reporting illegal activities both within the village and externally.
7. **Improved liaisons** between the local Forestry Officer and the villages of Isongo and Mpangayao. This would allow the communities to highlight problems, and the Forestry Officer to provide guidance and support; as well as being an opportunity to facilitate funding applications for community projects such as a tree nursery, new cottage industries etc. The Forestry Officer would have to be provided with adequate funds to ensure regular meetings.
8. **Regeneration of Mselezi FR** through tree planting to replace disturbed land with tree species that were formerly present and to reduce encroachment by scrub and dry forest species. Tree planting outside the borders of the reserve would also create a buffer zone around the reserve and facilitate the provision of alternative resources specified in Recommendation 9. The establishment of successful tree nurseries could also provide potential business opportunities in the community.
9. **Provide alternative resources for sustainable use** through planting tree species in village areas that can be set aside for village use. Sustainable resource use and practices here must be encouraged. Planting could include quick growing tree species to meet demands for firewood and timber (Rodgers & Burgess 2000), and plant species commonly used for food and medicine. Sustainable hunting of locally abundant species could also be encouraged in these areas, with education to designate quotas and sustainable practices.
10. **Conduct environmental education and awareness raising** about the boundaries of the forest reserves; its importance for the protection of water sources, soil and biodiversity; and the negative effects of human disturbance, including practical advice on controlling activities that can cause damage, for example using firebreaks to limit fires, and addressing the impact of poaching. Education in schools is particularly important, targeting future generations as well as being a resource to apply schemes such as tree planting. Teachers should be encouraged to use the forest and the natural environment in their lessons and to teach the importance of the forest and its resources, especially the traditional uses of forest plants.
11. **Investment in rural development** in the impoverished communities surrounding the forest reserves is necessary to establish essential services and infrastructures, and to help ensure effective and sustainable use of other natural resources in order to alleviate their dependence on the forest reserve. Alternative sources of income should be encouraged to deflect dependence away from the forest reserves. This could be achieved through cottage industries such as bee keeping, the growing of saleable crops and jewellery making.

7. CAPACITY-BUILDING & AWARENESS RAISING

WWF-TPO

7.1 INTRODUCTION

An Environmental Education (EE) & Awareness workshop for village leaders and community conservation committees for Sali and Isongo villages was conducted at the Udzungwa Mountains National Park (UMNP) Ecological Monitoring Centre on 19th – 21st November 2006 (appendix 11c).

The workshop was attended by 24 participants from Sali and Isongo villages as well as Government officials from Mahenge town (appendix 11d): the District Natural Resources Officer (DNRO), Ag. District Catchment Forest Officer (DCFO) and two other Catchment Forests Officers for Sali and Mselezi FRs, Village Executive Officers (VEO), members of the Village Community Conservation Committees (VCCC) and teachers. The facilitation team was led by Mr. Enock Chengullah, WWF-TPO's EE Programme Coordinator.

The main aim of the workshop was to develop Community Action Plans (CAPs) for the sustainable management of environmental conservation initiatives for Sali and Isongo villages; to raise community environmental awareness; and to generate an appreciation of forest resources and highlight areas in which the community needs support. Communities were trained on sustainable resource use, such as efficient stove construction, in order to reduce the demand for wood fuel and hence the strain on natural resources in these communities.

The objectives were:
- To discuss environmental problems and issues versus the importance of Sali and Mselezi FRs for Sali and Isongo villages;
- To identify existing opportunities for sustainable environmental management of Sali and Mselezi FRs;
- To provide training on sustainable resource use;
- To develop future strategies with implementation plans in order to initiate sustainable environmental management initiatives for the Sali and Mselezi areas.

7.2 WORKSHOP CONTENT

The workshop was opened by the DNRO Mr Mwinshehe Kulita who highlighted the importance of the forest reserves and the need for the villages to be involved in forest management and protection. The participants were asked what they expected to gain from the workshop, and the following answers were given:

- Knowledge about Environmental Education;
- Knowledge about sustainable conservation measures for catchment forests;
- To learn about UMNP and its experience in conservation work;
- Knowledge about energy saving stoves;
- An understanding of laws and policies which support conservation initiatives;

7.2.1 Conservation Philosophy

The presentation on conservation philosophy emphasised that all living things have the right of existence; conservation is beneficial for the world's life supporting systems; conservation is carried out for the present and future generations of mankind; and that resources are limited and need to be conserved and utilised in a sustainable manner.

7.2.2 An Overview of Environmental Issues and Problems Locally, Nationally and Globally

Initially the meaning of 'environment' and 'environmental issues' was discussed as well as current environmental issues in Tanzania. Participants were then required to discuss and list the problems that exist in their local area. Sali village listed pitsawing, footpaths in the forest, poaching signs (snares and pits) and wild fires due to farming activities (table 51).

Table 51: Environmental problems of Sali village

PROBLEMS	SOLUTIONS
• Poor environmental education	Environmental education
• Shifting cultivation	Better education and understanding of farm management Environmental education
• Fire damage	Environmental education Bylaws
• Logging for firewood and charcoal	Motivation of the community to use energy saving stoves Motivation of the community to start a tree nursery Bylaws
• Illegal fishing by poisons	Bylaws Environmental education

Problems listed by Isongo village were no clear forest boundary, the road goes through the forest, settlements within the forest area, footpaths, farming on the valley floor and on steep slopes, expansion of farmland, poaching, pitsawing, mining activities and wild fires (table 52).

Table 52: Environmental problems of Isongo village

PROBLEMS	SOLUTIONS
• Poor environmental education	Environmental education
• Shifting cultivation	Stop shifting cultivation
•	Joint farming initiatives Encourage more effective land use Better education on the principles of farm management
• Fire damage	Find the sources of the fire damage Environmental education in order to stop fire damage Cooperation within the community to stop fire damage Bylaws
• Timber extraction: illegal logging, fire wood and charcoal	To motivate the community to start growing trees nurseries and village forest for different uses Motivate the community to use energy saving stoves Bylaws Check for permits
• Mining and quarrying activities	Identify the people responsible and monitor the situation Environmental education Enforcement of bylaws
• Illegal hunting for forest animals	Identify the people responsible Education on keeping livestock Enforcement of bylaws
• Cultivation in steep areas and near sources of water	Identify the people responsible Enforcement of bylaws and monitoring of the situation

The participants agreed that the problems listed above were a major setback for conservation efforts in the area and highlighted that a lack of awareness of environmental issues is a major problem, due to low levels of education; and there was no feeling of environmental responsibility. Further issues that were highlighted during the discussions included farming around water sources, shifting cultivation and the use of fires for clearing land for cultivation. Everyone accepted that the practices discussed

had further consequences in relation to the two villages, for example that the destruction of water sources leads to a reduction in soil quality, soil erosion, and a decline in food production.

7.2.3 Forest Values, Cultural, Social and Biological Contexts

Participants were asked *"Why is it so important to conserve forests?"* Responses included livelihood/survival values, tourism, education and research, medicines, timber, recreation, spiritual values as well as the expansion of agriculture and ranching.

When asked to identify forest values those that were cited included carbon sequestration, rain attraction, soil fertility and control of soil erosion, forest products such as fuelwood, timber, medicines, fruit and honey, research, recreation and habitat.

7.2.4 Forest Governance Issues

The DNRO explained the formation of forest reserves through government policy and the involvement of local communities in its management; as well as regulations pertaining to government forest reserves. Mr. Octavian Nkawamba, the DCFO, explained about the Joint Forest Management (JFM) scheme, its aims and objectives, and its achievements to date.

Questions asked by participants included: 'Why it has taken so long for the Government through the District Authority to come to the grassroots to meet people for awareness about these policies'. Others wanted to know 'Is the Government keen to move people out of Mselezi FR and where will they go?' In response to these questions the DCFO said "efforts have been made to send one forest officer for each forest for Sali and Mselezi villages, to be stationed there for easy management of activities". The DNRO also revealed that people who live within catchment areas will definitely be moved out of those areas immediately.

7.2.5 Forest Conservation Experiences from Udzungwa Mountains National Park

Using the Udzungwa Mountains National Park as an example of community management and sustainable resource use, this section covered conservation work in the Udzungwas as part of the Eastern Arc forests; assessing the activities of the communities living adjacent to the park to increase understanding of local values and utilisation of resources. The environmental community initiatives established in and around the Udzungwas were described, focusing on issues that had to be overcome and measures that were utilised to resolve problems which existed in the area.

7.2.6 Study Visit for Training on Energy Saving Stoves and Alternative Livelihoods

Participants visited the village of Katurukila to learn about energy efficient stoves and alternative livelihood activities; there was a demonstration on the construction of the stoves, and an opportunity to witness their use. Talks were given by the Chairman of the VCCC on its role and how it was established; and on the beekeeping project operating in the village.

Participants asked how the villagers were able to budget their time for group work and for private concerns. The Chairman responded that they set aside two specific days for group work and the rest of the time for farming; and the group also operated its own bank account.

7.3 FUTURE STRATEGIES

Preparations for future strategies and plans of actions based on problems identified for each village took place. Each village prepared their own future implementation plans indicating follow-up strategies (appendix 11e).

7.4 CONCLUSIONS

The proposed outputs were successfully achieved through this workshop. Community awareness on the issues of Sali and Mselezi FRs were raised and discussed, while Community Action Plans for conservation of the reserves were prepared for both villages. Participants were also able to learn about energy saving stoves and alternative livelihood activities. The enthusiasm of the participants was evident at the workshop, as they were keen to keep records and to implement the CAPs they helped develop. Political will and commitment was also apparent in the Government officials present as well as from the local authorities.

For more information and greater detail regarding the capacity building component carried out by WWF-TPO please refer to the BREAM Consultant Report by WWF-TPO (2007).

8. THE MAHENGE MOUNTAINS

N. OWEN & V. WILKINS

8.1 FAUNA OF THE MAHENGE MOUNTAINS

During the course of this study, and incorporating previous peer-reviewed published research in the Mahenge Mountains (Burgess *et al.* 2007; Loader *et al.* 2003; table 53); 343 faunal species (in 92 families) have been recorded, of which 250 were vertebrate species (in 84 families), and 93 butterfly species (in 8 families). Of the vertebrates, the majority were small fauna: birds and herpetofauna; with 133 (53.2%) birds, 30 (12%) reptiles and 40 (16%) amphibians, and 47 (18.8%) mammals. Of the endemics previously recorded in Mahenge, all except two species were recorded again in this survey: the near endemic (Eastern Arc, Highlands, Southern Rift) mountain greenbul *Andropadus fusciceps* (Burgess *et al.* 2007); and the near endemic (Eastern Arc and Coastal Forests) Usambara forest gecko *Cnemaspis africana* (Loader *et al.* 2003).

Table 53: Faunal species recorded in the Mahenge Mountains (from this survey, Loader et al. 2003, Burgess et al. 2007), categorised by widespread species and those of conservation concern: endemic, threatened and forest-dependent; new records for the Mahenge Mountains are shown in parentheses.

Taxa	No. of families	No. of species[a]	Wide-spread species	Strict Mahenge endemics[b]	Eastern Arc endemics[c]	Eastern Arc near endemics[d]	IUCN[e] (2006)	CITES[f] (2006)	Forest-dependent species[g]	Total number of species of conservation concern[h]
Mammals	25	47 (29)	42 (25)	0	0	5 (4)	9	8	8	15 (12)
Birds[i]	41	133 (84)	126 (79)	0	1 (1)	6 (4)[j]	3	28	26	28 (20)
Amphibians[k]	8	40 (10)	23 (0)	4 (4)[l]	5 (4)	8 (2)	7	1	18	20 (10)
Reptiles[m]	10	30 (16)	23 (12)	3 (2)[n]	1 (1)	3 (1)[o]	0	3	6	8 (5)
Butterflies	8	93 (47)	87 (42)	0	1 (1)	5 (4)	0	0	27	27 (13)
Vertebrate Total	84	250 (139)	214 (116)	7 (6)	7 (6)	22 (11)	19	40	58	71 (47)
% total of vertebrate species			87.8	2.0	2.3	7.9	5.5	11.7	24.8	28.6
All taxa total	92	343 (186)	301 (158)	7 (6)	8 (7)	27 (15)	19	40	85	98 (60)
% total of all species			87.8	2.0	2.3	7.9	5.5	11.7	24.8	28.6

[a]Includes all verifiable opportunistic observations as well as those from systematic methodologies.

[b]Species thought to occur only in the Mahenge Mountains.

[c]Species found only in the Eastern Arc.

[d]Species found in the Eastern Arc Mountains and adjacent locations such as Coastal Forests, Southern Rift, Highlands;

[e]Species recognised as threatened with extinction to varying degrees.(listed on the IUCN Red List as Endangered, Vulnerable, Near Threatened, Conservation Dependent only; excludes Data Deficient, Not Evaluated and Least Concern).

[f]Species recognised as threatened with extinction and so with varying restrictions on trade.

[g]Species dependent upon and associated with primary forest.

[h]Includes endemic species, IUCN Red Listed species, forest-dependent species; excludes CITIES listed species;

[i]Includes birds seen at the forest edge.

[j]Includes one near endemic species previously recorded in Mahenge (Burgess *et al.* 2007) but not in this study: *Andropadus fusciceps*.

[k]Includes 12 species previously recorded in Sali FR (Loader *et al.* 2003) but not in this study: *B. gutturalis, B. maculatus, H. marmoratum, A. brachycnemis, H. mitchelli, H. nasutus, H. tuberilinguis, B. mossambicus, P. bifasciatus, P. edulis, C. xerampelina, K. senegalensis.*

[l]All four of these species appear to be new to science.

[m]Includes reptiles caught at the forest edge.

[n]Two of these species appear to be new to science.

[o]Includes one near endemic species previously recorded in Sali FR (Loader *et al.* 2003) but not in this study: *C. africana.*

Taking into account endemism, threatened status and forest-dependency, almost a third of all faunal species are of conservation concern (98 species; 28.6%) for all taxa studied, with the same proportion of vertebrate species of conservation concern (71 species; 28.6%).

8.1.1 Endemism

Within the vertebrate species, the number of endemics made up 14.4% (36 species). The endemics are divided as follows (table 54; fig. 50): 7 (2.8%); may be strictly endemic to the Mahenge Mountain block, 7 (2.8%) are endemic to the Eastern Arc Mountains, with 22 (8.8% near endemics, found in the Eastern Arc and adjacent eco-regions. The high numbers of endemics are particularly significant considering the small size of the Mahenge Mountain block, and especially considering that most of these species have so far been recorded from a single small forest reserve (Sali FR).

Table 54: Faunal endemics in the Mahenge Mountains by taxa

Taxa	Mahenge Endemic	Eastern Arc Endemic	Near endemic
Mammals (10.6%)			*Beamys hindei* (S&M) *Dendrohyrax validus* (M) *Galagoides granti* (S&M)† *Hylomyscus arcimontensis* (S) *Paraxerus vexillarius byatti* (S&M)
Birds (5.3%)		*Bubo vosseleri* (S)	*Andropadus fusciceps* (MM)***** *Andropadus masukuensis* (S&M) *Andropadus milanjensis* (S&M) *Batis mixta* (S&M) *Sheppardia sharpei* (S) *Stactolaema olivacea* (S&M)
Amphibians (42.5%)	*Callulina sp. nov* (S) *Hoplophyrne sp. nov* (S) *Nectophrynoides sp. nov 2* (S) *Probreviceps sp. nov* (S)	*Afrixalus sp nov?* (S) *Arthroleptides yakusini* (S&M) *Leptopelis uluguruensis* (S) *Nectophrynoides sp. nov 1* (S) *Phrynobatrachus udzungwensis* (S)	*Afrixalus uluguruensis complex* (S) *Arthroleptis cf. reichei* (S&M) *Hyperolius punctilatus* (S) *Leptopelis vermiculatus* (S) *Nectophrynoides tornieri* (S) *Probreviceps cf rungwensis* (S) *Spelaeophryne methneri* (S&M) *Scoleocomorphus kirkii* (S)
Reptiles (23.3%)	*Kinyongia sp. nov?* (S) *Rhampholeon beraduccii* (S) *Cnemaspis sp. nov* (S&M)	*Xyeledontophis sp.* (S)	*Cnemaspis africana* (S) *****† *Crotaphopeltis tornieri* (S) *Rieppeleon brevicaudatus* (S&M)
Butterflies (6.5%)		*Cymothoe aurivilli* (S)	*Bicyclus danckelmani* (S) *Bicyclus simulacris* (M) *Neptis nina* (S) *Papilio fuelleborni fuelleborni* (S) *Papilio pelodorus vesper* (S)

†These two near endemic species were not included in the ranking analyses when comparing Mahenge to other mountain blocks using figures and methods from Burgess *et al.* 2007.
*****Records made by previous surveys, either listed in Burgess *et al.* (2007) or Loader *et al.* (2003).
Key: S=Sali FR; M=Mselezi FR; MM=Mahenge Mountains

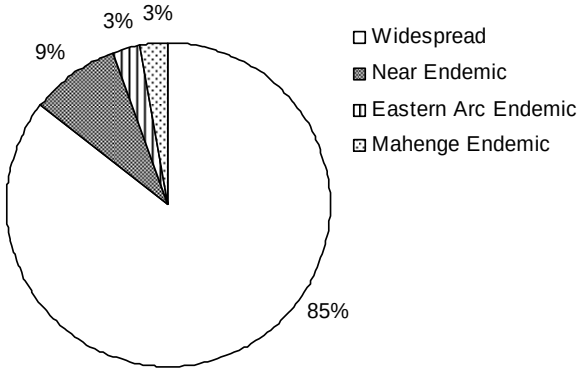


Figure 50: Vertebrate endemism in the Mahenge Mountains

Burgess *et al.* (2007) conducted a review of the biological importance of the Eastern Arc Mountains. Importance was assessed using two ranking methods: the summed numbers of species of interest (endemic, near endemic, threatened) per mountain block, and the numbers of species of interest corrected for area using:

$SA = S / A^z$

where S = number of species, A = forest area,
z = species-area exponent set at 0.2,
SA = number of species corrected for area.

This latter method incorporates the effect of forest area to "reduce the potential bias in the prioritisation approach – where larger forests contain more species simply due to the species-area relationship" (Burgess *et al.* 2007). The rankings produced by Burgess *et al.* (2007) have been updated with the new Mahenge data; but excluding two species that have been classed as near endemics in this Report, as they were not considered near endemics at the time of Burgess's paper but have now been reclassified by experts (A. Perkins, M. Menegon). These species are *Cnemaspis africana* and *Galagoides granti.* Numbers for all other mountains blocks are from Burgess *et al.* (2007); refer therein for a full description and rationale of methods and results. Figure 51 illustrates rankings of the mountain blocks by levels of endemism.

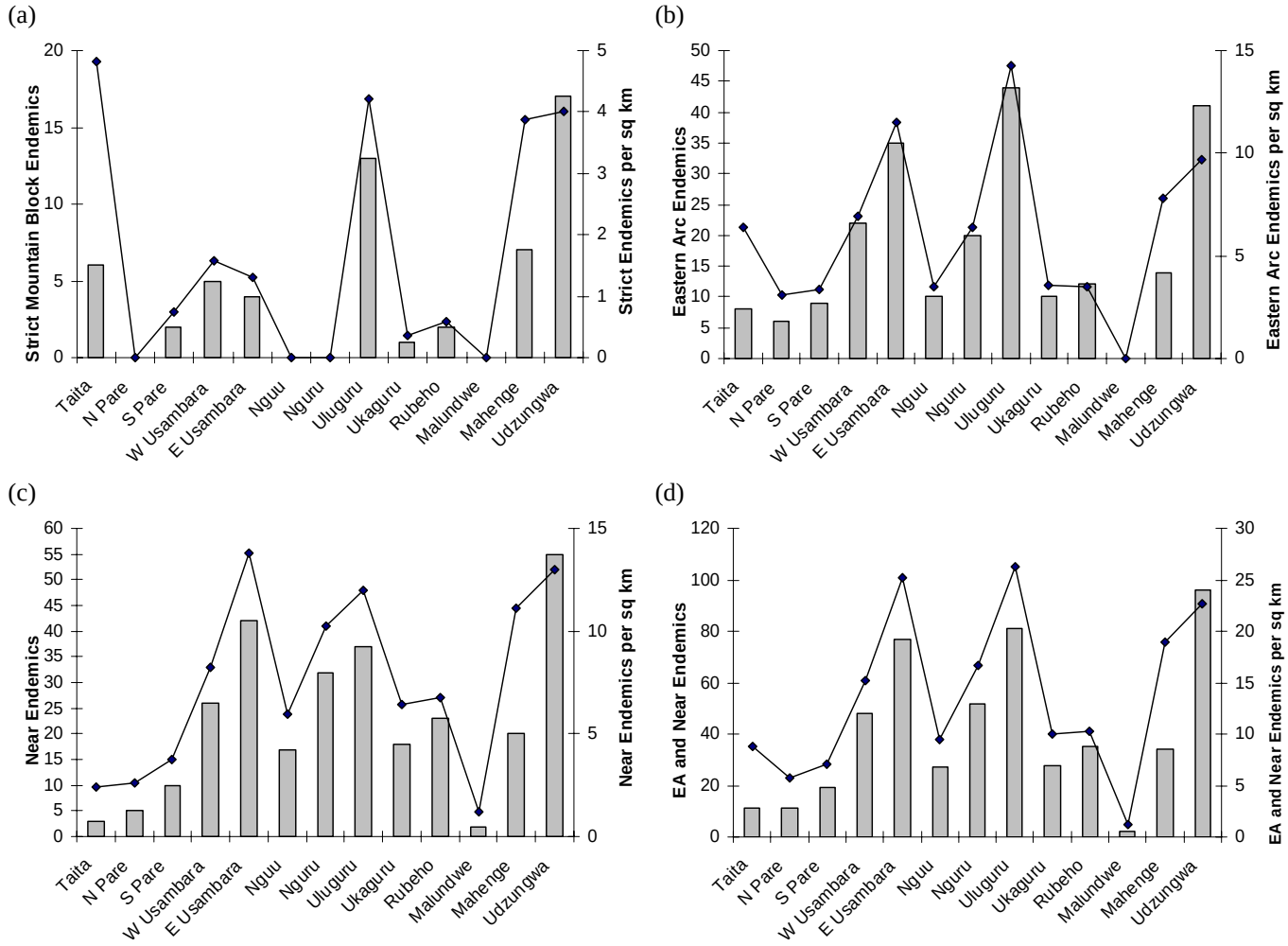


Figure 51: Ranked importance for endemic vertebrates of the Eastern Arc Mountains (grey bars = summed species data; black lines and diamonds = species data corrected for forest area); (a) single block endemic vertebrate species; (b) Eastern Arc endemic (including single block endemic) vertebrate species; (c) near endemic vertebrate species; (d) Eastern Arc endemic and near endemic vertebrate species; the 13 mountain blocks are arranged left to right from north to south in the Eastern Arc.

The 7 strict Mahenge Mountain block endemics recorded now places Mahenge third, after the Udzungwas (17 species) and Ulugurus (13 species). When corrected for forest area Mahenge becomes the fourth most important mountain block for strict endemics.

Considering Eastern Arc endemic vertebrates, Mahenge holds 14 species, placing it sixth below the Ulugurus (44 species), Udzungwas (41 species), East Usambara (35 species), West Usambara (22 species), and Ngurus (20 species). When corrected for forest area Mahenge becomes fourth most important for Eastern Arc endemics.

Combining strict endemic, endemic and near endemic vertebrates, Mahenge holds a total of 34 species (excluding the 2 near endemic species described above), ranking it seventh; below the Udzungwas (96 species), Ulugurus (81 species), East Usambaras (77 species), Ngurus (52 species), and West Usambaras (48 species). When corrected for area this now places Mahenge fourth (after the Ulugurus, Udzungwas and East Usambaras) in the list of mountain blocks arranged by conservation priority, where previously it was eleventh. This is a dramatic increase in conservation importance and indicates the importance of research in the Eastern Arc, particularly the lesser-known mountain blocks.

Of all vertebrate endemic species, 22 represent new records for Mahenge (6 strict Mahenge endemics, 6 endemics, 11 near endemics); and 6 of these are potentially new to science (all strict Mahenge endemics).

The proportion of endemics within some taxa is also significant (fig. 52).

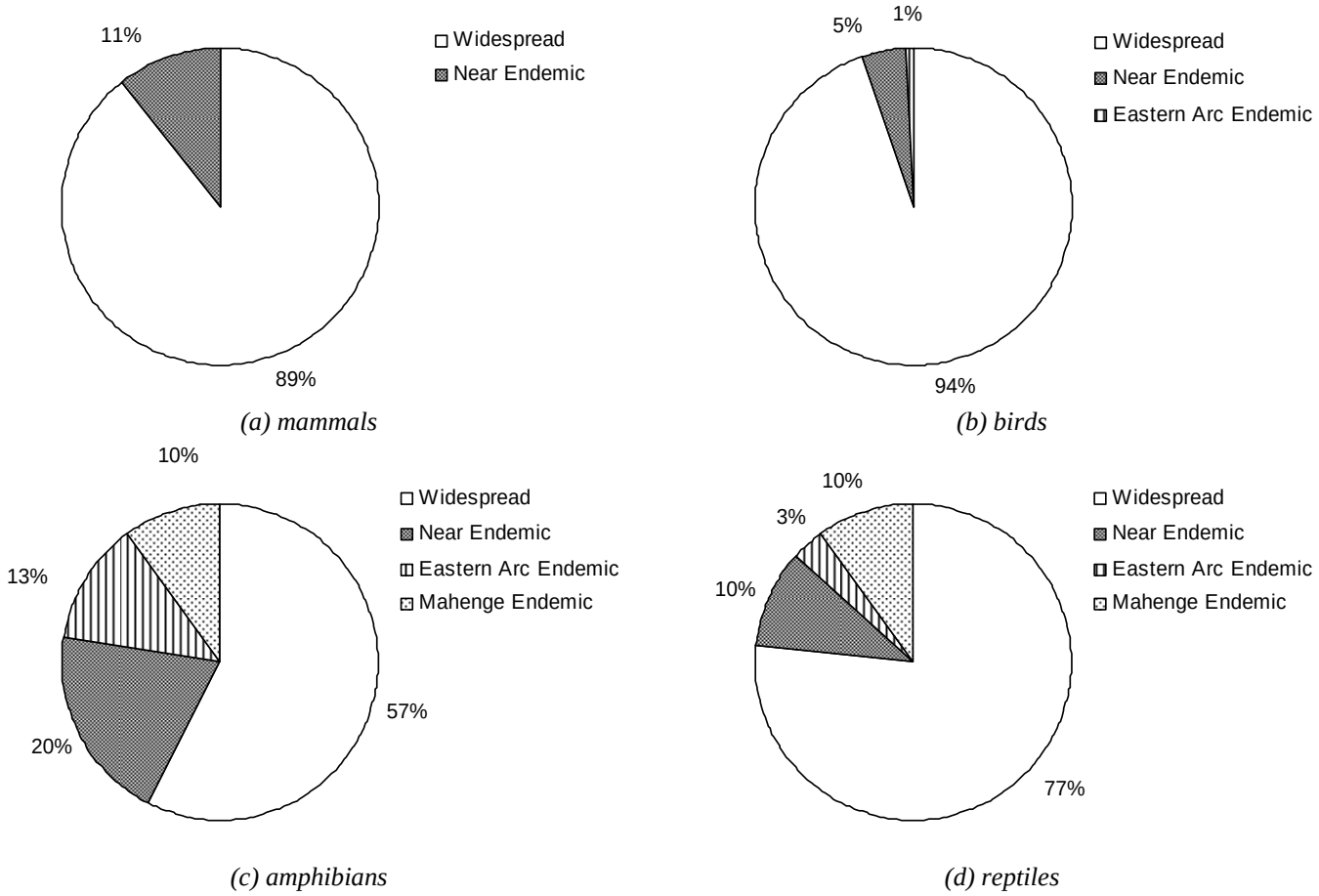


Figure 52: Vertebrate endemism in the Mahenge Mountains by taxa

For amphibians, 42.5% (17 endemic species out of a total of 40 recorded species) are endemic. For reptiles, 23.3%, (7 endemic species out of a total of 30 recorded species) are endemic. This compares favourably with other rich Eastern Arc forests, for example in Udzungwa Scarp FR, 53.6% of 36 amphibian species and 21.7% of 33 reptile species were endemic (Menegon & Salvidio 2005). For herpetofauna as a whole, 34.3% are endemic, not as high as Udzungwa Scarp FR (37.7% endemic; Menegon & Salvidio 2005); but this is not unexpected considering that the forested area of the Udzungwas are much more extensive than that of Mahenge.

For butterflies, the importance of the Mahenge mountains has also risen (fig. 53); a total of six Eastern Arc endemic and near endemic butterfly species, corrected by forest area and compared to other mountains blocks using Burgess *et al.* (2007) produces a new ranking of second, after the Rubehos (13 species).

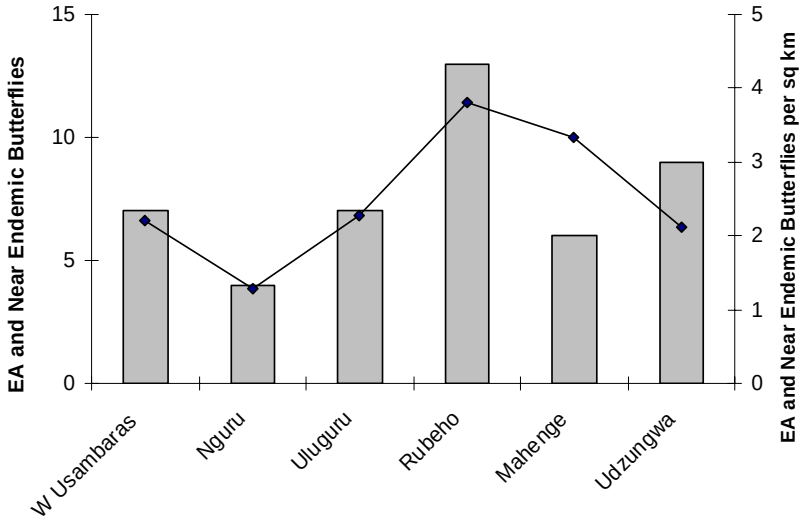


Figure 53: Ranked importance for endemic and near endemic butterfly species of the Eastern Arc Mountains (grey bars = summed species data; black lines and diamonds = species data corrected for forest area); the 13 mountain blocks are arranged left to right from north to south in the Eastern Arc.

8.1.2 Threatened Species

A total of 19 (7.6%) vertebrate species in Mahenge are considered to be at risk, listed on the IUCN Red List as Endangered, Vulnerable, Near Threatened or Conservation Dependent (table 55). Of these, 9 (3.6%) species are threatened (Endangered or Vulnerable) with 10 species at lower risk (Near Threatened or Conservation Dependent). Thirty-six species remain Not Evaluated; one species is considered Data Deficient; while 181 species are listed as Least Concern, a category that now includes widespread and common species. Forty species are CITES listed.

Comparing the new Mahenge Mountains data with that of the other mountain blocks (fig. 54) using figures from Burgess *et al.* (2007) produces a change in ranking for Mahenge. Mahenge has moved to fifth most important in terms of conservation priorities when corrected for area, where previously it was twelfth. Despite this, it is still lower than the main priorities of the Udzungwas (40 IUCN threatened species), East Usambaras (30 IUCN threatened species) and the Ulugurus (29 IUCN threatened species).

However, the Red List has recently been updated and species listed as at risk in Burgess *et al.* (2007;) have now been downgraded to Least Concern (e.g. *Dendrohyrax validus* was listed as VU but is now listed as LC); and equally other species may be assigned higher levels of threat based on recent research. Therefore revising the data from other mountain blocks may change the rankings further.

Table 55: IUCN (2006) Red Listed species in the Mahenge Mountains by vertebrate taxa

Taxa	IUCN Threatened (Endangered, Vulnerable)	IUCN Lower Risk (Near Threatened, Conservation Dependent)	IUCN Not yet at Risk (Data Deficient, Not Evaluated, numbers of Least Concern)
Mammals (19.1%)	*Loxodonta africana* (VU; S) *Paraxerus vexillarius byatti* (VU; S&M)	*Beamys hindei* (NT; S&M) *Cephalophus harveyi* (CD; S&M) *cf. Crocuta crocuta* (CD; S) *Neotragus moschatus* (CD; S&M) *Praomys delectorum* (NT; S) *Rhynchocyon cirnei reichardi* (NT; S) *Syncerus caffer* (CD; S)	*Galagoides granti* (DD; S&M) *Graphiurus murinus* (NE; S) *Hylomyscus arcimontensis* (NE; S) 30 species listed as Least Concern (20S; 20M)
Birds (2.3%)	*Bubo vosseleri* (VU; S)	*Circaetus fasciolatus* (NT; M) *Coracias garrulous* (NT; M)	*Centropus burchelli* (NE; M) *Psalidoprocne holomelas* (NE; S&M) *Malaconotus nigrifrons* (NE; S) 127 species listed as Least Concern (56S; 105M)
Amphibians (17.5%)	*Afrixalus uluguruensis complex* (VU; S) *Arthroleptides yakusini* (EN; S&M) *Leptopelis uluguruensis* (VU; S) *Leptopelis vermiculatus* (VU; S) *Phrynobatrachus udzungwensis* (VU; S) *Probreviceps cf rungwensis* (VU; S)	*Arthroleptis reichei* (NT; S&M)	*Hyperolius nasutus* (NE; S) 24 species listed as Least Concern (9S; 8M)
Reptiles (0%)			30 species Not Evaluated (26S; 8M)

Key: S=Sali FR; M=Mselezi FR; MM=Mahenge Mountains

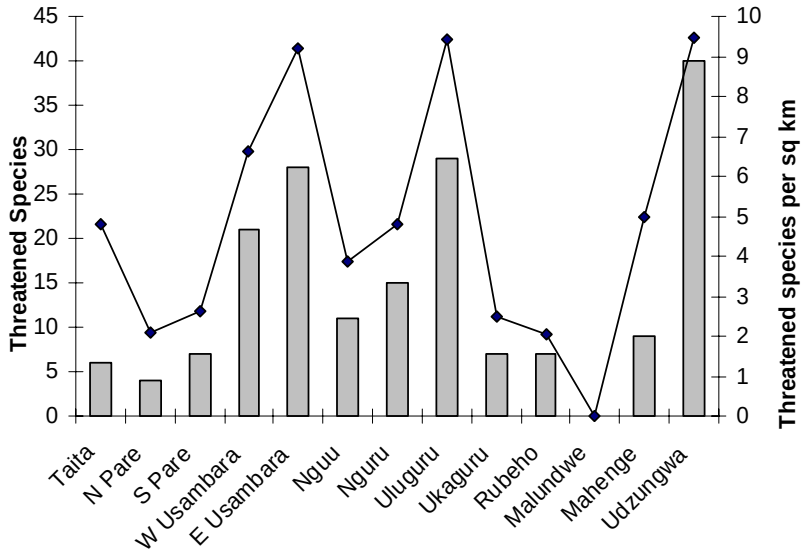


Figure 54: Ranked importance for threatened vertebrate species of the Eastern Arc Mountains (grey bars = summed species data; black lines and diamonds = species data corrected for forest area); threatened species are listed as Critically Endangered, Endangered or Vulnerable on the IUCN Red List (2005 apart from Mahenge which uses 2006 listings); the 13 mountain blocks are arranged left to right from north to south in the Eastern Arc.

No butterflies were listed on the IUCN Red List; however the African Butterfly Research Institute (Collins & Bampton 2007) has assessed levels of threat to produce a measure of conservation status (table 56). A total of nine species (9.7%) are considered to be at risk: one Vulnerable; three Threatened; five Near Threatened. Seven species are listed as Not Evaluated; while the rest are not considered to be at risk.

Table 56: Threatened butterfly species in the Mahenge Mountains according to ABRI (2007) criteria

Taxa	ABRI Threatened (Vulnerable, Threatened)	ABRI Lower Risk (Near Threatened)	AB RI Not yet at Risk (Not Evaluated; numbers of 'Least Concern')
Butterflies (9.7%)	*Cymothoe aurivilli* (VU; S) *Amauris crawshayi* (T; S) *Bicyclus danckelmani* (T; S) *Bicyclus simulacris* (T; M)	*Euphaedra orientalis* (M), *Euxanthe tiberius* (S) *Papilio fuelleborni fuelleborni* (S) *Alaena picata* (M) *Oboronia beuronicai* (S&M)	*Amauris tartarea* (NE; S) *Sevenia garega* (NE; S) *Sevenia moranti* (NE; S&M) *Bicyclus campus* (NE; M) *Bicyclus tanzanicus* (NE; S&M) *Tuxentius cretosus* (NE; S) *Uranothauma delatorum* (NE; S) 72 species listed as 'Least Concern' (58S; 22M)

Key: S=Sali FR; M=Mselezi FR; MM=Mahenge Mountains

8.1.3 Forest-dependent Species

Much of the fauna found was typical of good submontane forest; a quarter of vertebrate species recorded are strictly forest-dependent (23.2%; 58 species; table 57). A similar proportion of a fifth of species were forest-dependent when considering all taxa (24.8%; 85 species).

Table 57: Forest-dependent species in the Mahenge Mountains by taxa

Taxa	Forest-dependent Species
Mammals (17%)	*Anomalurus derbianus* (S), *Cephalophus harveyi* (S&M), *Cephalophus monticola* (S&M), *Cercopithecus mitis cf. moloney* (S&M), *Dendrohyrax validus* (M), *Galagoides granti* (S&M), *Paraxerus vexillarius byatti* (S&M), *Rhynchocyon cirnei reichardi* (S)
Birds (19.5%)	*Alethe fuelleborni* (S), *Andropadus fusciceps* (MM)*****, *Andropadus masukuensis* (S&M), *Andropadus milanjensis* (S&M), *Apalis melanocephala* (S), *Apaloderma vittatum* (S), *Batis mixta* (S&M), *Bradypterus lopezi* (S), *Bycanistes brevis* (S&M), *Bycanistes bucinator* (S&M), *Bubo vosseleri* (S), *Circaetus fasciolatus* (M), *Chrysococcyx cupreus* (S&M), *Coracina caesia* (S), *Cossypha natalensis* (S&M),*Cryptospiza reichenovii* (S&M), *Dicrurus ludwigii* (S&M), *Malaconotus nigrifrons* (S), *Mesopicos griseocephalus* (S), *Phyllastrephus placidus* (S&M), *Pogonocichla stellata* (S), *Sheppardia sharpei* (S), *Stephanoaetus coronatus* (S&M), *Tauraco livingstonii* (S&M), *Tockus alboterminatus* (S&M), *Zoothera gurneyi* (S)
Amphibians (45%)	*Afrixalus sp. nov?* (S), *Afrixalus uluguruensis complex* (S), *Arthroleptides yakusini* (S&M), *Arthroleptis cf. reichei* (S&M), *Callulina sp. nov* (S), *Hoplophyrne sp. nov* (S), *Hyperolius sp.(nov?)* (S), *Leptopelis flavomaculatus* (S), *Leptopelis uluguruensis* (S), *Leptopelis vermiculatus* (S), *Nectophrynoides tornieri* (S), *Nectophrynoides sp. nov 1* (S), *Nectophrynoides sp. nov 2* (S), *Phrynobatrachus udzungwensis* (S), *Probreviceps sp. nov* (S), *Probreviceps cf rungwensis* (S), *Stephopaedes loveridgei* (M), *Scoleocomorphus kirkii* (S)
Reptiles (20%)	*Kinyongia sp. nov?* (S&M), *Cnemaspis sp. nov* (S), *Cnemaspis africana* (S)*****, *Crotaphopheltis tornieri* (S), *Natriciteres sylvatica* (S), *Xyeledontophis sp.* (S)
Butterflies (29%)	*Acraea aganice* (S), *Acraea cerasa* (S), *Acraea johnstoni* (S), *Acraea pentapolis* (S), *Acraea satis* (S), *Amauris niavus* (S), *Bicyclus danckelmani* (S), *Bicyclus simulacris* (M), *Celaenorrhinus bettoni* (S), *Charaxes cithaeron* (S&M), *Charaxes xiphares* (S), *Cymothoe aurivilli* (S), *Euphaedra castanoides* (S), *Euphaedra orientalis* (M), *Eurema floricola* (S), *Euxanthe tiberius*, *Euxanthe wakefieldi* (M), *Graphium policenes* (S&M), *Lachnoptera iole ayresi* (S), *Neptis nina* (S), *Papilio dardanus* (S), *Papilio fuelleborni fuelleborni* (S), *Papilio pelodorus vesper* (S), *Papilio phorcas* (S), *Pseudacraea dolomena* (S), *Uranothauma delatorum* (S), *Uranothauma falkensteini* (S)

*****Records made by previous surveys, either listed in Burgess *et al.* (2007) or Loader *et al.* (2003).
Key: S=Sali FR; M=Mselezi FR; MM=Mahenge Mountains

8.1.4 Patterns of Species Distribution by Habitat and Altitude

Analyses were conducted for certain taxa (those with sufficient data and with a high number of different species) to establish patterns of species distribution and determine communities related to habitat (plant communities) across the study sites in the Mahenge Mountains; using TWINSPAN. Sali FR clearly hosts a significantly different butterfly and herpetofaunal community compared to Mselezi FR indicating a specialist Eastern Arc montane fauna, although there are aspects of overlap into the Mselezi FR community, which is likely to be a result of the presence of widespread species.

The Mahenge Mountains are thus shown to support several different species communities within the butterfly and herpetofaunal taxa as the mountains encompass a range of habitats and altitudes. The Mahenge Mountains hold three distinct communities of herpetofauna (semi-riverine forest, undifferentiated submontane forest and widespread lowland woodland); and three distinct communities of understory butterfly species (montane forest, wetland and dry woodland), as well as a separate canopy butterfly community that appears to be consistent throughout the mountain block.

8.1.5 Vertebrate Distribution following Altitudinal Gradients and Levels of Disturbance

Considering vertebrate species along altitudinal gradients and levels of disturbance at each work unit conducted within the Mahenge Mountains gives some interesting conclusions (fig. 55). As could be expected, disturbance (index given by percentage of 100m sections of disturbance transects within which some form of human disturbance occurred) was greatest at the most accessible and lowest altitude study site, Mselezi FR (600m asl). Here there was also the highest species richness, due to the large numbers of widespread open and savannah species (particularly birds) that were recorded. Species richness then decreased with increasing elevation, a typical Eastern Arc trend (e.g. Lovett & Wasser 1993; Poynton *et al.* subm.; Poynton 2003; Romdal 2001; Stuart *et al.* 1987).

However, when considering indices of conservation concern (represented by total numbers of species of conservation concern, total numbers of endemics and proportions of endemics), Mselezi FR was the most impoverished site. Within Sali FR, Work Unit 1 (1050m asl) was slightly richer than Work Unit 2 (1250m asl). This agrees with studies that have shown the mid-elevation zone (750m – 1250m asl) to hold the greatest number of endemics (Iverson 1991; Lovett 1996, 1999; Romdal 2001; Rosenzweig 1995), as higher levels of precipitation and productivity occur in this zone. Despite this, recent studies have suggested that the proportion of endemics for some taxa such as herpetofauna should increase with increasing altitude (Menegon & Salvidio 2005), although this is not supported by these results. However, because Sali covers a small elevation (1000m asl – 1500m asl) trends in altitudinal variation are less apparent and conclusions should be cautious.

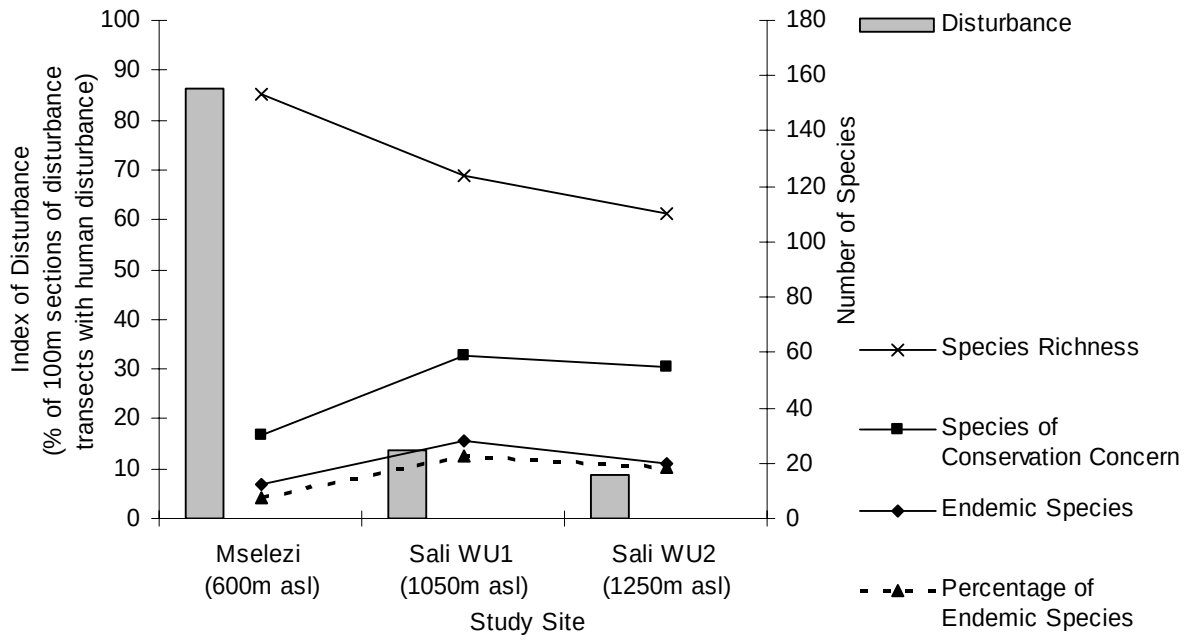


Figure 55: Vertebrate species in the Mahenge Mountains along altitudinal gradients and levels of disturbance

8.2 VEGETATION OF THE MAHENGE MOUNTAINS

Combining data collected by this study together with other previous collections in the Mahenge Mountains (Burgess *et al.* 2007; FTEA 1952-; Lovett *et al*. 2006; Lovett & Pócs 1993, Tropicos 2007) gives a total of 358 plant species (in 94 families) recorded in the Mahenge Mountains to date (table 58). Of these, 227 are tree species (in 59 families) and 131 species of other plant life forms (in 51 families). The current survey has therefore contributed to 33% of the total tree species records and 16% for other life forms in the Mahenge Mountains. This new data has greatly improved understanding of the botanical nature of the Mahenge Mountain block, with a particular emphasis on trees. Although collections for other plant life forms were not as comprehensive as for trees it has provided an insight to the botanical nature of the reserves. Relative to the two forest reserves studied, Sali and Mselezi, no previous botanical surveys have been published; therefore this comprehensive dataset can now provide a baseline for future monitoring and management.

Table 58: Plant species recorded in the Mahenge Mountains including previous records (Burgess et al. 2007; Lovett et al. 2006; Lovett & Pócs 1993; Tropicos 2007); categorised by species of conservation concern: endemic and threatened; new records for the Mahenge Mountains are shown in parentheses.

Life form	No. of Families	No. of species[a]	Endemic Species[b]	Potentially Threatened Species (2003)[c]	IUCN (2006)[d]	Forest Specialists	Total Species of Conservation Concern[e]
Trees	59	227 (75)	22 (8)	5 (2)	15 (9)	48 (28)	28 (12)
Other life forms	51	131 (21)	19 (2)	21 (2)	1 (0)	2 (1)	21 (2)
Total	94	358 (96)	41 (10)	27 (4)	16 (9)	50 (29)	49 (14)
% total of all species			11%	8%	4%	14%	14%

[a]Not all previous specimen records are present in the botanical appendices, only those of conservation concern are present, for information on other species see citied sources;
[b]Includes strict endemics, endemics and near endemics as distinctions between the categories were oftern not made in the literature;
[c]Species recognised as Potentially Threatened with extinction by Gereau & Luke (2003, revised 2006);
[d]Species recognised as threatened with extinction to varying degrees on the IUCN Red List, all plants listed are Vulnerable; excludes Data Deficient, Not Evaluated and Least Concern)
[e]Includes endemic species, Potentially Threatened species and IUCN Red Listed species; excludes forest-specialists;

8.2.1 Species Richness and Assemblages

This report demonstrates Sali and Mselezi FRs to be botanically very different. Sali FR consists of tree species that are mostly montane specialists with a few species that are widespread; and Mselezi FR holds tree species that are either exclusively lowland or occur in both lowland and montane areas. Endemic species can occur at a range of altitudes, often restricted to narrow altitudinal bands (Lovett *et al*. 2001). Therefore a mountain block such as Mahenge that comprises a number of forest reserves at a range of altitudes can potentially harbour a very high number of endemic species relative to its size. This has been demonstrated in relation to tree species, and it is likely to be true for other plant life forms, but more research is necessary for clarification. In relation to species assemblages and tree species richness it is difficult to compare Sali and Mselezi to other forest reserves due to a dearth of published comparative data.

Taking into account endemics and species with a threatened status (excluding forest specialists), 28 tree species are of conservation concern (12%) with a similar proportion for other plant life forms (21 species; 16%).

8.2.2 Endemism

The current survey recorded 13 Eastern Arc endemic tree species in the Mahenge Mountains, including the Mahenge endemic *Peddiea lanceolata*, eight of these species represent new records. Previous surveys have recorded another nine endemics within the block, giving a new overall total of 22 endemic tree species (10%) present in the Mahenge Mountains, of these one is a strict endemic, 17 are Eastern Arc endemics and 4 are near endemics (fig. 57; table 59).

Table 59: Endemic plants in the Mahenge Mountains by life form

Life Form	Mahenge Endemic	Eastern Arc Endemic	Near Endemic
Trees (10%)	*Peddiea lanceolata* (S)	*Allanblackia stuhlmannii* (S) *Alsodeiopsis schumannii* (S) *Baphia semseiana?* (S) *Beilschmiedia kweo?* (S&M) *Commiphora eminii subsp. trifoliolata** (M) *Craterispermum longipedunculatum?* (S) *Dicranolepis usambarica** (MM) *Erythrina sacleuxii** (MM) *Eugenia toxanatolica** (MM) *Garcinia semseii** (MM) *Memecylon schliebenii** (MM) *Octoknema orientalis** (MM) *Pavetta lynesii* (S&M) *Psychotria megalopus* (S) *Pterocarpus mildbraedii subsp. usambarensis** (MM) *Sibangea pleioneura* (S) *Vitex amaniensis?* (S)	*Bombax rhodognaphalon* (M) *Leptonychia usambarensis* (S) *Lettowianthus stellatus* (M) *Millettia elongatistyla** (MM)
Other Life Forms (15%)		*Anchomanes abbreviatus* (S&M) *Cyphostemma muhulense** (MM) *Dombeya amaniensis* (M) *Gravesia pulchra var. pulchra* (S) *Impatiens confusa subsp. longicornu* (S) *Impatiens joachimii** (S) *Impatiens mahengeensis** (MM) *Impatiens paludicola** (MM) *Impatiens saliensis** (S) *Ipomoea microcalyx** (S) *Lobelia longisepala** (M) *Meineckia grandiflora** (S) *Monanthotaxis dictyoneura** (S) *Parapentas silvatica subsp. silvatica** (MM) *Pavetta pócsii** (MM) *Psychotria pandurata** (S) *Thunbergia heterochondros** (M) *Tricalysia microphylla** (M) *Whitfieldia orientalis** (MM)	

*****Records made by previous surveys listed in one or more of the following sources: Burgess *et al.* (2007); Lovett *et al.* (2006); Lovett & Pócs (1993); Tropicos (2007);
Key: S=Sali FR; M=Mselezi FR; MM=Mahenge Mountains

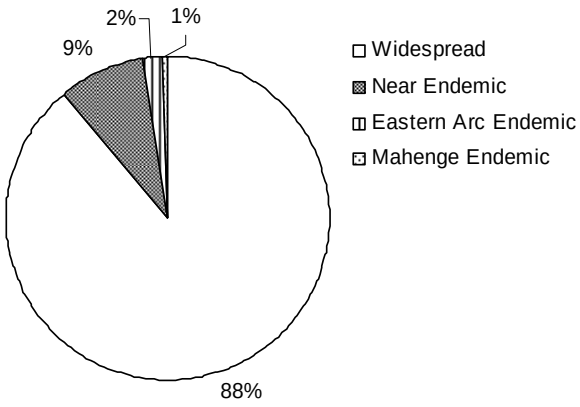


Figure 56: Tree endemism for the Mahenge Mountains

The Eastern Arc has 68 endemic tree species (Burgess *et al*. 2007) therefore the Mahenge Mountain block holds just under a third (32%). Mahenge is now the sixth most important Eastern Arc Mountain block in regard to numbers of endemic tree species; where previously Mahenge was ranked eighth (Burgess *et al*. 2007). Correcting for forest area raises Mahenge to the second most important mountain block after the East Usambaras (fig. 56); with 12.2 endemic tree species per square kilometre compared with 13.1 for the East Usambaras. During surveying, data for other plant life forms were collected only opportunistically, yet despite this four endemics were recorded, including two new records for the Mahenge Mountains. When previous data is also considered, a total of 19 endemics of other plant life forms have been recorded in the Mahenge Mountain block to date; however there is no comparable published data for other mountain blocks.

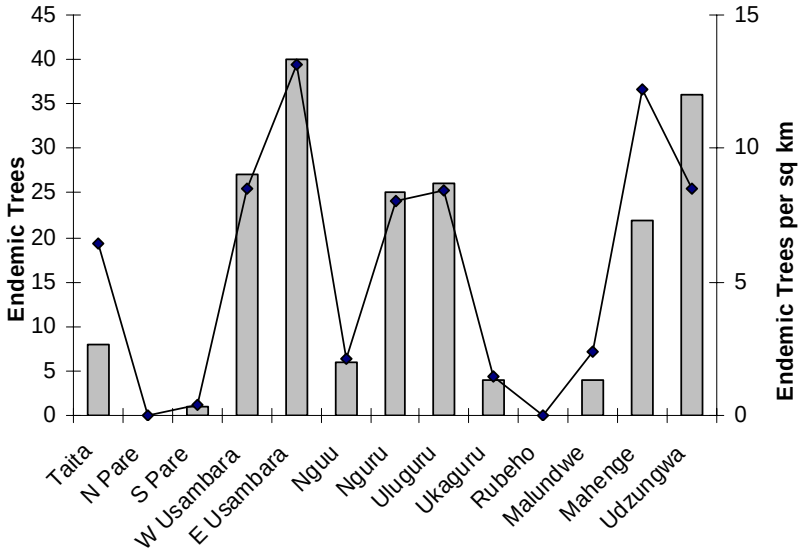


Figure 57: Ranked importance for endemic trees of the Eastern Arc Mountains (grey bars = summed species data; black lines and diamonds = species data corrected for forest area); the 13 mountain blocks are arranged left to right from north to south in the Eastern Arc.

8.2.3 Threatened Species

Several plant and tree species recorded in the Mahenge Block are listed as threatened (table 60) by the IUCN Red List or 'Potentially Threatened' by Gereau & Luke (2003). These include 15 IUCN Vulnerable tree species (7%), of which 3 had been recorded during previous surveys and 12 were recorded during this survey. For Potentially Threatened trees there are 5 species (2%) known to be present in Mahenge, 3 from this survey and 2 from previous studies. There is only one species (1%) of other plant life forms that are listed as Vulnerable by IUCN; this was recorded in the current survey. Mahenge records of Potentially Threatened life forms other than trees stands at 21 species (16%); including 18 previous records and an additional 3 records from this survey.

Table 60: Threatened plants in the Mahenge Mountains by life form

Life Form	IUCN Red List (2006) (Vulnerable)	Potentially Threatened (Gereau & Luke 2003, revised 2006)
Trees (7%)	*Allanblackia stuhlmannii* (S)	*Commiphora eminii subsp. trifoliolata** (M)
	Alsodeiopsis schumannii (S)	*Cylicomorpha parviflora* (S)
	Baphia semseiana? (S)	*Dicranolepis usambarica** (MM)
	Beilschmiedia kweo? (S&M)	*Monodora globiflora* (S)
	Craterispermum longipedunculatum? (S)	*Peddiea lanceolata* (S)
	*Garcinia semseii** (MM)	
	*Khaya anthotheca** (M)	
	Lettowianthus stellatus (M)	
	*Millettia elongatistyla** (MM)	
	Morinda asteroscepa? (S)	
	Premna schliebenii (M)	
	Pavetta lynesii (S&M)	
	Psychotria megalopus (S)	
	Sibangea pleioneura (S)	
	Vitex amaniensis? (S)	
Other Life Forms (16%)	*Dombeya amaniensis* (M)	*Anchomanes abbreviatus* (S&M)
		*Coccinia schliebenii** (MM)
		*Cyphostemma muhuluense** (MM)
		Gravesia pulchra var. pulchra (S)
		Impatiens confusa subsp. longicornu (S)
		*Impatiens joachimii** (S)
		*Impatiens mahengeensis** (MM)
		*Impatiens paludicola** (MM)
		*Impatiens saliensis** (S)
		*Ipomoea microcalyx** (S)
		Justicia interrupta (S)
		*Lobelia longisepala** (M)
		*Meineckia grandiflora** (S)
		*Monanthotaxis dictyoneura** (S)
		*Parapentas silvatica subsp. silvatica** (MM)
		*Pavetta Pócsii** (MM)
		*Psychotria pandurata** (S)
		*Thunbergia heterochondros** (M)
		*Tricalysia microphylla** (M)
		*Uvaria acuminata** (M)
		*Whitfieldia orientalis** (MM)

*****Records made by previous surveys listed in one or more of the following sources: Burgess *et al.* (2007); Lovett *et al.* (2006); Lovett & Pócs (1993); Tropicos (2007);
Key: S=Sali FR; M=Mselezi FR; MM=Mahenge Mountains

8.2.4 Tree Distribution following Altitudinal Gradients and Levels of Disturbance

The current survey has demonstrated the high number of endemic and threatened plants present in the Mahenge Mountains. As the Mahenge Mountain block forest reserves are at range of altitudinal levels and endemics are restricted to narrow altitudinal bands, the Mahenge Mountains could potentially conserve a relatively high number of plant endemics for its small size.

Tree species relative to levels of disturbance were assessed by using an index given by the percentage of 100m sections of disturbance transects within which human disturbance occurred, this was then compared between the three work units (fig. 58). Sali Work Unit 1 displayed significantly reduced species richness and endemism, and held fewer numbers of threatened species in comparison with Work Unit 2. This is most likely due to its easy accessibility, as it is in an area of comparatively low altitude, and therefore there is a greater probability of human and large mammal disturbance. This is further demonstrated by the regeneration analysis where higher numbers of canopy species were observed regenerating in Work Unit 2 in comparison to Work Unit 1 suggesting a lower level of disturbance. Considering these regeneration differences, together with species richness and numbers of species of conservation concern, it seems likely that disturbance has previously been more intense and widespread around Work Unit 1 than recorded by the current survey. This reiterates the vulnerability of the lower altitudes of Sali FR; where without sufficient protection and management, degradation will continue to occur.

The level of tree species richness and endemism in Sali FR Work Unit 1 was similar to that of the Mselezi FR, although there were slightly higher numbers of threatened tree species than in Sali. This was surprising as Work Unit 1 in Sali had a much lower level of disturbance; this would again emphasise the fact that lower altitudes in Sali FR have been subjected to disturbance in the past. It may also suggest that despite a great loss of forest cover and high levels of disturbance Mselezi FR is species rich and has numerous endemics and threatened plant species; with rigorous and intensive management it could once again return to a good quality forest reserve.

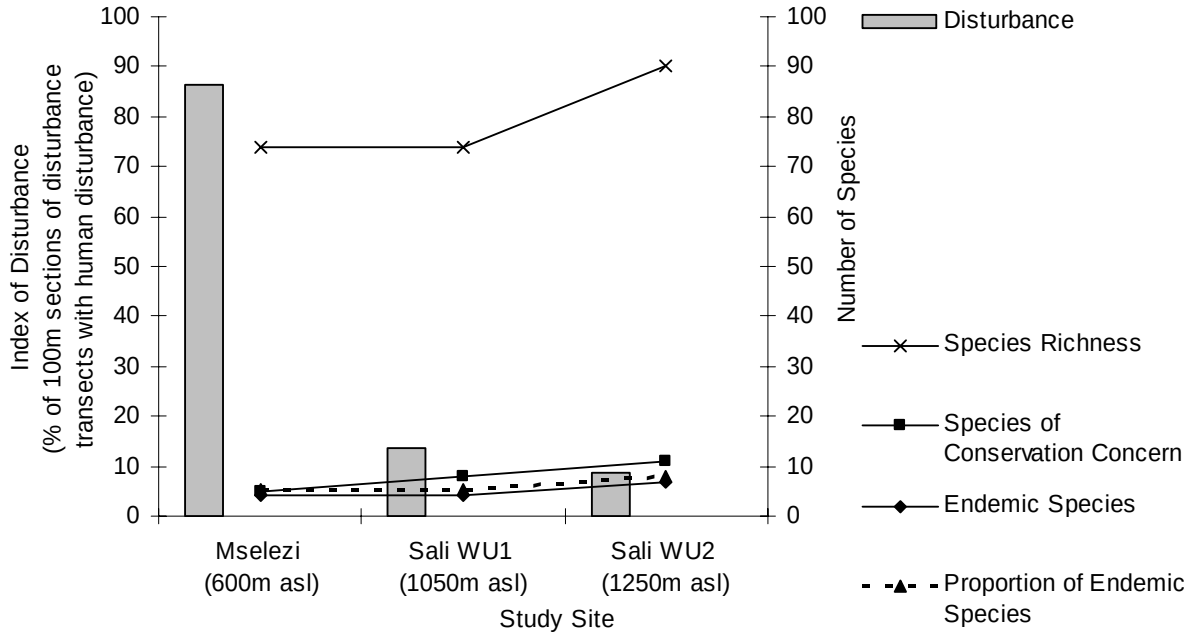


Figure 58: Tree species in the Mahenge Mountains along altitudinal gradients and levels of disturbance

8.3 HUMAN RESOURCE USE AND DISTURBANCE IN THE MAHENGE MOUNTAINS

The growing human population within the Mahenge Mountains is resulting in an increased demand on natural resources, and is a pressing threat. Illegal activities are rife in Mselezi FR, where human settlements are located within and adjacent to the reserve, although Sali FR's remoteness has so far hindered major human activity. Major activities within the forests of the Mahenge Mountains include hunting, fire, small-scale cultivation, and wood extraction; less common activities include mining and settlements. Many of the problems faced by these reserves are typical of those pressuring other Eastern Arc forest reserves, stemming from a lack of investment in local communities and law enforcement.

8.4 COMMUNITY KNOWLEDGE OF THE MAHENGE MOUNTAINS

The communities in the Mahenge Mountains appear enthusiastic to learn more about the importance of their forests. A common trend appears to be that the management and protection of the reserve by local communities is suppressed by a lack of resources. Currently, no local livelihoods rely directly on the forests remaining in a pristine state, meaning there is little economic incentive for community participation. Communities have expressed a desire for additional support to help with management; better communication facilities to allow prosecution of those who break the law; and also training and awareness raising to increase understanding of the participatory management process. Although local people appreciate that the forest needs protecting, there is still some confusion over the purpose of the reserve, therefore environmental education to raise awareness of the importance of catchment forest reserves is essential. Communities surrounding Sali FR were keen to participate in the JFM scheme, yet the communities surrounding Mselezi FR appeared disillusioned with the lack of support they had received in implementing the JFM contract.

8.5 MANAGEMENT PRIORITIES FOR THE MAHENGE MOUNTAINS

Management strategies in catchment forest reserves are primarily based on the need to protect water supplies rather than specifically for biodiversity conservation, aims that are mutually compatible to the extent that both rely on the prevention of deforestation and illegal exploitation of forest reserve resources. However precedence is currently granted to catchment value preservation through rapid afforestation rather than conservation orientated practices such as regulating illegal hunting. Resource demand is increasing in proportion to population growth, and impacting most severely on those reserves with peripheral or included human settlements, such as Mselezi FR.

The Joint Forest Management scheme has admirable aims and if implemented correctly should achieve a significant level of success. However, the current JFM contract for Mselezi FR has not put into place any conservation or management measures due to a lack of support by government representatives and a lack of understanding regarding its meaning and implementation within the local community. It has been suggested that one reason for this is the lack of financing for forest officers to visit outlying forest reserves and their peripheral communities, which is vital if these officers are to provide advice, education, support and law enforcement. After the WWF-TPO capacity building workshop, FBD agreed to station dedicated Forestry Officers at each village to facilitate this.

Current management priorities for the Mahenge Mountains should include environmental education, boundary demarcation, and the implementation of the Joint Forest Management scheme, applied in current contracts and expanded to other forest reserves in the area. Management plans need to involve and be developed in conjunction with the local communities, to reduce illegal activities and provide alternative resources in order to address current conservation issues, as initiated by the WWF-TPO capacity building workshop. This is a first step in raising awareness among local communities and generating interest, involvement and incentives on their part to conserve, protect and sustainably manage their forest reserves and resources.

In terms of conservation priorities, Sali FR offers most potential for successful conservation of the widest range of Eastern Arc species. The surveys in Sali FR have been conducted before human resource use and disturbance have grown to significant levels, providing an exceptional opportunity to conserve this forest and maintain its pristine nature. There may even be some scope for limited and regulated eco-tourism in Sali FR, which is pristine forest with spectacular scenery, gigantic trees and opportunities to spot wildlife. Although very few species of conservation concern were found in Mselezi FR alone, species of conservation concern confined to lower altitude Eastern Arc forest reserves are more vulnerable to disturbance and therefore more conservation efforts are needed to preserve these reserves; to ensure that a range of altitudinal Eastern Arc forests and their associated species are conserved. In addition, the association between the hyrax species and the fact that the reserve is a transitional state between coastal and montane forest provides an incentive for further research and conservation. However, conservation measures may be too late for Mselezi FR, which has been exploited almost beyond redemption. Nevertheless there is potential for Mselezi to be the basis for a pilot forest regeneration project as part of the JFM scheme. The interesting biodiversity findings in Mselezi and the human need for this catchment forest to be preserved for the environmental services it offers does mean that conservation of this area continues to be a necessity and immediate action needs to be taken to ensure this forest has a future.

8.6 CONCLUSIONS FOR THE MAHENGE MOUNTAINS

The limited previous scientific work and incomplete species inventories conducted in the Mahenge Mountains, combined with the small and fragmented areas of forest remaining, mean that Mahenge has ranked low on the list of conservation priorities for the Eastern Arc (CEPF 2005, Burgess *et al.* 2007). Assessments of the Mahenge Mountains previously described the area as containing one single block endemic vertebrate species, one Eastern Arc endemic vertebrate, nine Eastern Arc near endemic vertebrates, and six Eastern Arc endemic trees (Burgess *et al.* 2007; Mariaux & Tilbury 2006). Despite this, as part of the Eastern Arc the Mahenge Mountains were expected to contain many more species of interest and further work was deemed necessary to enable an accurate update and assessment of conservation priority.

This study has significantly improved our knowledge of the Mahenge Mountains and increased the conservation importance of this area, with an increased number of vertebrate and plant endemics that can now be attributed to Mahenge and that represent new records for this mountain block (table 61). The two reserves surveyed demonstrated the diverse nature of the block, which encompasses a range of altitudes.

Comparing the Mahenge Mountains with other Eastern Arc Mountain blocks using figures and methods from Burgess *et al.* (2007) illustrates the dramatic increase in conservation importance of the Mahenge Mountains based on results from this survey.

Considering numbers of endemic vertebrates (36 species; 14.4%; 7 strict endemics, 7 Eastern Arc endemics and 22 near endemics; including the discovery of up to six species that are new to science), Mahenge rises to seventh most important; but incorporating a measure of forest area into ranking analyses raises the Mahenge Mountains to fourth most important Eastern Arc mountain block (after the Ulugurus, East Usambaras and Udzungwas). For threatened vertebrate species the Mahenge Mountains rises to fifth most important from twelfth. For endemic butterflies the Mahenge Mountains rises to second most important after the Rubehos.

Mahenge holds 22 endemic tree species, representing just over a third of all Eastern Arc endemic trees. Once forest area is corrected for Mahenge becomes second in terms of biological importance for Eastern Arc endemic tree species, only less significant than the East Usambaras. This is reiterated by the high number of endemics of other plant life forms as well as numbers of Potentially Threatened and Red Listed plant species. The fact that reserves within the Mahenge Mountains are at a range of altitudinal habitats gives potential for the block to harbour numerous endemic plants.

Table 61: Faunal vertebrate and plant endemics in the Mahenge Mountains: listing previous records (from Burgess et al. (2007); Loader et al.(2003); Lovett et al. (2006); Lovett & Pócs (1993); Tropicos (2007); new records from this survey shown in parentheses; and subsequent new total for the Mahenge Mountains

	FAUNAL VERTEBRATE ENDEMICS				
	Mahenge Mtn Endemics	**EA Endemics**	**Near Endemics**	**Total Endemics**	**PLANT ENDEMICS**
Previous surveys	1	1	9	11	31
BREAM	7 (6)	7 (6)	22† (11)	36 (23)	17 (10)
New Mahenge total	7	7	22	36	41

†This includes two species that were not classed as near endemics in Burgess *et al.* (2007) but that leading experts in the field have now reclassified. For comparison purposes with other mountain blocks using figures from Burgess *et al.* (2007) these two species are excluded.

The research conducted in Sali and Mselezi forest reserves provides a concrete baseline dataset for monitoring purposes, enabling future assessments of changes in biodiversity values and human resource use over time, as well as furthering scientific knowledge of the Eastern Arc as a whole. The majority of the species of conservation concern were recorded solely from Sali FR making this a priority site within the Mahenge Mountains; but although Mselezi FR was less diverse the species documented therein are also worthy of scientific interest and conservation concern.

Further research is necessary as thorough and comprehensive botanical and faunal surveys of the other forest reserves in the Mahenge Mountain block (Muhulu, Nawenge, Mahenge Scarp, Myoe, Ligamba) are needed to produce a clearer picture of the nature of the mountain block and its importance within the Eastern Arc. Also necessary is more detailed botanical surveys of the plant life forms other than tree species in both Sali and Mselezi FRs as this survey only touched on their nature, however this study has indicated it to be diverse and of conservation value in the Eastern Arc. Conservation of the remaining Mahenge Mountain forests is vital to the preservation of the endemic and newly discovered species found in this mountain block. The biodiversity conservation and management of the Mahenge Mountain block should be reassessed in the light of these new findings and given support; both from the governmental FBD and from non-governmental organisations who can facilitate management within this area.

9. ANNEXES

ANNEX 1: MAPS

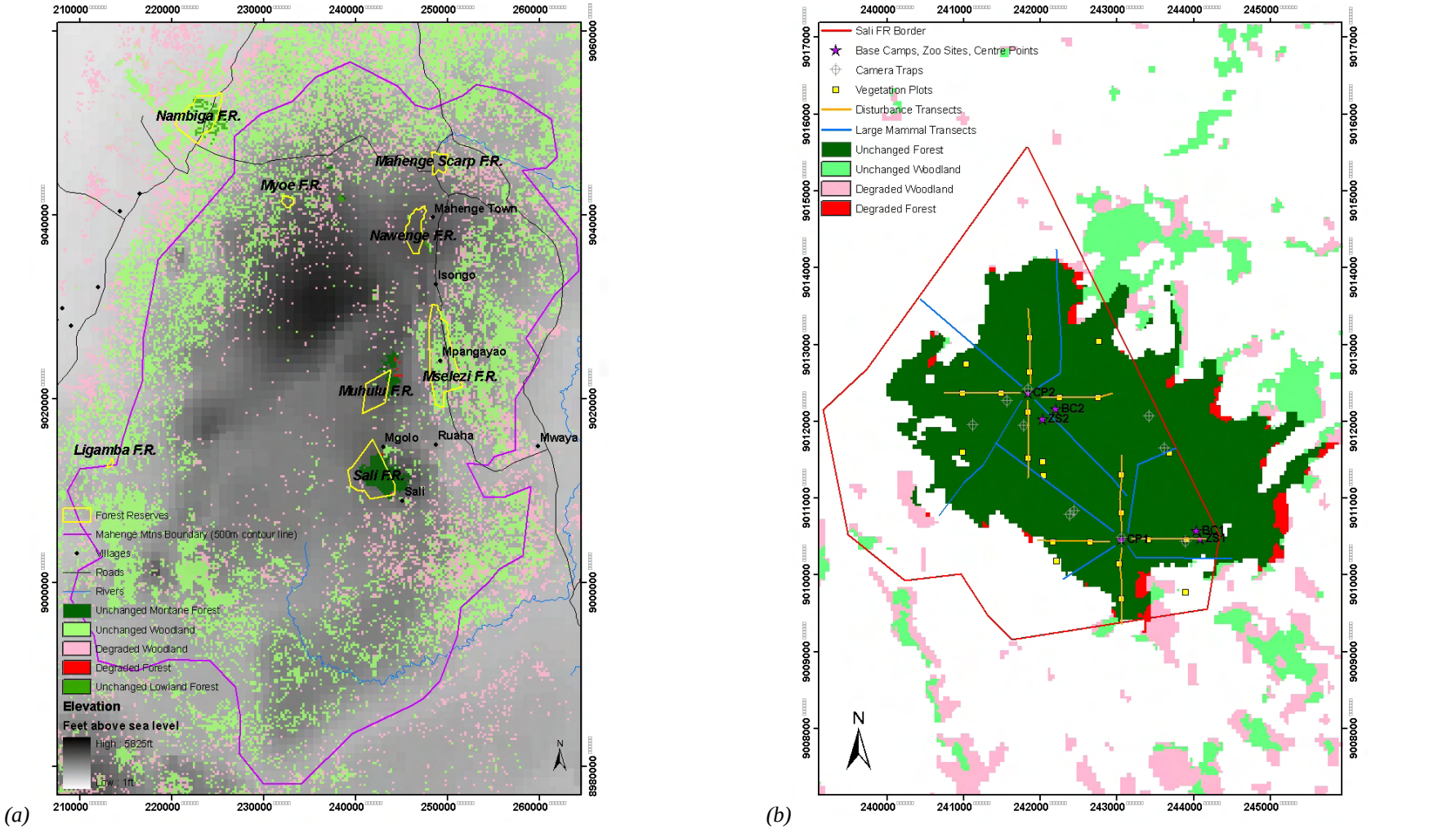
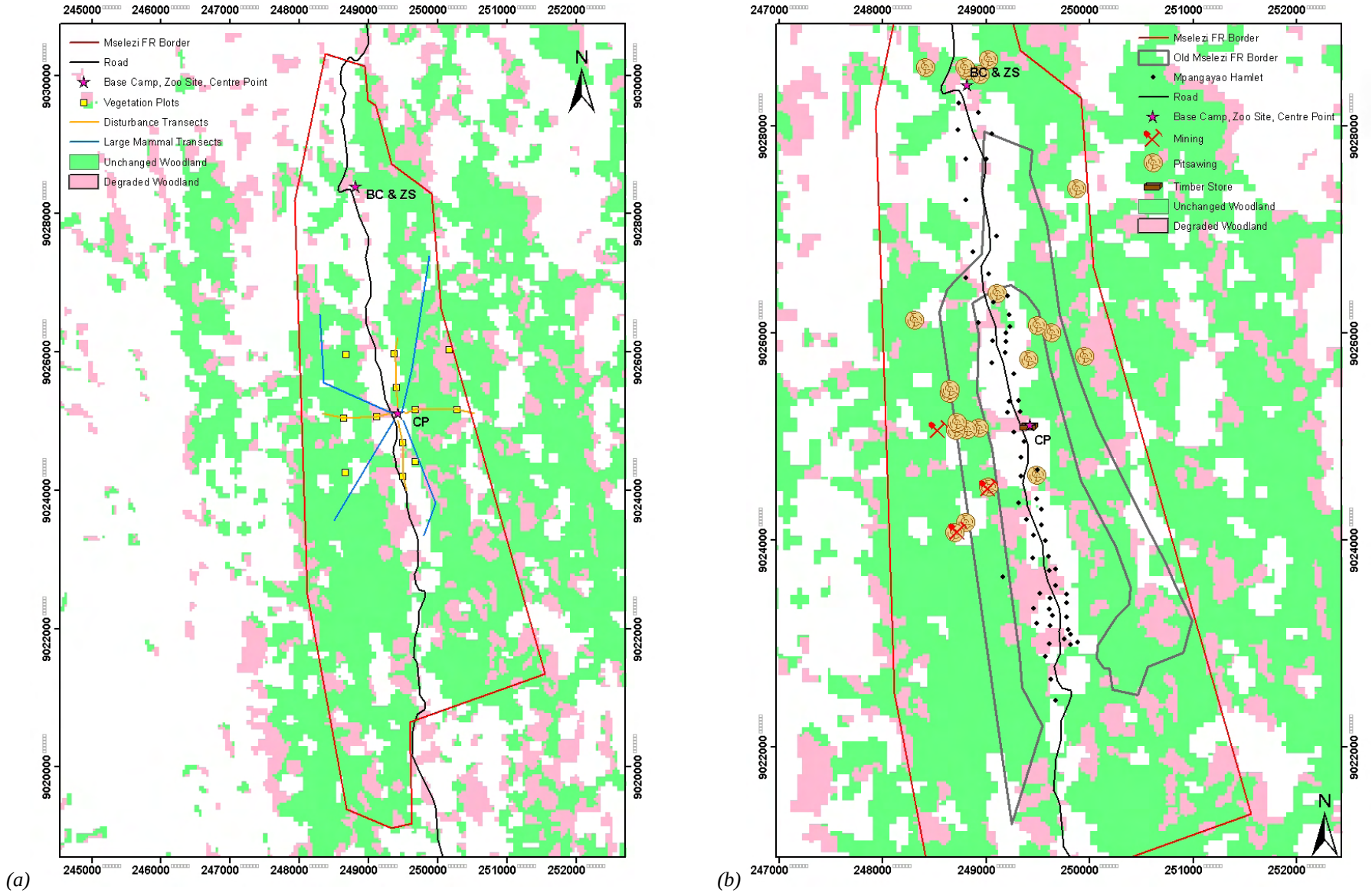


Figure 59: (a) The Mahenge Mountains showing forest reserves and change in forest and woodland cover between 1970's - 2000 (based on information from CMEAMF 2006) (b) Map of Sali FR showing work units and camera traps



(a) *(b)*

Figure 60: (a) Map of Mselezi FR showing work unit (b) Map of Mselezi FR showing major forms of human disturbance (pitsaw sites, mining, timber stores) and settlements

ANNEX 2: PHOTOGRAPHS

2a: Sali Forest Reserve

(a) Cephalophus harveyi

(b) Rhynchocyon cirnei reichardi

(c) Galagoides granti

Figure 61: Mammalian species records for the Mahenge Mountains
(a) The Mahenge population of C. harveyi has typical facial markings but no dark markings on the legs, unlike the nearest population of C. harveyi (Udzungwas); (b) The sub-species of sengi present in the Mahenge Mountains follows predicted distribution patterns (G. Rathbun pers.comm.); (c) G.granti was the only galago species identified as being present in the submontane forests of Sali FR; although O.crassicaudatus was also present in Mselezi FR..

(a) Xyeledontophis sp.

(b) Cnemaspis sp. nov

(c) Kinyongia sp. nov?

(d) Probreviceps sp. nov

(e) Callulina sp. nov

(f) Hyperolius sp. (nov?)

Figure 62: Some amphibian and reptile species of interest in the Mahenge Mountains.

(a) The genus Xyeledontophis is known only from one species from the Ulugurus (X. uluguruensis), this specimen would be a significant range extension or may even be a new species; (b) (c) (d) (e) are thought to be new to science based on preliminary morphological and genetic analyses;(f) Hyperolius species are variable and difficult to identify, thus the taxonomic status of this species is currently under investigation.

(a) Buffalo snare

(b) Fire damage within Sali FR

(c) The BREAM team.

Figure 63: Human disturbance in Sali FR was primarily hunting and fire damage
(a) Large migratory mammals such as buffalo are hunting targets, snares for medium sized mammals (duiker) and small mammals (rodents) were also documented; (b) Gongo peak lies within Sali FR, on arrival at the forest reserve this peak was forested, on departure extensive fires (probably lit to clear ground for cultivation) had entered, destroyed parts of the forest and cleared the peak; (c) The pristine nature of the submontane forest in Sali FR is illustrated by the ancient tree used as a backdrop for the BREAM team photograph. Many trees of enormous diameter were present in the forest, preserved from pitsawing by the remoteness of the forest.

2b: Mselezi Forest Reserve

(a) View of Mselezi FR

(b) Hidden store of planks in Mpangayao hamlet within Mselezi FR.

(c) Fire damage and cultivation on the western ridge-top within Mselezi FR.

(d) 'Squash' trap for medium sized mammals e.g. hyrax

Figure 64: Human disturbance was rife throughout Mselezi FR.

(a) Cultivation is permitted within 10m of the road running through the reserve but farmland extending beyond this is clearly visible in this view of Mselezi FR, as is scrub and secondary forest resulting from old disturbance, villagers claim they did not know the recent variation order now includes the valley floor within the reserve; (b) Many pitsawing sites were documented in Mselezi FR as well as two hidden stores of planks from these operations; (c) The local people were unaware of the forest boundary on several sides, the ridge-top in the west is included in the reserve yet clearance for cultivation was ongoing here, the villager claimed that the forest reserve only covered the slopes; (d) Low populations of animals in the FR can be attributed to high levels of hunting (as well as habitat loss); all species appeared to be targeted in a variety of different traps and snares.

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11. APPENDICES

APPENDIX 1: TAXONOMISTS

BOTANY

Mr. Y. Abeid Mr. R. Abdallah	Frontier Tanzania	P.O. Box 9473, DSM, Tanzania frontier@africaonline.co.tz
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Mr. Q. Luke	East African Herbarium	Nairobi, Kenya quentin.luke@swiftkenya.com
Mr. R. Gereau	Missouri Botanical Gardens	Missouri, USA Roy.Gereau@mobot.org

ZOOLOGY

Prof. K. M. Howell	University of Dar es Salaam	Department of Zoology P.O. Box 35064, DSM, Tanzania kmhowell@udsm.ac.tz

Mammals:

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Dr. W. Stanley	Chicago Field Museum	Mammal Section, Field Museum, Chicago, IL, 60605, USA stanley@fieldmuseum.org
Dr. G. Rathbun	California Academy of Sciences	California, USA grathbun@calacademy.org

Herpetofauna

Mr. M. Menegon	Museo Tridentino Di Scienze Naturali	Trento, Italy menegon@mtsn.tn.it
Prof. J. Poynton Dr. Simon Loader	British Natural History Museum	Cromwell Road, North Kensington, London, UK poynton@ukonline.co.uk

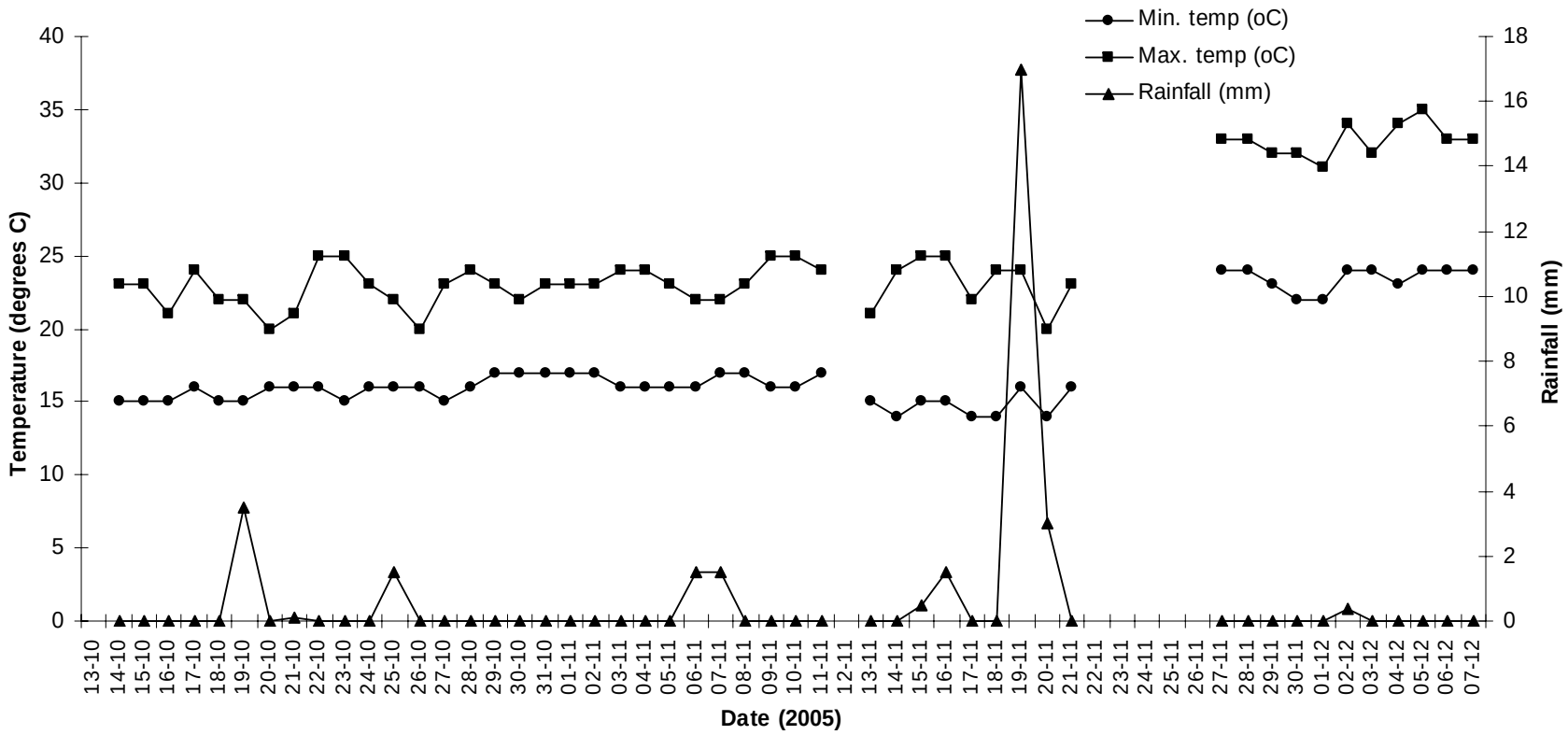
Butterflies:

Mr. Colin Congdon Mr. Steve Collins	African Butterfly Research Institute	Nairobi, Kenya colin.congdon@tiscali.co.uk scollins@iconnect.co.ke

Birds:

Mr. J. Kiure	Zoological Museum of Copenhagen	Copenhagen, Denmark j_kiure@yahoo.com

APPENDIX 2: WEATHER



Sali FR

Training Period	13th October 2005 – 29th October 2005	
Work Unit 1	30th October 2005 – 11th November 2005	1050m asl
Work Unit 2	12th November 2005 – 22nd November 2005	1250m asl

Mselezi FR

Work Unit 1	25th November 2005 – 6th December 2005	600m asl

APPENDIX 3: GPS CO-ORDINATES

3a: Basecamps, Centre-Points, Zoological Sites

Site	Description of location	Longitude (S)	Latitude (E)	Grid ref UTM/UPS (E)	Grid ref UTM/UPS (N)	Altitude (m asl)
Sali CP1	Primary submontane forest near ridge-top	08° 56' 46.5"	036 ° 39' 48.4"	0243068	9010365	1100
Sali ZS1	Primary high canopy submontane forest, 1.5hrs walk from Sali village	08° 56' 46.3"	036° 40' 22.0"	0244097	9010377	1050
Sali BC1	Primary submontane forest	08° 56' 43.0"	036° 40' 20.4"	0244046	9010480	1050
Sali CP2	Primary submontane forest on ridge-top	08° 55' 44.1"	036° 39' 8.9"	0241850	9012275	1270
Sali ZS2	Dense low canopy submontane forest near to open wetland, in the northern more inaccessible part of the reserve	08° 55' 55.2"	036° 39' 15.2"	0242044	9011934	1250
Sali BC2	Primary submontane forest	08° 55' 51.0"	036° 39' 20.8"	0242214	9012065	1250
Mselezi CP1	Lowland forest/secondary scrub in the centre of the reserve near the road	08° 48' 47.9"	036° 43' 19.5"	0249435	9025022	550
Mselezi ZS1	Lowland/riverine forest in the north end of the reserve, near the road	08° 47' 03.8"	036° 43' 00.4"	0248826	9028308	550
Mselezi BC1	Lowland/riverine forest	08° 47' 03.8"	036° 43' 00.4"	0248826	9028308	550

3b: Camera Traps in Sali FR

Camera Trap	Description of location	Longitude (S)	Latitude (E)	Grid ref UTM/UPS (E)	Grid ref UTM/UPS (N)	Altitude (m asl)
Vision Scout 1	Closed dense forest, on gentle mid slope	08° 52' 48.6"	36° 24' 12.4"	0243906	9010338	1155
Vision Scout 2	Large animal ridgetop trail, semi-closed forest with grasses	08° 51' 58"	36° 21' 15.7"	0243428	9011970	1400
Vision Scout 3	Small duiker trail, closed dense forest	08° 51' 9.3"	36° 18' 57.1"	0242393	9010690	1400
Vision Scout 4	Large animal ridgetop trail, semi-closed forest with grasses	08° 51' 48.2"	36° 15' 1.6"	0241579	9012171	1300
Vision Scout 5	Several converging duiker trails, closed dense forest	08° 51' 40.0"	36° 16' 1.1"	0241797	9011846	1350
CamTrakker 11	Small duiker trail, near large gaps, open regenerating forest	08° 51' 46.9"	36° 22' 16.4"	0243630	9011557	1300
CamTrakker 12	Small duiker trail, closed dense forest with large gap nearby	08° 51' 11.3"	36° 19' 5.8"	0242450	9010740	1400
CamTrakker 13	Small duiker trail near ridge-top, open forest	08° 51' 5.6"	36° 21' 25.3"	0243068	9010385	1340
CamTrakker 14	Small duiker trail, steep upper slope, closed dense forest	08° 51' 34.5"	36° 13' 48.5"	0241125	9011855	1320
CamTrakker 15	Several converging duiker trails, regenerating forest	08° 51' 55.2"	36° 15' 47.3"	0241850	9012320	1275

3c: Large Mammal Transects

Transect	Description of location	Longitude (S)	Latitude (E)	Grid ref UTM/UPS (E)	Grid ref UTM/UPS (N)	Altitude (m asl)
Sali LM T1	Along LMT1 North East WU1	08° 56' 14.3"	036° 39' 55.5"	0243279	9011338	1389
Sali LM T1	End of Sali LMT1 North East WU1	08° 56' 07.4"	036° 40' 11.9"	0243779	9011570	1471
Sali LM T2	End of Sali LMT2 South East WU1	08° 56' 51.9"	036° 40' 35.8"	0244522	9010117	1100
Sali LM T3	End of Sali LMT3 South West WU1; outside the forest edge	08° 57' 0.1"	036° 39' 23."	0242300	9009850	1350
Sali LM T4	Start of Sali LMT4 North West WU1	08° 56' 43.3"	036° 39' 45.1"	0242967	9010468	1370
Sali LM T4	End of Sali LMT4 North West WU1	08° 56' 04.9"	036° 39' 54.4"	0241411	9011634	1415
Sali LM T5	Start of Sali LMT5 North East WU2	08° 56' 41.3"	036° 39' 13.2"	0241980	9012350	1250
Sali LM T5	Along Sali LMT5 North East WU2	08° 55' 32.7"	036° 39' 22.4"	0242265	9012538	1300
Sali LM T5	Along Sali LMT5 North East WU2	08° 55' 21.7"	036° 39' 23"	0242280	9012875	1300
Sali LM T5	Along Sali LMT5 North East WU2	08° 54' 53.7"	036° 39' 21.4"	0242227	9013735	1340
Sali LM T5	End of Sali LMT5 North East WU2	08° 55' 46.0"	036° 39' 21.1"	0242212	9014152	1493
Sali LM T6	Start of Sali LMT6 South East WU2	08° 55' 43.8"	036° 39' 11.4"	0241930	9012195	1300
Sali LM T6	Along Sali LMT6 South East WU2	08° 56' 16.7"	036° 39' 43.3"	0242914	9011188	1350
Sali LM T6	End of Sali LMT6 South East WU2	08° 56' 27.8"	036° 39' 50.5"	0243131	9010939	1320
Sali LM T7	Along Sali LMT7 South West WU2	08° 56' 14.4"	036° 38' 48.4"	0241260	9011341	1439
Sali LM T7	Along Sali LMT7 South West WU2	08° 56' 21.7"	036° 38' 41.3"	0241013	9011114	1385
Sali LM T7	End of Sali LMT7 South West WU2; outside the forest edge	08° 56' 36.0"	036° 38' 30.4"	0240684	9010672	1342
Sali LM T8	End of Sali LMT8 North West WU2; outside the forest edge	08° 55' 1"	036° 38' 23.2"	0240450	9013500	1350
Mselezi LM T1	Start of Mselezi LMT1 North East	08° 48' 47.7"	036° 43' 21.3"	0249491	9025028	565
Mselezi LM T1	Along Mselezi LMT1 North East	08° 48' 29.7"	036° 43' 26.2"	0249632	9025674	660
Mselezi LM T1	End of Mselezi LMT1 North East	08° 47' 33.8"	036° 43' 34.6"	0249883	9027304	770
Mselezi LM T2	Start of Mselezi LMT2 South East	08° 48' 47.5"	036° 43' 20.8"	0249473	9025036	560
Mselezi LM T2	End of Mselezi LMT2 South East	08° 49' 48.3"	036° 43' 31.0"	0249794	9023261	550
Mselezi LM T3	Start of Mselezi LMT3 South West	08° 48' 54.5"	036° 43' 17.0"	0249372	9024924	540
Mselezi LM T3	End of Mselezi LMT3 South West	08° 49' 40.6"	036° 42' 40.5"	0248508	9023484	850
Mselezi LM T4	Along Mselezi LMT4 North West	08° 48' 33.3"	036° 42' 44.6"	0248366	9025467	820
Mselezi LM T4	End of Mselezi LMT4 North West	08° 48' 1.3"	036° 42' 42.7"	0248300	9026450	730

3d: Vegetation Plots

Vegetation Plot	Description of location	Longitude (S)	Latitude (E)	Grid ref UTM/UPS (E)	Grid ref UTM/UPS (N)	Altitude (m asl)
Sali VP 5	250m along DT3 S WU1	08° 56' 56.8"	036° 39' 47.4"	0243039	9010047	1360
Sali VP 6	750m along DT3 S WU1	08° 57' 11.6"	036° 39' 48.3"	0243070	9009593	1080
Sali VP 7	250m along DT4 W WU1	08° 56' 47.2"	036° 39' 35.1"	0242662	9010340	1300
Sali VP 8	750m along DT4 W WU1	08° 56' 47.1"	036° 39' 19.1"	0242172	9010340	1500
Sali VP 9	NE quadrant WU1	08° 56' 6.7"	036° 40' 9.1"	0243700	9011500	1340
Sali VP 10	SE quadrant WU1	08° 57' 5.9"	036° 40' 15.6"	0243908	9009682	1160
Sali VP 13	250m along DT5 N WU2	08° 55' 32.2"	036° 39' 9.6"	0241875	9012550	1240
Sali VP 14	750m along DT5 N WU2	08° 55' 17.7"	036° 39' 9.7"	0241875	9012995	1250
Sali VP 15	250m along DT6 E WU2	08° 55' 43"	036° 39' 22.3"	0242264	9012222	1250
Sali VP 16	750m along DT6 E WU2	08° 55' 43.1"	036° 39' 38.7"	0242764	9012222	1320
Sali VP 22	SE quadrant WU2	08° 55' 13.2"	036° 39' 15.1"	0242045	9011381	1300
Sali VP 23	SW quadrant WU2	08° 56' 6"	036° 38' 40.8"	0240999	9011506	1280
Sali VP 24	NW quadrant WU2	08° 55' 28.5"	036° 38' 42.5"	0241045	9012658	1200
Mselezi VP 1	250m along DT1 N	08° 48' 38.6"	036° 43' 19.2"	0249418	9025400	590
Mselezi VP 2	750m along DT1 N	08° 48' 22.8"	036° 43' 17.9"	0249377	9025884	630
Mselezi VP 4	750m along DT2 E	08° 48' 49.3"	036° 43' 47.6"	0250289	9025075	600
Mselezi VP 5	250m along DT3 S	08° 49' 04.5"	036° 43' 21.8"	0249502	9024604	550
Mselezi VP 6	750m along DT3 S	08° 49' 20.6"	036° 43' 21.9"	0249509	9024108	540
Mselezi VP 7	250m along DT4 W	08° 48' 52.2"	036° 43' 09.6"	0249127	9024980	550
Mselezi VP 8	750m along DT4 W	08° 48' 52.9"	036° 42' 53.9"	0248649	9024955	660
Mselezi VP 9	NE quadrant	08° 48' 20.9"	036° 43' 44.5"	0250179	9025946	780
Mselezi VP 10	SE quadrant	08° 49' 13.5"	036° 43' 27.7"	0249686	9024328	580
Mselezi VP 11	SW quadrant	08° 49' 18.6"	036° 42' 54.5"	0248672	9024165	773

3e: Disturbance Observations

Disturbance Type	Description	Longitude (S)	Latitude (E)	Grid ref UTM/UPS (E)	Grid ref UTM/UPS (N)	Altitude (m asl)
Timber store	Hidden store of timber 50m NW of CP in Mselezi FR	08° 48' 51.4"	036° 43' 19.2"	249421	9025006	543
Pitsawing	Old pitsaw site *Excelsa milicia* (Mvule), 1year old along DT1 N in Mselezi FR	08° 48' 27.3"	036° 43' 19.1"	249418	9025656	550
Pitsawing	Recent pitsaw site with 80 cut timbers along DT4 W in Mselezi FR	08° 48' 50.8"	036° 43' 03.3"	248936	9024989	550
Pitsawing	Old pitsaw site along DT4 W in Mselezi FR	08° 48' 52.3"	036° 42' 59.7"	248827	9024975	550
Pitsawing	Old pitsaw site along DT4 W in Mselezi FR	08° 48' 52.4"	036° 42' 55.9"	248708	9024971	550
Pitsawing	Recent pitsaw site along LMT1 NE in Mselezi FR	08° 47' 36.7"	036° 43' 34.8"	249883	9027304	740
Pitsawing	Pitsaw site along LMT1 NE in Mselezi FR	08° 48' 19.7"	036° 43' 28.6"	249503	9025982	640
Pitsawing	Recent pitsaw site along LMT3 SW in Mselezi FR; *Albizia* sp.	08° 49' 10.3"	036° 43' 06.3"	249031	9024423	540
Pitsawing	Old pitsaw site along LMT3 SW in Mselezi FR	08° 49' 21.5"	036° 42' 59.0"	248808	9024077	600
Pitsawing	Recent pitsaw site along LMT3 SW; *Afzelia quanzensis.* (*leisurahili mbambakofi*) in Mselezi FR	08° 49' 24.7"	036° 42' 55.5"	248703	9023978	680
Pitsawing	Recent pitsaw site along LMT4 NW in Mselezi FR	08° 48' 40.8"	036° 42' 54.0"	248648	9025328	578
Pitsawing	Old pitsaw site along LMT4 NW in Mselezi FR	08° 48' 39.7"	036° 42' 54.2"	248654	9025361	578
Pitsawing	Pitsaw site on path from village to ridge-top, in use, *Khaya sp.* (Mkangazi) in Mselezi FR	08° 48' 09.5"	036° 43' 09.3"	249112	9026290	530
Pitsawing	Pitsaw site, 2 months old, *Khaya* sp. (Kiswahili: Mkagazi); near BC in Mselezi FR	08° 46' 56.5"	036° 43' 0.3"	0248827	9028444	587
Pitsawing	Pitsaw site, 2 months old, *Pterocarpus tinctorius* (Mninga maji); near BC in Mselezi FR	08° 46' 55.3"	036° 42' 59.4"	0248800	9028480	595
Pitsawing	Pitsaw site, 3 weeks - 1 month old, *Khaya* sp. (Mkangazi) & *Milletia excelsa* (Mvule) in Mselezi FR	08° 46' 57.7"	036° 43' 4.3"	0248949	9028409	600
Pitsawing	Pitsaw site, old (over 3 months), *Khaya* sp. (Mkangazi) in Mselezi FR	08° 46' 53"	036° 43' 7"	0249032	9028553	620
Pitsawing	Pitsaw site, one month old, *Khaya* sp. in Mselezi FR	08° 46' 55.3"	036° 42' 47.1"	0248423	9028478	687
Pitsawing	Pitsaw site in Mselezi FR	08° 48' 21.8"	036° 43' 26.4"	249637	9025915	640
Pitsawing	Pitsaw site in Mselezi FR	08° 48' 29.6"	036° 43' 36.8"	249954	9025680	740
Mining	Fresh mining for gemstones at 900-1000m along DT4 S in Mselezi FR	08° 48' 51.9"	036° 42' 50.8"	248544	9024986	780
Mining	Ruby mining along LMT3 SW in Mselezi FR	08° 49' 10.3"	036° 43' 06.3"	249031	9024423	550
Mining	Ruby mining along LMT3 SW in Mselezi FR	08° 49' 23.9"	036° 42' 56.6"	248736	9024002	700
Cultivation	Cultivation along LMT1 NE in Mselezi FR	08° 50' 22.0"	036° 43' 34.0"	249892	9022223	600
Settlement & Cultivation	Old buildings & farmland along DT3 S in Mselezi FR	08° 49' 11.0"	036° 43' 22.3"	249520	9024403	530
Settlement	Old building along LMT4 NW in Mselezi FR	08° 48' 44.6"	036° 43' 0.9"	248862	9025212	576
Settlement	Sugar-cane yard in VP7 in Mselezi FR	08° 48' 52.2"	036° 43' 9.6"	249127	9024980	540
Fire damage	Burnt land along DT1 N in Mselezi FR	08° 48' 48.3"	036° 43' 20.2"	249451	9025101	530
Fire damage	Burnt land along DT3 S in Mselezi FR	08° 49' 26.9"	036° 43' 22.9"	249542	9023917	530

Fire damage	Burnt area along LMT1 NE in Mselezi FR	08° 48' 10.9"	036° 43' 36.9"	249956	9026253	730
Fire damage	Burnt land along LMT4 NW in Mselezi FR	08° 48' 36.2"	036° 42' 44.8"	248366	9025467	848
Fire damage	Burnt land in VP2 in Mselezi FR	08° 48' 22.8"	036° 43' 17.9"	249377	9025884	560
Trap	Wire snare in Sali FR	08° 56' 23.7"	036° 40' 23.7"	0244550	9010983	1160
Trap	Wire snare in Sali FR	08° 56' 34.9"	036° 40' 48.6"	0244912	9010643	1100
Trap	Two wire snares in Sali FR	08° 55' 45.6"	036° 39' 16.2"	0242077	9012141	1300
Trap	Buffalo rope snare in Sali FR	08° 55 45.5"	036° 38' 59.2"	0241559	9012141	1300
Trap	Two wire snares in Sali FR	08° 57' 3.1"	036° 39' 48.1"	0243067	9009765	1010
Trap	Old 'crush' trap for leopard in Mselezi FR	08° 49' 31.8"	036° 42' 50.1"	0248550	9023668	800
Trap	Old squash traps for cane rat in Mselezi FR	08° 46' 45.3"	036° 42' 46.5"	0248404	9028784	880
Trap	Squash trap along DT3 S in Mselezi FR	08° 49' 15.5"	036° 43' 22.3"	249520	9024265	530
Trap	Duiker trap along LMT1 NE in Mselezi FR	08° 50' 22.0"	036° 43' 34.0"	249892	9022223	800
Trap	Snare along LMT1 NE in Mselezi FR	08° 49' 08.8"	036° 43' 35.5"	249922	9024475	660
Trap	Snare along LMT1 NE in Mselezi FR	08° 49' 34.1"	036° 43' 33.0"	249852	9023697	580
Trap	Old snare along LMT4 NW in Mselezi FR	08° 48' 18.8"	036° 42' 44.8"	248364	9026001	854

Key to Following Appendices of Faunal Species Tables:

Range: SE = Strict Endemic, confined to the Mahenge mountain block, E = Endemic, range restricted to the Eastern Arc Mountains, NE = Near Endemic, range restricted to the Eastern Arc Mountains and at least one other African ecoregion (CF = Coastal Forests; SR = Southern Rift; H = Kilimanjaro, Meru and/or Kenya Highlands, W = Widespread;

Habitat: FF = forest-dependent, F = forest dwelling, f = forest visitor, O = non-forest species;

IUCN (2006) Status: VU = Vulnerable, EN = Endangered, NT = Near Threatened, CD = Conservation Dependent, LC = Least Concern, NE = Not Evaluated;

CITES (2006) Status: Appendices I, II, or III;

Butterfly Conservation Status by ABRI (2007): VU = Vulnerable, EN = Endangered, T = Threatened, NT = Near Threatened, LC = Not at Risk, NE = Not Evaluated;

Recording Method: VIS = visual; PH = photographed (not by camera traps); CT = camera trap photograph; SR = sound recording; BS = biopsy specimen; SP = specimen; S = sign (with details);

Previous Records: NR = New Record;

Source: FT = Frontier Tanzania;

APPENDIX 4: MAMMALS

4a: Full list of mammals recorded in Sali & Mselezi Forest Reserves. Information on forest-dependency, endemism, conservation status, taxonomy and nomenclature follows Burgess *et al.* (2007); CITES (2006); Grubb *et al.* (2003); IUCN (2006); Kingdon (1974); Kingdon (1989); Kingdon (2001).

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Recording Method	Sali FR	Mselezi FR	Previous records in Mahenge	Source
PRIMATES												
CERCOPITHECIDAE												
Cercopithecus mitis moloney	Wolf 1822	Sykes monkey	W	E. & S. Africa	FF	LC	II	VIS & PH	+	+	Mahenge Scarp (Nambiga)	FT 2001; 2004b
Cercopithecus pygerythrus	Linnaeus 1758	Vervet monkey	W	E. & C. Africa	F/f	LC	-	VIS & PH		+	Nawenge Mahenge Scarp (Nambiga)	FT 2001; 2004a; 2004b
Papio cynocephalus	Linnaeus 1766	Yellow baboon	W	E. & sub-equatorial Africa	f/O	LC	-	VIS		+	Nawenge Mahenge Scarp (Nambiga)	FT 2001; 2004a; 2004b
GALAGONIDAE												
Galagoides granti	Thomas & Wroughton 1907	Mozambique galago	NE	E. Udzungwa, Coastal Forests (S of Rufiji R.), Mozambique, Malawi	FF	DD	-	BS & SR	+	+	Mahenge Scarp	FT 2004b
Otolemur crassicaudatus	Geoffroy 1812	Thick-tailed bushbaby	W	E. & sub-equatorial Africa	F/f	LC	II	SR & VIS		+	NR	
CHIROPTERA												
PTEROPODIDAE												
Epomophorus cf. wahlbergi	Sundevall 1846	Epauletted bat	W	E. & C. Africa	F/f	LC	-	SP	+		NR	
Lissonycteris cf. angolensis	Bocage 1898	Angola fruit bat	W	Tropical Africa	F	LC	-	SP	+	+	Mahenge Scarp	FT 2004b
NYCTERIDAE												
Nycteris cf. hispida	Schreber 1775	Slit-faced bat	W	Africa	F/f	LC	-	SP		+	NR	
RHINOLOPHIDAE												
Rhinolophus clivosus	Cretzschmar 1828	Horseshoe bat	W	Africa	F/f	LC	-	SP	+		Nawenge Mahenge Scarp	FT 2004a; 2004b

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Recording Method	Sali FR	Mselezi FR	Previous records in Mahenge	Source
Rhinolophus cf. fumigatus	Rüppell 1842	Horseshoe bat	W	Africa	F/f	LC	-	SP		+	NR	
Rhinolophus hildebrandti	Peters 1878	Horseshoe bat	W	Africa	F/f	LC	-	SP		+	Mahenge Scarp	FT, 2004b
VESPERTILIONIDAE												
Eptesicus cf pusillus		Serotine bat	W	Tropical Africa	F	NE	-	SP	+		NR	
Eptesicus sp.		Serotine bat	W	Tropical Africa				SP	+			
Myotis welwitschii	Gray 1866	Hairy bat	W	Africa	F/f	LC	-	SP	+		NR	
AFROSORICIDA												
CHRYSOCHLORIDAE												
Chrysochloris stuhlmanni	Matschie 1894	Stuhlmann's golden mole	W	E. & C. Africa	F/f	LC	-	S (molehills)	+		NR	
SORICOMORPHA												
SORICIDAE												
Crocidura spp.		White-toothed shrew	W		F			SP	+	+		
Sylvisorex sp.		Climbing shrew	W		F			SP	+			
MACROSCELIDEA												
MACROSCELIDIDAE												
Rhynchocyon cirnei reichardi	Peters 1847	Chequered sengi	W	E. & C. Africa	FF	NT	-	CT	+		NR	
RODENTIA												
SCIURIDAE												
Paraxerus vexillarius byatti	Kershaw 1923	Svynnerton's bush squirrel	NE	Usambaras, Nguru, Uluguru, Udzungwa, Southern Rift	FF	VU	-	CT & VIS	+	+	NR	
ANOMALURIDAE												
Anomalurus derbianus	Gray 1842	Lord Derby's Anomalure	W	Tropical Africa	FF	LC	III	VIS	+		NR	

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Recording Method	Sali FR	Mselezi FR	Previous records in Mahenge	Source
MYOXIDAE												
Graphiurus cf. murinus	Desmarest 1822	African dormouse	W	E. Africa	F	NE	-	SP	+		NR	
HYSTRICIDAE												
Hystrix cf. cristata	Linnaeus 1758	Crested porcupine	W	E. & N.W. Africa	f/O	LC	III	S (quills)		+	NR; (Nambiga)	FT 2001
THRYONOMYIDAE												
Thryonomys cf. gregorianus	Thomas 1894	Cane rat	W	Tropical Africa	f	LC	-	S (dung)	+	+	Nawenge	FT 2004a
MURIDAE												
Acomys spinosissimus	Peters 1852	Spiny mouse	W	Africa	O	LC	-	SP		+	Mahenge Scarp (Nambiga)	FT 2001; 2004b
Beamys hindei	Thomas 1909	Lesser pouched rat	NE	S. Pare, Usambaras, Nguu, Nguru, Uluguru, Ukaguru Rubeho, Malundwe, Udzungwa, Coastal Forests, Highlands, Southern Rift	F	NT	-	SP	+	+	NR† (Nawenge Mahenge Scarp Nambiga)	(FT 2001; 2004a; 2004b)†
Cricetomys gambianus	Waterhouse 1840	Giant pouched rat	W	Tropical Africa	F	LC	-	CT & S (dung)	+	+	NR; (Nambiga)	FT 2001
Grammomys sp.		Narrow footed wood mouse	W	E. Africa				SP	+	+		
Hylomyscus arcimontensis	Carleton & Stanley 2005	African wood mouse	NE	S. Pare, Usambaras, Nguu, Nguru, Uluguru, Ukaguru Udzungwa, Southern Rift	F	NE	-	SP	+		NR	
Lophuromys flavopunctatus	Thomas 1888	Brush-furred mouse	W	E. Africa	F/f	LC	-	SP	+	+	Nawenge Mahenge Scarp	FT 2004a; 2004b
Praomys delectorum	Thomas 1910	Soft-furred rat	W	E. Africa	F	NT	-	SP	+		Nawenge Mahenge Scarp	FT 2004a; 2004b
CARNIVORA												
HERPISTIDAE												
Atilax paludinosus robustus	Cuvier 1829	Marsh mongoose	W	Tropical Africa	F/f	LC	-	VIS & S (dung)	+		NR	

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Recording Method	Sali FR	Mselezi FR	Previous records in Mahenge	Source
Bdeogale crassicauda puisa	Peters 1852	Bushy tailed mongoose	W	S.E. Africa	F	LC	-	CT	+		NR	
Herpestes/Galerella sanguinea	Rüppell 1836	Slender mongoose	W	Tropical Africa	F/f	LC	-	CT & VIS	+	+	NR	
HYAENIDAE												
cf. Crocuta crocuta	Erxleben 1777	Spotted hyaena	W	Africa	f/O	CD	-	S (dung)	+		NR; (Nambiga)	FT 2001
VIVERRIDAE												
Genetta maculata	Gray 1830	Large spotted genet	W	Tropical Africa	F	LC	-	CT & VIS	+	+	NR	
NANDINIIDAE												
Nandinia binotota	Gray 1830	African palm civet	W	Tropical Africa	F	LC	-	SR & VIS	+	+	NR	
FELIDAE												
Panthera pardus	Linnaeus 1758	Leopard	W	Africa	F	LC	I	S (tracks)	+		NR; (Nambiga)	FT 2001
TUBULIDENTATA												
ORYCTEROPODIDAE												
Orycteropus afer	Pallas 1766	Aardvark	W	Sub-Saharan Africa	F	LC	II	S (holes)	+		Mahenge Scarp (Nambiga)	FT 2001; 2004b
HYRACOIDEA												
PROCAVIDAE												
Dendrohyrax validus	True 1890	Tree hyrax	NE	Taita, S. Pare, Usambaras, Nguu, Nguru, Uluguru, Rubeho, Udzungwa, Coastal Forests, Highlands	FF	LC	-	SR & VIS		+	NR† (Mahenge Scarp)	(FT 2004b)†
Heterohyrax cf. brucei	Gray 1868	Bush hyrax	W	S., E., NE Africa & Sinai	f/O	LC	-	SR		+	NR	
PROBOSCIDEA												
ELEPHANTIDAE												
Loxodonta africana	Blummenbach 1797	African elephant	W	Tropical Africa	f/O	VU	I	S (jawbone)	+		NR; (Nambiga)	FT 2001

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Recording Method	Sali FR	Mselezi FR	Previous records in Mahenge	Source
ARTIODACTYLA												
SUIDAE												
Potamochoerus larvatus	Cuvier 1822	Bushpig	W	E. Africa	F	LC	-	S (diggings)	+	+	Mahenge Scarp (Nambiga)	FT 2001; 2004b
BOVIDAE												
Cephalophus harveyi	Thomas 1893	Red duiker	W	E. Africa	FF	CD	-	CT	+	+	NR	
Cephalophus monticola	Thunberg 1789	Blue duiker	W	Equatorial Africa	FF	LC	II	VIS	+		NR	
Neotragus moschatus	Van Duben 1847	Suni	W	E. Africa	F	CD	-	CT & S (dung & tracks)	+	+	NR	
Syncerus caffer	Sparrman 1779	Buffalo	W	Tropical Africa	f/O	CD	-	VIS	+		NR; (Nambiga)	FT 2001
Tragelaphus scriptus	Pallas 1766	Bushbuck	W	Tropical Africa	F	LC	-	CT & S (dung & tracks)	+	+	Nawenge Mahenge Scarp (Nambiga)	FT 2001; 2004a; 2004b

†These records (*Beamys hindei*, *Dendrohyrax validus*) from FT's previous work have not been included in peer-reviewed literature (Burgess *et al.* 2007), and have therefore been considered unverified for Mahenge. This survey presents the first confirmed records of these species for the Mahenge Mountains.

4b: Descriptions of unconfirmed species observations

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Description of Observation	Forest Reserve	Previous records in Mahenge
GALAGONIDAE										
Galagoides orinus	Lawrence & Washburn 1936	Mountain Galago	E	E. Usambara, Nguru, Uluguru, Rubeho, Udzungwa	FF	DD	II	A call resembling this species and different to *G. granti* was heard briefly on two occasions by the same observer (J. Kiure) but no recordings were obtained; this call was not heard by more than one observer.	Sali	None
RHYNCHOCYONINAE										
Rhynchocyon petersi	Bocage 1880	Black and rufous sengi	NE	S. Pare, Usambaras, Nguu, Nguru, Uluguru, Udzungwa	F	VU	-	Two separate observers (R. Rajabu & H. Abedi) witnessed fleeting glimpses of an elephant shrew that appeared to have black and red colouring, and a shorter tail than *R. cirnei.*	Sali	None
ANOMALURIDAE										
Anomalurus sp.								Two observers (J. Birch & H. Abedi) together witnessed an anomaleur gliding through the trees, with distinct reddish-brown colouration, appearing different to the primarily greyish *A. derbianus*.	Sali	-
FELIDAE										
Panthera leo	Linnaeus 1758	Lion	W	Africa	f/O	VU	I	Reported sighting by a local villager of a lion on the road to Sali village near the border of Sali FR	Sali	(Nambiga)

4c: Large mammal transect data

4c i: Sali FR

Encounter rates are based on a total of 28km for direct observation large mammal transects and 8km for indirect observation disturbance transects.

Species	Sighting Type (Large mammal transects) Visual	Sighting Type (Large mammal transects) Sign	Sighting Type (Disturbance transects) Visual	Sighting Type (Disturbance transects) Sign	Total Sightings	Mean Encounter Rates (ER) Individual ER	Group ER	Sign ER	±SD
Cercopithecus mitis cf. moloney	7				7		0.13		0.23
Rhynchocyon cirnei reichardi	1	5			6	0.11			0.36
Paraxerus vexillarius cf. byatti	14				14	0.25			0.50
Anomalurus derbianus	1				1	0.02			0.07
Thryonomys cf. gregorianus		3			3			0.05	0.16
Cricetomys gambianus		8		1	9			0.21	0.38
Small carnivore *spp.*	1	16			17			0.30	0.80
cf. Crocuta crocuta		1			1			0.02	0.07
Orycteropus afer		1		3	4			0.21	0.75
Potamochoerus larvatus		33		9	42			1.15	1.28
Syncerus caffer	1	1		2	4		0.16		0.50
Tragelaphus scriptus		7		1	8			0.19	0.38
Cephalophus harveyi	3	30	1	12	46			1.40	1.56
Cephalophus monticola	3	13		16	32			1.29	1.81
Neotragus moschatus		7		4	11			0.38	0.58
Total	**28**	**125**	**1**	**48**	**202**				

4c ii: Mselezi FR

Encounter rates are based on a total of 14km for direct observation large mammal transects and 4km for indirect observation disturbance transects.

Species	Sighting Type (Large mammal transects) Visual	Sighting Type (Large mammal transects) Sign	Sighting Type (Disturbance transects) Visual	Sighting Type (Disturbance transects) Sign	Total Sightings	Mean Encounter Rates (ER) Individual ER	Group ER	Sign ER	±SD
Cercopithecus mitis cf. moloney	24	3			27		0.84		0.99
Papio cynocephalus		1		1	2			0.16	0.35
Paraxerus cf. vexillarius byatti	4				4	0.25			0.20
Thryonomys cf. gregorianus		3			3			0.09	0.19
Cricetomys gambianus		2			2			0.06	0.18
Small carnivore *spp.*				1	1			0.13	0.35
Procavidae *spp.*	5	10		2	17			0.72	0.62
Potamochoerus larvatus		11		1	12			0.47	0.65
Tragelaphus scriptus		15			15			0.47	1.33
Cephalophus harveyi		6			6			0.19	0.37
Neotragus moschatus		17		6	23			1.28	0.96
Total	**33**	**68**	**0**	11	112				

4d: Camera Trap Data

4d i: Total number of trap events for each species recorded by camera in Sali FR (290 camera trap-days)

Species		Camera ID										Total Events	Total Camera Trapping Rate (events per trap day)
		VIS 1	VIS 2	VIS 3	VIS 4	VIS 5	CT 11	CT 12	CT 13	CT 14	CT 15		
Cercopithecus	*mitis cf. moloney*	1										1	0.34
Rhynchocyon	*cirnei reichardi*		1		3		1		3	1	1	10	3.45
Paraxerus	*vexillarius cf. byatti*	3									1	4	1.38
Beamys	*hindei*				1						4	5	1.72
Cricetomys	*gambianus*	3	16	3	1		18		1		2	44	15.17
Bdeogale	*crassicauda puisa*	6	9	10	3		3	1		1		33	11.38
Herpestes	*sanguinea*			1					1			2	0.69
Genetta	*maculata*			1	2							3	1.03
Cephalophus	*harveyi*	18	1	2								21	7.24
Neotragus	*moschatus*	14	2	7		1		1				25	8.62
Tragelaphus	*scriptus*	1										1	0.34
Total		**46**	**29**	**24**	**10**	**1**	**22**	**2**	**5**	**2**	**8**	**149**	**51.38**

4d ii: Camera trapping encounter rates for each species recorded by camera in Sali FR (290 camera trap-days)

Species		**Camera ID & Number of Trap Days per camera**										**Mean Encounter Rate**	**Standard Deviation**
		VIS 1	**VIS 2**	**VIS 3**	**VIS 4**	**VIS 5**	**CT 11**	**CT 12**	**CT 13**	**CT 14**	**CT 15**		
		39	**23**	**42**	**29**	**8**	**45**	**19**	**38**	**22**	**25**		
		Encounter rate (number of events per camera trap-day)											
Cercopithecus	*mitis cf. moloney*	2.56										2.56	
Rhynchocyon	*cirnei reichardi*		4.35		10.34		2.22		7.89	4.55	4.00	5.56	2.98
Paraxerus	*vexillarius cf. byatti*	7.69									4.00	5.85	2.61
Beamys	*hindei*				3.45						16.00	9.72	8.88
Cricetomys	*gambianus*	7.69	69.57	7.14	3.45		40.00		2.63		8.00	19.78	25.47
Bdeogale	*crassicauda puisa*	15.38	39.13	23.81	10.34		6.67	5.26		4.55		15.02	12.62
Herpestes	*sanguinea*			2.38					2.63			2.51	0.18
Genetta	*maculata*			2.38	6.90							4.64	3.19
Cephalophus	*harveyii*	46.15	4.35	4.76								18.42	24.02
Neotragus	*moschatus*	35.90	8.70	16.67		12.50		5.26				15.80	12.01
Tragelaphus	*scriptus*	2.56										2.56	
Total		**117.95**	**126.09**	**57.14**	**34.48**	**12.50**	**48.89**	**10.53**	**13.16**	**9.09**	**32.00**	**46.18**	**43.30**

4e: Nocturnal mammal data collected through transects & sound recordings

4e i: Sali FR

Transect summary

Transect ID	Species	No. of individuals	Hours	Encounter Rate (no. of inds per hr)
T1	*Galagoides granti*	6	4	1.5
T2	*Galagoides granti*	20	4	5
T3	*Galagoides granti*	14	2.5	5.6
T4	*Galagoides granti*	14	4	3.5

Species summary

Species	No. of individuals	Total hrs	Total km	Mean ER	SD
Galagoides granti	54	14h20m	10.5	3.90	1.83

4e ii: Mselezi FR

Transect summary

Transect ID	Species	No. of individuals	Hours	Encounter Rate (no. of inds per hr)
T1	*Galagoides granti*	6	4h30	1.35
T1	*Otolemur crassicaudatus*	6	4h30	1.35
T1	Procavidae *spp.*	23	4h30	5.16
T2	*Galagoides granti*	8	5h50	1.37
T2	*Otolemur crassicaudatus*	8	5h50	1.37
T2	Procavidae *spp.*	39	5h50	6.9

Species summary

Species	No. of individuals	Total hrs	Mean ER	SD
Galagoides granti	14	10h20	1.38	0.23
Otolemur crassicaudatus	14	10h20	1.54	1.11
Procavidae *spp.*	62	10h20	5.89	2.21

4f: Small mammal data from the zoological trapsites.

4f i: Sali FR

Species	No. individuals Zoosite 1		No. individuals Zoosite 2		KMH nos.
	Sherman	Bucket Pitfall	Sherman	Bucket Pitfall	
SORICIDAE					
Crocidura (spp. A, B, C)		13		19	26820 - 26824, 26677, 26679 - 26682
Sylvisorex sp.		1			26678
MYOXIDAE					
Graphiurus cf. murinus	6		5 (9)		26826, 26827, 26828
MURIDAE					
Beamys hindei	10 (18)	1		19 (29)	26816
Grammomys sp.	1		5	2	26830, 26832,
Hylomyscus arcimontensis	42 (91)		34 (55)		26817, 26818, 26829,
Lophuromys flavopunctatus			1		26834
Praomys delectorum	16 (25)		6 (7)	1	26819, 26825, 26831, 26833

Numbers in parentheses indicate total captures including recaptures

4f ii: Mselezi FR

Species	No. individuals		KMH nos.
	Sherman	Bucket Pitfall	
SORICIDAE			
Crocidura sp. A		3	26684, 26685
Crocidura sp. B		1	26683
MURIDAE			
Acomys spinosissimus	11 (13)		26836
Beamys hindei	2 (3)		26838
Lophuromys flavopunctatus	1		26837
Grammomys sp	1		26835

Numbers in parentheses indicate total captures including recaptures

4g: Bat data collected through mist netting

4g i: Sali FR

Trapping summary

Trapping session ID	Base camp	Total net-metre-hours	No. species	No. individuals
1	1	57.5	3	4
2	1	29.46	1	1
3	1	55	0	0
4	1	49.5	0	0
5	2	87.5	3	4
6	2	25	0	0
7	2	66.5	0	0
8	2	0.16	0	0

Species summary

Species	No. individuals Zoosite 1		No. individuals Zoosite 2	KMH nos.
	Net	Casual	Net	
PTEROPODIDAE				
Epomophorus wahlbergi		1*	1	26118
Lissonycteris cf. angolensis	2			26114
RHINOLOPHINAE				
Rhinolophus clivosus	1			26116
VESPERTILIONIDAE				
Eptesicus cf. pusillus			1	26120
Eptesicus sp.	1		1	26117
Myotis welwitschii	1		1	26115

*A single individual was caught in a bird mist net early one morning

4g ii: Mselezi FR

Trapping summary

Trapping session ID	Base camp	Total net metre hours	No. species	No. individuals
1	1	84	1	2
2	1	54	1	2
3	1	84	2	2
4	1	54	1	1

Species summary

Species	No. individuals		KMH nos.
	Net	Casual*	
PTEROPODIDAE			
Lissonycteris cf. angolensis		1	26125
NYCTERIDAE			
Nycteris cf. hispida	3		26122, 26123
RHINOLOPHINAE			
Rhinolophus cf. fumigatus	2		26124
Rhinolophus hildebranti	1		26121

*A single individual was caught in a bird mist net early one morning

APPENDIX 5: AVIFAUNA

5a: Full list of avian species recorded in Sali & Mselezi Forest Reserves. Information on forest-dependency, endemism, conservation status, taxonomy and nomenclature follows Burgess *et al.* (2007); CITES (2006); IUCN (2006); Stevenson & Fanshawe (2002).

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Sali FR	Mselezi FR	Previous records in Mahenge	Source
FALCONIFORMES											
ACCIPITRIDAE											
Accipiter tachiro[#]	Daudin 1800	African goshawk	W	Sub-Saharan Africa	F	LC	II	+	+	NR	
Aquila pomarina	Brehm 1831	Lesser spotted eagle	W		O	LC	II		+	NR	
Aviceda cuculoides	Swainson 1837	African cuckoo-hawk	W		F	LC	II		+	NR	
Buteo augur	Rüppell 1836	Augur buzzard	W	E. & S. Africa	f/O	LC	II	+	+	NR	
Circaetus cinereus	Vieillot 1818	Brown snake-eagle	W		F	LC	II		+	NR	
Circaetus fasciolatus	Kaup 1850	Southern banded snake-eagle	W	E. & S. Africa, localised	FF	NT	II		+	NR	
Circaetus pectoralis	Smith 1829	Black-chested snake-eagle	W		F	LC	II		+	NR	
Elanus caeruleus	Desfontaines 1789	Black-shouldered kite	W		F	LC	II		+	NR	
Gypohierax angolensis	Gmelin 1788	Palm-nut vulture	W		F	LC	II		+	NR	
Hieraaetus spilogaster	Bonaparte 1850	African hawk-eagle	W		F	LC	II		+	NR	
Lophaetus occipitalis	Daudin 1800	Long-crested eagle	W		F	LC	II		+	Nawenge	FT 2004a
Polyboroides typus	Smith 1829	African harrier-hawk	W	Sub-Saharan Africa	F/f	LC	II	+		NR	
Stephanoaetus coronatus[#]	Linnaeus 1766	African crowned eagle	W	Tropical Africa	FF	LC	II	+	+	Mahenge Scarp	FT 2004b
Terathopius ecaudatus	Daudin 1800	Bateleur	W		F	LC	II		+	Mahenge Scarp	FT 2004b
GALLIFORMES											
NUMIDIDAE											
Numida meleagris	Linnaeus 1758	Helmeted guineafowl	W		F	LC	-		+	NR	
Guttera pucherani	Hartlaub 1860	Crested guineafowl	W	Africa	F	LC	-	+		NR	
COLUMBIFORMES											
COLUMBIDAE											
Columba arquatrix	Temminck 1809	Olive pigeon	W	E. Africa	F	LC	-	+		NR	

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Sali FR	Mselezi FR	Previous records in Mahenge	Source
Streptopelia semitorquata	Rüppell 1837	Red-eyed dove	W		F	LC	III		+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
Treron calvus	Temminck 1808	African green-pigeon	W		F	LC	III		+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
Turtur chalcospilos	Wagler 1827	Emerald-spotted wood-dove	W		O	LC	-		+	NR	
Turtur tympanistria	Temminck 1809	Tambourine dove	W	Africa & Islands	F/f	LC	III	+	+	Mahenge Scarp	FT 2004b
PSITTACIFORMES											
PSITTACIDAE											
Poicephalus cryptoxanthus	Peters 1854	Brown-headed parrot	W	E. & S. Africa	F	LC	II	+		NR	
CUCULIFORMES											
MUSOPHAGIDAE											
Tauraco livingstonii	Gray 1864	Livingstone's turaco	W	Forests of Africa	FF	LC	II	+	+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
CUCULIDAE											
Centropus burchelli	Swainson 1838	Burchell's coucal	W		O	NE	-		+	NR	
Centropus grillii	Hartlaub 1861	Black coucal	W		O	LC	-		+	NR	
Cercococcyx montanus	Chapin 1928	Barred long-tailed cuckoo	W		F	LC	-	+		NR	
Chrysococcyx caprius	Boddaert 1783	Dideric cuckoo	W		O	LC	-		+	NR	
Chrysococcyx cupreus	Shaw 1792	African emerald cuckoo	W	C., E. & S. Africa	FF	LC	-		+	NR	
Chrysococcyx klaas	Stephens 1815	Klaas's cuckoo	W		F	LC	-	+	+	Mahenge Scarp	FT 2004b
Cuculus solitarius	Stephens 1815	Red-chested cuckoo	W	Sub-Saharan Africa	F	LC	-		+	NR	
STRIGIFORMES											
STRIGIDAE											
Bubo vosseleri	Reichenow 1908	Usambara eagle-owl	E	Usambaras, Nguru, Uluguru, Rubeho, Udzungwa	FF	VU	II	+		NR	
Strix woodfordii[#]	Smith 1834	African wood owl	W	C. & S. Africa	F	LC	II	+	+	NR	
CAPRIMULGIFORMES											
CAPRIMULGIDAE											
Caprimulgus pectoralis	Cuvier 1817	Fiery-necked nightjar	W		F	LC	-		+	NR	

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Sali FR	Mselezi FR	Previous records in Mahenge	Source
APODIFORMES											
APODIDAE											
Apus affinis	Gray 1830	Little swift	W	Sub-Saharan Africa, Europe & Asia	O	LC	-	+	+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
Apus apus	Linnaeus 1758	Eurasian swift	W		O	LC	-	+	+	NR	
Apus caffer	Lichtenstein 1823	White-rumped swift	W	Africa	O	LC	-	+		Mahenge Scarp	FT 2004b
Neafrapus boehmi	Schalow 1882	Bohm's spinetail	W		F	LC	-		+	NR	
COLIIFORMES											
COLIIDAE											
Colius striatus	Gmelin 1789	Speckled mousebird	W		O	LC	-		+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
TROGONIFORMES											
TROGONIDAE											
Apaloderma narina	Stephens 1815	Narina trogon	W	Sub-Saharan Africa	F	LC	-		+	NR	
Apaloderma vittatum	Shelley 1882	Bar-tailed trogon	W	C. & E. Africa	FF	LC	-	+		NR	
CORACIIFORMES											
ALCEDINIDAE											
Halcyon albiventris	Scopoli 1786	Brown-hooded kingfisher	W		F	LC	-		+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
Halcyon chelicuti	Stanley 1814	Striped kingfisher	W		O	LC	-		+	NR	
Halcyon leucocephala	Müller 1776	Grey-headed kngfisher	W		F	LC	-		+	NR	
Ispidina picta / Ceyx pictus	Boddaert 1783	African pygmy kingfisher	W	C., E. & S. Africa	f/O	LC	-	+	+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
MEROPIDAE											
Merops apiaster	Linnaeus 1758	European bee-eater	W		O	LC	-		+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
Merops pusillus	Müller 1776	Little bee-eater	W		O	LC	-		+	Mahenge Scarp	FT 2004b
CORACIIDAE											
Coracias garrulus	Linnaeus 1758	European roller	W	Europe & Africa	O	NT	-		+	NR	
Eurystomus glaucurus	Müller 1776	Broad-billed roller	W		O	LC	-	+		NR	

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Sali FR	Mselezi FR	Previous records in Mahenge	Source
PHOENICULIDAE											
Phoeniculus purpureus	Miller 1784	Green wood-hoopoe	W		F	LC	-		+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
BUCETORIDAE			48								
Bycanistes brevis	Friedmann 1929	Silvery-cheeked hornbill	W	E. Africa	FF	LC	-	+	+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
Bycanistes bucinator[#]	Temminck 1824	Trumpeter hornbill	W	E. & S. Africa	FF	LC	-	+	+	Mahenge Scarp	FT 2004b
Tockus alboterminatus[#]	Büttikofer 1889	Crowned hornbill	W	E. & S. Africa	FF	LC	-	+	+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
PICIFORMES											
RAMPHASTIDAE											
Lybius melanopterus	Peters 1854	Brown-breasted barbet	W		F	LC	-		+	NR	
Pogoniulus bilineatus	Sundevall 1850	Yellow rumped tinkerbird	W	Africa	F	LC	-	+	+	Mahenge Scarp	FT 2004b
Stactolaema olivacea	Shelley 1880	Green barbet	NE	Usambaras, Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Udzungwa, Coastal Forests, Southern Rift	F	LC	-	+	+	NR[†] (Nawenge; Mahenge Scarp)	FT 2004a; 2004b[†]
INDICATORIDAE											
Indicator indicator	Sparrman 1777	Greater honeyguide	W		O	LC	-		+	NR	
Indicator variegatus	Lesson 1830	Scaly-throated honeyguide	W	Africa	F	LC	-	+		NR	
PICIDAE											
Campethera abingoni	Smith 1836	Golden-tailed woodpecker	W		F	LC	-		+	NR	
Dendropicos fuscescens	Vieillot 1818	Cardinal woodpecker	W	Sub-Saharan Africa	f/O	LC	-		+	Nawenge	FT 2004a
Mesopicos griseocephalus	Boddaert 1783	Olive woodpecker	W	E., C. & S. Africa	FF	LC	-	+		NR	
PASSERIFORMES											
EURYLAIMIDAE											
Smithornis capensis	Smith 1840	African broadbill	W	E., C. & S. Africa	F	LC	-	+		NR	

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Sali FR	Mselezi FR	Previous records in Mahenge	Source
HIRUNDINIDAE											
Delichon urbicum	Linnaeus 1758	Common house martin	W		F	LC	-	+	+	NR	
Hirundo abyssinica	Guérin-Méneville 1843	Lesser striped swallow	W	Sub-Saharan Africa	O	LC	-		+	NR	
Hirundo rustica	Linnaeus 1758	Barn swallow	W		O	LC	-	+		Mahenge Scarp	
Hirundo smithii	Leach 1818	Wire-tailed swallow	W		F	LC	-	+	+	NR	
Psalidoprocne holomelas	Rüppell 1840	Black saw-wing	W	E., C. & S. Africa	F	NE	-	+	+	Nawenge Mahenge Scarp	FT 2004a; 2004b
MOTACILLIDAE											
Motacilla clara	Sharpe 1908	Mountain wagtail	W	Africa	F	LC	-		+	NR	
CAMPEPHAGIDAE											
Campephaga flava	Vieillot 1817	Black cuckoo-shrike	W		F	LC	-		+	NR	
Coracina caesia	Lichtenstein 1823	Grey cuckoo-shrike	W		FF	LC	-	+		NR	
PYCNONOTIDAE											
*Andropadus fusciceps**	Shelley 1893	Mountain greenbul	NE	Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Mahenge, Udzungwa, Southern Rift	FF	LC	-			Mahenge	Burgess *et al.* (2007)
Andropadus masukuensis[#]	Shelley 1897	Shelley's greenbul	NE	S. Pare, Usambaras, Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Mahenge, Udzungwa, Southern Rift	FF	LC	-	+	+	Mahenge	Burgess *et al.* (2007)
Andropadus milanjensis[#]	Shelley 1894	Stripe-cheeked greenbul	NE	Taita, Pares, Usambaras, Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Udzungwa, Highlands, Southern Rift	FF	LC	-	+	+	NR	
Andropadus virens	Cassin 1858	Little greenbul	W	Africa	F	LC	-	+	+	NR	
Nicator gularis	Hartlaub & Finsch 1870	Eastern nicator	W	E. Africa	F	LC	-	+	+	Mahenge Scarp	FT 2004b

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Sali FR	Mselezi FR	Previous records in Mahenge	Source
Pycnonotus barbatus	Desfontaine 1789	Common bulbul	W	Africa	f/O	LC	-	+	+	Mahenge Scarp	FT 2004b
Phyllastrephus placidus[#]	Sharpe 1882	Placid greenbul	W	C. & E. Africa	FF	LC	-	+	+	NR	
Phyllastrephus cerviniventris	Shelley 1884	Grey-olive greenbul	W		F	LC	-		+	NR	
Phyllastrephus fischeri	Reichenow 1879	Fischer's greenbul	W		F	LC	-		+	NR	
TURDIDAE											
Alethe fuelleborni[#]	Reichenow 1900	White-chested alethe	W	E. Africa with restricted range in EA	FF	LC	-	+		NR	
Zoothera gurneyi	Hartlaub 1864	Orange ground-thrush	W	E. Africa, localised	FF	LC	-	+		NR	
CISTICOLIDAE					16						
Apalis flavida	Strickland 1852	Yellow-breasted apalis	W		F	LC	-		+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
Apalis melanocephala	Fischer & Reichenow 1884	Black-headed apalis	W	E. Africa	FF	LC	-	+		NR	
Cisticola cantans	Heuglin 1869	Singing cisticola	W		O	LC	-		+	NR	
Heliolais erythropterus	Jardine 1849	Red-winged warbler	W		O	LC	-		+	NR	
Prinia subflava	Gmelin 1789	Tawny-flanked prinia	W		O	LC	-		+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
SYLVIIDAE											
Bradypterus lopezi	Alexander 1903	Evergreen forest warbler	W	Africa	FF	LC	-	+		NR	
Camaroptera brachyura	Vieillot 1820	Green-backed camaroptera	W	Sub-Saharan Africa	F	LC	-	+	+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
Chloropeta natalensis	Smith 1847	Dark-capped yellow warbler	W		F	LC	-	+		NR	
Sylvia borin	Boddaert 1783	Garden warbler	W		F	LC	-		+	NR	
MUSCICAPIDAE											
Cossypha heuglini	Hartlaub 1866	White-browed robin-chat	W		O	LC	-		+	Mahenge Scarp	FT 2004b
Cossypha natalensis[#]	Smith 1840	Red-capped robin-chat	W	Africa	FF	LC	-	+	+	NR	
Muscicapa adusta	Boie 1828	African dusky flycatcher	W		F	LC	-	+		NR	
Muscicapa caerulescens	Hartlaub 1865	Ashy flycatcher	W	Africa	F	LC	-		+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
Muscicapa striata	Pallas 1764	Spotted flycatcher	W		O	LC	-		+	Mahenge Scarp	FT 2004b

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Sali FR	Mselezi FR	Previous records in Mahenge	Source
Myioparus plumbeus	Hartlaub 1858	Lead-coloured flycatcher	W		F	LC	-	+	+	NR	
Pogonocichla stellata[#]	Vieillot 1818	White-starred robin	W	E. & S. Africa	FF	LC	-	+		NR	
Sheppardia sharpei[#]	Shelley 1903	Sharpe's akalat	NE	S. Pare, Usambaras, Nguru, Uluguru, Rubeho, Udzungwa, Southern Rift	FF	LC	-	+		NR	
PLATYSTEIRIDAE											
Batis mixta	Shelley 1889	Forest batis	NE	Pares, Usambaras, Nguu, Nguru, Coastal Forests, Highlands	FF	LC	-	+	+	NR	
Platysteira peltata	Sundevall 1850	Black-throated wattle eye	W		F	LC	-		+	Nawenge	FT 2004a
MONARCHIDAE											
Terpsiphone viridis	Müller 1776	African paradise-flycatcher	W	Africa & Arabia	F	LC	-	+	+	Nawenge Mahenge Scarp	FT 2004a; 2004b
Trochocercus cynomelas	Vieillot 1818	Blue-mantled crested-flycatcher	W	E. & S. Africa	F	LC	-		+	NR	
TIMALIIDAE											
Turdoides jardineii	Smith 1836	Arrow-marked babbler	W		O	LC	-		+	NR	
NECTARINIIDAE											
Anthreptes collaris	Vieillot 1819	Collared sunbird	W	Forests of Africa	F	LC	-	+	+	Nawenge Mahenge Scarp	FT 2004a; 2004b
Nectarinia amethystina	Shaw 1812	Amethyst sunbird	W		F	LC	-		+	NR	
Nectarinia olivacea	Smith 1840	Olive sunbird	W	E. & S. Africa	F	LC	-	+	+	NR	
MALACONOTIDAE											
Dryoscopus cubla	Shaw 1809	Black-backed puffback	W		O	LC	-	+	+	Mahenge Scarp	FT 2004b
Laniarius aethiopicus	Gmelin 1788	Tropical boubou	W	E. & S. Africa	F/f	LC	-	+	+	Nawenge	FT 2004a
Malaconotus nigrifrons	Reichenow 1896	Black-fronted bush-shrike	W	E. & S. Africa	FF	NE	-	+		NR	
Malaconotus sulfureopectus	Lesson 1831	Sulphur-breasted bush-shrike	W		O	LC	-		+	NR	
Tchagra australis	Smith 1836	Brown-crowned tchagra	W		F	LC	-		+	Mahenge Scarp	FT 2004b
Tchagra senegalus	Linnaeus 1766	Black-crowned tchagra	W		O	LC	-		+	NR	
Prionops plumatus	Shaw 1809	White-crested helmet-shrike	W		O	LC	-		+	NR	

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Sali FR	Mselezi FR	Previous records in Mahenge	Source
DICRURIDAE											
Dicrurus adsimilis	Bechstein 1794	Fork-tailed drongo	W		O	LC	-		+	NR	
Dicrurus ludwigii	Smith 1834	Square-tailed drongo	W	Africa	FF	LC	-	+	+	Mahenge Scarp	FT 2004b
CORVIDAE			105								
Corvus albus	Müller 1776	Pied crow	W		O	LC	-		+	NR	
STURNIDAE											
Cinnyricinclus leucogaster	Boddaert 1783	Violet-backed starling	W		O	LC	-		+	NR	
Lamprotornis elisabeth	Stresemann 1924	Southern blue-eared starling	W		O	LC	-		+	NR	
PASSERIDAE											
Petronia superciliaris	Blyth 1845	Yellow-throated petronia	W		O	LC	-		+	NR	
PLOCEIDAE											
Amblyospiza albifrons	Vigors 1831	Grosbeak weaver	W	Sub-Saharan Africa	f/O	LC	III		+	NR	
Euplectes capensis	Linnaeus 1766	Yellow bishop	W		O	LC	-		+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
Euplectes hordeaceus	Linnaeus 1758	Black-winged red bishop	W		O	LC	III		+	NR	
Ploceus bicolor	Vieillot 1819	Dark-backed weaver	W	Africa	F	LC	-	+	+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
Ploceus intermedius	Rüppell 1845	Lesser masked weaver	W		O	LC	-		+	NR	
Ploceus ocularis	Smith 1839	Spectacled weaver	W		O	LC	-		+	Nawenge; Mahenge Scarp	FT 2004a; 2004b
ESTRILDIDAE											
Cryptospiza reichenovii[#]	Hartlaub 1874	Red-faced crimsonwing	W	E. Africa	FF	LC	-	+	+	NR	
Estrilda astrild	Linnaeus 1758	Common waxbill	W		O	LC	III		+	Mahenge Scarp	FT 2004b
Estrilda perreini	Vieillot 1817	Black-tailed grey waxbill	W		F	LC	-		+	Mahenge Scarp	FT 2004b
Hypargos niveoguttatus[#]	Peters 1868	Peters's twinspot	W	Africa	f/O	LC	-		+	Mahenge Scarp	FT 2004b
Lagonosticta rubricata	Lichtenstein 1823	African firefinch	W		F	LC	III		+	Mahenge Scarp	FT 2004b
Lagonosticta senegala	Linnaeus 1766	Red-billed firefinch	W		O	LC	III		+	NR	
Lonchura bicolour	Fraser 1843	Black-and-white mannikin	W		F	LC	III		+	Mahenge Scarp	FT 2004b

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Sali FR	Mselezi FR	Previous records in Mahenge	Source
VIDUIDAE											
Vidua obtuse	Chapin 1922	Broad-tailed paradise whydah	W		f/O	LC	-		+	NR	
FRINGILLIDAE											
Serinus mozambicus	Muller 1776	Yellow-fronted canary	W		O	LC	III		+	Nawenge; Mahenge Scarp	FT 2004a; 2004b

†This record (*Stactolaema olivacea*) from Frontier Tanzania's previous work has not been included in peer-reviewed literature (Burgess *et al.* 2007), and has therefore been considered unverified for Mahenge. This survey presents the first confirmed record of these species for the Mahenge Mountains.

*****Species previously recorded in the Mahenge Mountains (Burgess *et al.* 2007) but not in this study: *Andropadus fusciceps*.

#Opportunistic breeding records were documented for these species. For further details see Appendix 5e.

5b: Avian survey sites in Sali & Mselezi FR

Forest Reserve	Surveyed site	Coordinates	Altitude (m asl)	Habitat description	Duration	Total mistnetting time (net-metre-hrs)	Observation hrs
SALI FR	Base Camp 1	Longitude (S)08°56'46.3" Latitude (E) 036°40'22.0"	1050	Submontane forest	22/11/2005-29/11/2005	7599	12
	Base Camp 2	Longitude (S) 08° 55.2" Latitude (E) 036°39'15.2"	1250	Submontane forest	12/11/2005-20/11/2005	5364	12
MSELEZI FR	Base Camp 1	Longitude (S) 08 ° 47' 03.8" Latitude (E) 036 °43' 00.4"	585	Rocky riverine forest with rocky grassland	1/12/2005-09/12/2005	7748	12

5c: Mist netting data for each surveyed locality within the Mahenge Mountains, Ulanga District

SPECIES	**SALI FR**		**MSELEZI FR**
	Base Camp 1	**Base Camp 2**	**Base Camp 1**
Net metre hours	**7599**	**5364**	**7748**
Accipiter tachiro	1	1	1
Turtur tympanistria			1
Ispidina picta	2	2	4
Smithornis capensis	1	3	
Psalidoprocne holomelas			1
Motacilla clara			0
Andropadus virens	8	17	14
Andropadus masukuensis	14	3	
Andropadus milanjensis		5	
Nicator gularis	2	1	
Phyllastrephus cerviniventris			5
Phyllastrephus fischeri			1
Pycnonotus barbatus			0
Phyllastrephus placidus	21	16	2
Alethe fuelleborni	4	3	
Zoothera gurneyi	3	1	
Apalis flavida			2
Heliolais erythropterus			1
Prinia subflava			1
Camaroptera brachyura	1	1	1
Sylvia borin			3
Cossypha heuglini			2
Cossypha natalensis	3		4
Pogonocichla stellata		8	
Sheppardia sharpei	3	10	
Batis mixta	7	6	
Platysteira peltata			1
Terpsiphone viridis	6		
Trochocercus cyanomelas			2
Anthreptes collaris			5
Nectarinia olivacea	27	24	6
Tchagra australis			1
Dicrurus ludwigii	2		
Euplectes capensis			1
Cryptospiza reichenovii	3	1	3
Hypargos niveoguttatus			11
Total	**108**	**102**	**73**

5d: Avian specimens collected from Sali & Mselezi Forest Reserves

Species	Blood sample	Skins
ACCIPITRIDAE		
Accipiter tachiro		1
EURYLAIMIDAE		
Smithornis capensis	1	
PYCNONOTIDAE		
Andropadus virens	2	
Andropadus masukuensis	11	
Andropadus milanjensis	1	
Nicator gularis	1	1
Phyllastrephus placidus	4	
MUSCICAPIDAE		
Cossypha natalensis	2	1
Pogonocichla stellata	1	1
Sheppardia sharpei	3	2
Batis mixta	7	2
TURDIDAE		
Alethe fuelleborni	2	
Zoothera gurneyi	1	
NECTARINIIDAE		
Nectarinia olivacea	1	
Total	**37**	**8**

5e: Avian breeding records through opportunistic observations in Sali & Mselezi Forest Reserves

Species	Breeding records	Sali FR	Mselezi FR
Accipiter tachiro	d	+	
Stephanoaetus coronatus	d		+
Strix woodfordii	d	+	
Bycanistes bucinator	d		+
Tockus alboterminatus	n	+	
Andropadus masukuensis	b	+	
Andropadus milanjensis	b, d	+	
Phyllastrephus placidus	b		+
Alethe fuelleborni	n	+	
Cossypha natalensis	d		+
Pogonocichla stellata	d	+	
Sheppardia sharpei	d, n	+	
Cryptospiza reichenovii	d	+	
Hypargos niveoguttatus	d		+

Key:
b = fresh brood patch of scores 4 and 5;
d= dependent juvenile;
n= active nest with young or eggs;

5f: Avian behavioural observations in Sali & Mselezi Forest Reserves

Species	Behaviour	Date & Time	Forest Reserve
Stephanoaetus coronatus	An adult bird was seen swooping into a group of blue monkeys, capturing one juvenile and flying away with it.	6/12/05 ~1630hrs	Mselezi FR
Bycanistes bucinator	A single bird was seen attacking a fruit bat near Base Camp 1.	7/12/05 ~1200hrs	Mselezi FR

APPENDIX 6: AMPHIBIANS

6a: Full list of amphibian species found in Sali & Mselezi Forest Reserves. Information on forest-dependency, endemism, conservation status, taxonomy and nomenclature follows Burgess *et al.* (2007); Channing & Howell (2006); CITES (2006); IUCN (2006); Passmore & Carruthers (1995); Schiøtz (1999).

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Recording Method	Sali FR	Mselezi FR	Previous records in Mahenge	Source
GYMNOPHIONA												
SCOLECOMORPHIDAE												
cf. Scolecomorphus kirkii	Boulenger 1883	Kirk's caecilian	NE	Nguru, Uluguru, Rubeho, Mahenge, Udzungwa, Southern Rift	FF	LC	-	VIS	+		Sali; Nawenge; Mahenge Scarp	Loader *et al.* 2003; FT 2004a; 2004b
ANURA												
ARTHROLEPTIDAE												
Arthroleptis sp.								SP	+	+		
Arthroleptis reichei	Nieden 1910	Reiche's squeaker	NE	Nguru, Uluguru, Udzungwa, Southern Rift	FF	NT	-	SP	+		NR	
Arthroleptis stenodactylus	Pfeffer 1893	Common squeaker	W	S. & E. Africa	F/f	LC	-	SP	+		Sali; Nawenge; Mahenge Scarp; (Nambiga)	Loader *et al.* 2003; FT 2001; 2004a; 2004b
Arthroleptis. xenodactyloides	Hewitt 1933	Dwarf squeaker	W	S. & E. Africa	F/f	LC	-	SP	+	+	Sali; Nawenge; Mahenge Scarp; (Nambiga)	Loader *et al.* 2003; FT 2001; 2004a; 2004b
BUFONIDAE												
*Bufo gutturalis**	Power 1927	African common toad	W	E., C. & S. Africa	O/f	LC	-		*		Sali	Loader *et al.* 2003
*Bufo maculatus**	Hallowell 1855	Flat backed toad	W	W., E. & S. Africa	O/f	LC	-		*		Sali	Loader *et al.* 2003
Nectophrynoides sp. nov 1			E?	Udzungwa?	FF?			SP	+		NR	
Nectophrynoides sp. nov 2			SE?		FF?			SP	+		NR	

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Recording Method	Sali FR	Mselezi FR	Previous records in Mahenge	Source
Nectophrynoides tornieri	Roux 1906	Tornier's forest toad	NE	E. Usambara, Nguru, Uluguru, Udzungwa, Mahenge, Southern Rift	FF	LC	I	SP	+		Sali	Loader *et al.* 2003
Stephopaedes loveridgei	Poynton 1991	Loveridge's toad	W	Coastal S. Tanzania	FF	LC	-	SP	*	+	Sali; Mahenge Scarp; (Nambiga)	Loader *et al.* 2003; FT 2001; 2004a
HEMISITIODAE												
*Hemisus marmoratus**	Peters 1854	Marbled snout burrower	W	Tropical Africa	O/f	LC	-		*		Sali	Loader *et al.* 2003
HYPEROLIIDAE												
Afrixalus sp. nov			E?	Udzungwa?	FF?			SP	+		NR	
*Afrixalus brachycnemis**	Boulenger 1896	Short legged spiny reed frog	W	E. Africa	O/f	LC	-		*		Sali	Loader *et al.* 2003
Afrixalus fornasinii	Bianconi 1849	Fornasini's spiny reed frog	W	S. & E. Africa	F/f	LC	-	SP	+	+	Sali	Loader *et al.* 2003
Afrixalus uluguruensis complex	Barbour & Loveridge 1928	Uluguru spiny reed frog	NE	E. Usambara, Nguu, Nguru, Uluguru, Ukaguru, Rubeho, Mahenge, Udzungwa, Coastal Forests	FF	VU	-	SP	+		Sali	Loader *et al.* 2003
Hyperolius sp. 1								SP	+			
Hyperolius sp. (nov?)			SE?		FF?			SP	+		NR	
*Hyperolius mitchelli**	Loveridge 1953	Mitchell's reed frog	W	E. Africa	F	LC	-		*		Sali	Loader *et al.* 2003
*Hyperolius nasutus**	Günther 1865	Long reed frog	W	Tropical & South Africa	f/O	LC	-		*		Sali	Loader *et al.* 2003

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Recording Method	Sali FR	Mselezi FR	Previous records in Mahenge	Source
Hyperolius puncticulatus	Pfeffer 1893	Spotted reed frog	NE	Usambaras, Nguu, Nguru, Uluguru, Ukaguru, Malundwe, Mahenge, Udzungwa, Coastal Forests, Southern Rift	F	LC	-	SP	+		Sali; Nawenge	Loader *et al.* 2003; FT 2004a
*Hyperolius tuberilinguis**	Smith 1849	Tinker reed frog	W	E. & S. Africa	O/f	LC	-		*		Sali	Loader *et al.* 2003
*Kassina senegalensis**	Duméril & Biron 1841	Senegal kassina	W	Sub-Saharan Africa	O	LC	-		*		Sali	Loader *et al.* 2003
Leptopelis flavomaculatus	Gunther 1864	Yellow spotted tree frog	W	E. Africa	FF	LC	-	SP	+		Sali; (Nambiga)	Loader *et al.* 2003; FT 2001
Leptopelis uluguruensis	Barbour & Loveridge 1928	Uluguru tree frog	E	E. Usambara, Nguu, Nguru, Uluguru, Udzungwa	FF	VU	-	SP	+		NR	
Leptopelis vermiculatus	Boulenger 1909	Vermiculated tree frog	NE	Usambaras, Nguu, Nguru, Mahenge, Udzungwa, Southern Rift	FF	VU	-	SP	+		Sali	Loader *et al.* 2003
MICROHYLIDAE												
*Breviceps mossambicus**	Peters 1854	Mozambique rain frog	W	E. & S. Africa	O	LC	-		*		Sali	Loader *et al.* 2003
Callulina sp. nov?			SE?		FF?			SP	+		NR	
Hoplophryne sp. nov			SE?		FF?			SP	+		NR	
*Phrynomantis bifasciatus bifasciatus**	Smith 1847	Banded rubber frog	W	E., C. & S. Africa	O	LC	-		*		Sali	Loader *et al.* 2003
Probreviceps sp. nov?			SE?		FF?			SP	+		NR	
Probreviceps cf. rungwensis	Loveridge 1932	Snouted forest frog	NE	Udzungwa & Southern Rift	FF	VU	-	SP	+		NR	
Spelaeophryne methneri	Ahl 1924	Scarlet snouted frog	NE	Uluguru, Mahenge, Udzungwa, Coastal Forests, Southern Rift	F	LC	-	SP	+	+	Sali; Nawenge; (Nambiga)	Loader *et al.* 2003; FT 2001; 2004a

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Recording Method	Sali FR	Mselezi FR	Previous records in Mahenge	Source
RANIDAE												
Afrana angolensis	Bocage 1866	Angolan river frog	W	N.E., E & S. Africa	F/f	LC	-	SP	+		Sali; Mahenge Scarp; (Nambiga)	Loader *et al.* 2003; FT 2001; 2004b
Arthroleptides yakusini	Channing *et al*. 2002	Southern torrent frog	E	Nguru, Uluguru, Mahenge, Udzungwa	FF	EN	-	SP	+	+	Sali	Loader *et al.* 2003
Phrynobatrachus sp.								SP	+			
Phrynobatrachus acridoides	Cope 1867	East African puddle frog	W	W., S. & S.E. Africa	F/f	LC	-	SP	*****	+	Sali; (Nambiga)	Loader *et al.* 2003 FT 2001
Phrynobatrachus natalensis	Smith 1849	Natal puddle frog	W	S. Africa	f/O	LC	-	SP	*****	+	Sali; (Nambiga)	Loader *et al.* 2003; FT 2001
Phyrnobatrachus uzungwensis	Grandison & Howell 1983	Udzungwa puddle frog	E	Nguu, Nguru, Uluguru, Udzungwa	FF	VU	-	SP	+		NR	
Ptychadena anchietae	Bocage 1867	Anchieta's ridged frog	W	E., C. & S. Africa	O	LC	-	VIS	*****	+	Sali	Loader *et al.* 2003
*Pyxicephalus edulis******	Peters 1854	Edible bullfrog	W	E. & S. Africa	O	LC	-		*****		Sali	Loader *et al.* 2003
RHACOPHORIDAE												
*Chiromantis xerampelina******	Peters 1854	Southern foam nest frog	W	E. & S. Africa	O	LC	-		*****		Sali	Loader *et al.* 2003

*****Species previously recorded in Sali FR (Loader *et al.* 2003) but not in this study: *B. gutturalis, B. maculatus, H. marmoratum, A. brachycnemis, H. mitchelli, H. nasutus, H. tuberilinguis, B. mossambicus, P. bifasciatus, P. edulis, C. xerampelina, K. senegalensis.*

6b: Summary of amphibian captures

6b i: Sali FR

Species	No. individuals zoosite 1			No. individuals zoosite 2			KMH nos.
	VES	Bucket Pitfall	Casual	VES	Bucket Pitfall	Casual	
CAECILIIDAE/ SCOLECOMORPHIDAE							
sp. (cf. Scolecomorphus kirkii?)					1		
ARTHROLEPTIDAE							
Arthroleptis sp.	54	376	3		7		26255, 26238, 26239, 26240, 26265, 26267, 26268, 26636, 26983, 26985, 26987,
Arthroleptis reichei	23	131		5	13		26632, 26633,
Arthroleptis stenodactylus	2	3					26908,
Arthroleptis xenodactyloides	20	416		3	12	1	26253, 26642, 26982, 26984, 26988, 26989, 26995,
BUFONIDAE							
Nectophrynoides sp. nov 1	27	1		1	1		26252, 26259, 26260, 26263, 26264, 26648, 26649, 26650, 26912,
Nectophrynoides sp. nov 2				16	20		26637, 26638, 26639, 26641, 26643, 26644, 26998, 26999,
Nectophrynoides tornieri	3	1			2		26254, 26261, 26262, 26647, 26652, 26986,
HYPEROLIIDAE							
Afrixalus sp. nov				16			26651, 26958, 26980, 26962, 26968, 26971, 26974, 26970,
Afrixalus fornasini				2		1	26634, 26952,
Afrixalus uluguruensis complex	2			6			26269, 26646, 26950, 26957, 26992, 26993, 26966,
Hyperolius sp. 1			7	2			26955, 26959, 26960, 26967, 26972, 26976, 26977, 26979, 26996,
Hyperolius sp. (nov?)	1	3		2			26951, 26954, 26973, 26978, 26997,
Hyperolius puncticulatus			2				26956, 26961,
Leptopelis flavomaculatus			1				26645,
Leptopelis uluguruensis	1		2	3			26906, 26251, 26258
Leptopelis vermiculatus			1	41			26635, 26964, 26965,

Species	No. individuals zoosite 1			No. individuals zoosite 2			KMH nos.
	VES	Bucket Pitfall	Casual	VES	Bucket Pitfall	Casual	
MICROHYLIDAE							
Callulina sp. nov		6				1	26266, 26911, 26963, 26975,
Hoplophryne sp. nov		1					26981,
Probreviceps sp. nov	2	2			1		26256, 26969, 26991,
Probreviceps cf. rungwensis					1		26640
Spelaeophryne methneri		1					26990
RANIDAE							
Rana angolensis	2						26241
Arthroleptides yakusini	51						26242-26250, 26907,
Phyrnobatrachus sp.				1			26257
Phyrnobatrachus uzungwensis	2						26953, 26994

6b ii: Mselezi FR

Species	No. individuals			KMH nos.
	VES	Bucket Pitfall	Casual	
ARTHROLEPTIDAE				
Arthroleptis sp.	10	71	1	26463, 26655, 26656,
Arthroleptis xenodactyloides	66	114		26423, 26460, 26657, 26658, 26659, 26660,
BUFONIDAE				
Stephopaedes loveridgei			1	26653
HYPEROLIIDAE				
Afrixalus fornasini	1			26462
MICROHYLIDAE				
Spaleophryne methneri		1		26461
RANIDAE				
Arthroleptides yakusini	9			26419, 26420
Phrynobatrachus acridoides	2			26421, 26458
Phrynobatrachus natalensis	4			26422, 26459, 26654
Ptychadena cf. anchietae			1	

APPENDIX 7: REPTILES

7a: Full list of reptile species found in Sali & Mselezi Forest Reserves, with previous records from the Mahenge Mountains (Loader *et al.* 2003). Information on forest-dependency, endemism, conservation status, taxonomy and nomenclature follows Burgess *et al.* (2007); CITES (2006); Howell (1993); IUCN (2006); Spawls *et al.* (2002).

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Recording Method	Sali FR	Mselezi FR	Previous records in Mahenge	Source
SAURIA												
GEKKONIDAE												
Cnemaspis sp. nov			SE?		FF?			SP	+	+	NR	
*Cnemaspis africana**	Werner 1895	Usambara forest gecko	NE	Shimba, Mt Meru, Mt Kilimanjaro, Taita Hills, Pares, Usambaras, Nguru, Southern Highlands	FF	NE	-		*		Sali	Loader *et al.* 2003
CHAMAELEONIDAE												
Kinyongia sp. nov?			SE?		FF?			SP	+		NR	
Chamaeleo dilepis‡	Leach 1819	Flap-necked chameleon	W	E. & S. Africa	O/f	NE	II	PH	+		Sali; Nawenge; (Nambiga)	Loader *et al.* 2003; FT 2001; 2004a
Chamaeleo melleri‡	Gray 1864	Giant one-horned chameleon	W	Malawi, Tanzania, Mozambique	O/f	NE	II	PH	+		Sali	Loader *et al.* 2003
Rieppeleon brevicaudatus	Matschie 1892	Bearded pygmy chameleon	NE	Shimba Hills, Usambaras, Uluguru, Nguru, Udzungwa, Mahenge, Coastal Forests	F	NE	-	SP	+	+	Sali; Nawenge; Mahenge Scarp	Loader *et al.* 2003; FT 2004a; 2004b
Rhampholeon beraduccii	Mariaux & Tilbury 2006	Pygmy chameleon	SE	Mahenge	F/f	NE	-	SP	+		Sali	Loader *et al.* 2003
VARANIDAE												
Varanus niloticus	Linnaeus 1766	Nile monitor lizard	W	E. Africa	O	NE	II	PH		+	NR; (Nambiga)	FT 2001

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Recording Method	Sali FR	Mselezi FR	Previous records in Mahenge	Source
SCINCIDAE												
Mabuya sp. (cf. striata or planifrons)			W					VIS		+		
Melanoseps loveridgei	Brygoo & Roux-Esteve 1981	Loveridge's limbless skink	W	SE. Africa	O	NE	-	SP	+	+	Nawenge	FT 2004a
Trachylepis cf. striata	Peters 1844	Eastern striped skink	W	E. Africa	f/O	NE	-	SP	+		NR	
SERPENTES												
TYPHLOPIDAE												
Rhinotyphlops mucruso‡	Peters 1854	Zambezi blind snake	W	E. & S. Africa	F/f	NE	-	SP	+		Sali	Loader *et al.* 2003
BOIDAE												
Python sp.		Rock python	W					VIS & PH	+		NR	
ATRACTASPIDIDAE												
Atractaspis aterrima	Günther 1863	Slender burrowing asp	W	Udzungwa, Uluguru, C. Africa	F/f	NE	-	SP	+		Nawenge	FT 2004a
COLUBRIDAE												
Crotaphopeltis tornieri	Werner 1908	Tornier's cat snake	NE	Usambaras, Nguru, Uluguru, Rubeho, Udzungwa, Southern Rift	FF	NE	-	SP	+		NR	
Crotaphopeltis hotamboeia‡	Pitman 1974	White-lipped snake	W	E. & S. Africa	O	NE	-	SP	+		NR	
Dasypeltis medici‡	Bianconi 1859	Rufous egg eater	W	E. & S. Africa	F/f	NE	-	SP	+		Sali ; (Nambiga)	Loader *et al.* 2003; FT 2001
Lamprophis fuliginosus complex	Boie 1827	Brown house snake	W	E. Africa	O	NE	-	SP	+		NR; (Nambiga)	FT 2001
Lycodonomorphus whytei	Boulenger 1897	Whyte's water snake	W	S. Tanzania, Mozambique, S. Africa.	O	NE	-	SP	+		NR	

Species	Authority	Common Name	Range	Details	Habitat	IUCN status	CITES status	Recording Method	Sali FR	Mselezi FR	Previous records in Mahenge	Source
Natriciteres sylvatica‡	Broadley 1966	Forest marsh snake	W	S. Tanzania, Mozambique, Malawi, Zimbabwe, Zululand	FF	NE	-	SP	+		NR	
Philothamnus sp. ‡		Green snake	W					SP	+			
Philothamnus cf. angolensis‡	Bocage 1882	Angolan green snake	W	E. & S. Africa	F/f	NE	-	SP	+		NR	
Philothamnus cf. hoplogaster‡	Gunther 1863	South-eastern green snake	W	E., C. & S. Africa	F/f	NE	-	SP	+		NR; (Nambiga)	FT 2001
Philothamnus semivariegatus	Smith 1847	Spotted bush snake	W	NE., E. & C. Africa	F/f	NE	-	SP		+	NR	
Psammophis orientalis‡	Broadley 1977	Eastern stripe-bellied sand snake	W	SE. Africa	O	NE	-	SP	+		NR; (Nambiga)	FT 2001
Thelotornis mossambicanus‡	Bocage 1895	Eastern vine snake	W	S. Somalia to N. Mozambique, E. Zimbabwe, Malawi	O/f	NE	-	SP & PH	+	+	NR; (Nambiga)	FT 2001
Xyeledontophis sp.			E?	Uluguru?	FF?			SP	+		NR	
ELAPIDAE												
Dendroaspis angusticeps	Smith 1849	Green mamba	W	E. & S. Africa	F/f	NE	-	VIS	+		Nawenge; (Nambiga)	FT 2001; 2004a
cf. Naja sp.		Cobra	W					VIS	+	+	Mahenge Scarp; (Nambiga)	FT 2001; 2004b
VIPERIDAE												
Causus defilippi‡	Jan 1862	Snouted night adder	W	SE. Africa	F/f	NE	-	SP	+		Mahenge Scarp; (Nambiga)	FT 2001; 2004b

‡These species were found by local villagers at the forest edge and in farms surrounding the reserve.
*****Species previously recorded in Sali FR (Loader *et al.* 2003) but not in this study: *C. africana*

7b: Summary of reptile captures

7b i: Sali FR

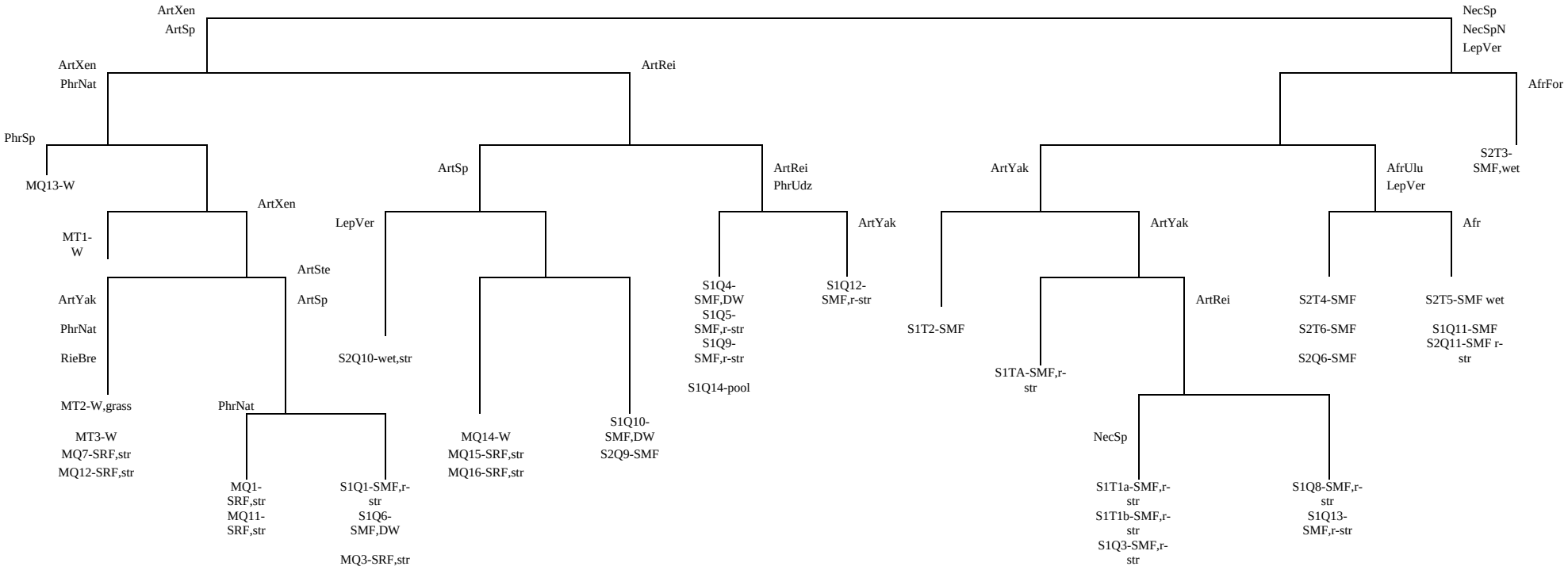
Species	No. individuals	No. individuals Zoosite 1			No. individuals Zoosite 2			KMH nos.
	Forest edge / Farm	VES	Bucket Pitfall	Casual	VES	Bucket Pitfall	Casual	
GEKKONIDAE								
Cnemaspis sp. nov?		2	1	2	2	2		26756, 26757, 26762, 26767, 26768, 26772
CHAMAELEONIDAE								
Rieppeleon brevicaudatus		13		23	18			26753, 26760
Rhampholeon beraduccii		7		1	1			26752, 26754, 26758, 26759, 26775
Kinyongia sp. nov?				1				26761
Chamaeleo dilepis	1							
Chamaeleo melleri	1							
SCINCIDAE								
Melanoseps loveridgei		1				2		26765, 26771, 26774
Trachylepis cf. striata				1				26769
TYPHLOPIDAE								
Rhinotyphlops mucruso	1							26770
BOIDAE								
Python sp.				1				
ATRACTASPIDIDAE								
Atractaspis aterrima				1				26764
COLUBRIDAE								
Crotaphopeltis tornieri				3				26763, 26781
Crotaphopeltis hotamboeia	2							26782, 26784,
Dasypeltis medici	1							26780
Lamprophis fuliginosus complex				1				26766
Lycodonomorphus whytii							1	26773
Natriciteres sylvatica	2							26418, 26783
Philothamnus sp.	3							26415
Philothamnus cf. angolensis	2							26779, 26417
Philothamnus cf. hoplogaster	2							26416

Species	No. individuals	No. individuals Zoosite 1			No. individuals Zoosite 2			KMH nos.
	Forest edge / Farm	VES	Bucket Pitfall	Casual	VES	Bucket Pitfall	Casual	
Psammophis orientalis	1							26785
Thelotornis mossambicanus	1							26778
Xyeledontophis sp.							1	26755
ELAPIDAE								
Dendroaspis angusticeps							1	
cf. Naja sp.				2				
VIPERIDAE								
Causus defilippi	2							26776, 26777

7b ii: Mselezi FR

Species	No. individuals			KMH nos.
	VES	Bucket Pitfall	Casual	
GEKKONIDAE				
Cnemaspis sp. nov?	4	2		23945, 23946
CHAMAELEONIDAE				
Rieppeleon brevicaudatus	11			23947
VARANIDAE				
Varanus niloticus			1	
SCINCIDAE				
Mabuya sp. (cf. planifrons or striata)	2			
Melanoseps loveridgei		1		23948
COLUBRIDAE				
Philothamnus semivariegatus			1	23949
Thelotornis mossambicanus	1			
ELAPIDAE				
cf. Naja sp.			1	

7c: TWINSPAN analysis of herpetofaunal communities in the Mahenge Mountains based on presence-absence data



AfrFor	:	*Afrixalus fornasinii*
AfrUlu	:	*Afrixalus uluguruensis*
ArtYak	:	*Arthroleptidis yakusini*
ArtRei	:	*Arthroleptis reichei*
ArtSp	:	*Arthroleptis sp.*
ArtSte	:	*Arthroleptis stenodactylus*
ArtXen	:	*Arthroleptis xenodactyloides*
LepVer	:	*Leptopelis vermiculatus*
NecSp	:	*Nectophrynoides sp. nov 1*
NecSpN	:	*Nectophrynoides sp. nov. 2*
PhrNat	:	*Phrynobatrachus natalensis*
PhrSp	:	*Phrynobatrachus sp.*
PhrUz	:	*Phrynobatrachus uzungwensis*
RieBre	:	*Rieppeleon brevicaudatus*
S1	:	Sali FR Base camp 1
S2	:	Sali FR Base camp 2
M	:	Mselezi FR
Q	:	Quadrat (diurnal)
T	:	Transect (nocturnal)
SMF	:	Undifferentiated (sub) Montane Forest,
SRF	:	Semi Riverine Forest
SRF	:	Semi Riverine Forest
W	:	Woodland
str	:	Stream
r-str	:	Rocky Stream
wet	:	Wetland
pool	:	Pool, Standing Water
DW	:	Dead Wood
grass	:	Grassland

APPENDIX 8: BUTTERFLIES

8a: Full list of butterfly species found in Sali & Mselezi Forest Reserves. Information on forest-dependency, endemism, conservation status, taxonomy and nomenclature follows Collins & Bampton (2007); Congdon (unpubl.); De Jong & Congdon (1993); Kielland (1990); Larsen (1996).

Species	Author	Range	Details (if restricted)	Habitat	Conservation status (ABRI)	Recording Method	Sali FR (specimen no)	Mselezi FR (specimen no)	Previous records in Mahenge	Source
NYMPHALOIDEA										
Sp.		W				SN	32b			
ACRAEIDAE										
Acraea sp.		W				SN	76			
Acraea aganice	Hewitson 1852	W		FF	LC	SN	44		Mahenge Scarp	FT 2004b
Acraea cerasa	Hewitson 1861	W		FF	LC	SN	6&47a		New Record	
Acraea egina	Cramer 1775	W		f	LC	SN	63		New Record	
Acraea insignis	Distant 1880	W		F	LC	SN	77		New Record	
Acraea johnstoni	Goodman 1885	W		FF	LC	SN	38		Nawenge	FT 2004a
Acraea natalica	Boisduval 1847	W		f	LC	SN		16	Mahenge Scarp	FT 2004b
Acraea pentapolis	Ward 1871	W		FF	LC	SN	12&39		New Record	
Acraea satis	Ward 1871	W		FF	LC	SN	34, 85		Mahenge Scarp	FT 2004b
DANAIDAE										
Amauris crawshayi	Butler 1897	W		F	T	SN	72		New Record	
Amauris echeria	Stoll 1790	W		F	LC	SN	20		New Record	
Amauris niavus	Linnaeus 1758	W		FF	LC	SN	4&46a	2	Mahenge Scarp; (Nambiga)	FT 2004b (& 2001)
Amauris tartarea	Mabille 1886	W		F	NE	SN	21		New Record	
Tirumala formosa	Godman 1880	W		F	LC	SN	F		New Record	
NYMPHALIDAE										
Aterica galene	Brown 1776	W		F	LC	SN		D	Mahenge Scarp	FT 2004b
Bebearia cocalia	Fabricius 1793	W		F	LC	CT	68		New Record	

Species	Author	Range	Details (if restricted)	Habitat	Conservation status (ABRI)	Recording Method	Sali FR (specimen no)	Mselezi FR (specimen no)	Previous records in Mahenge	Source
Byblia anvatara	Boisduval 1833	W		0	LC	CT		19	Mahenge Scarp; Nawenge; (Nambiga)	FT 2004a&b (& 2001)
Charaxes macclounii	Butler 1895	W		F	LC	CT		25	New Record	
Charaxes brutus	Cramer 1779	W		F	LC	CT	75		Mahenge Scarp; (Nambiga)	FT 2004b (& 2001)
Charaxes cithaeron	Felder 1885	W		FF	LC	CT	57	24	Mahenge Scarp; Nawenge; (Nambiga)	FT 2004a&b (& 2001)
Charaxes druceanus	Butler 1869	W		F	LC	CT	79		Mahenge Scarp; Nawenge	FT 2004a&b
Charaxes pleione	Godart 1824	W		F	LC	SN	9		New Record	
Charaxes violetta	Grose-Smith 1885	W		F	LC	CT		11a	Mahenge Scarp; (Nambiga)	FT 2004b (& 2001)
Charaxes xiphares	Cramer 1781	W		FF	LC	CT	58		New Record	
Cymothoe aurivilli	Staudinger 1899	E	Nguru, Nguu, Uluguru, Rubeho, Udzungwa	FF	V		36		New Record	
Cyrestis camillus	Fabricus (1781)	W		F	LC	SN	A		New Record	
Euphaedra castanoides	Hecq 1985	W		FF	LC	SN	D		Sali	Kielland 1990
Euphaedra crawshayi	Butler 1895	W		F	LC	SN	C		New Record	
Euphaedra neophron	Hopffer 1855	W		F	LC	SN		F	Mahenge Scarp; (Nambiga)	FT 2004b (& 2001)
Euphaedra orientalis	Rothschild 1898	W		FF	NT	SN		A	Mahenge Scarp	FT 2004b
Eurytela dryope	Cramer 1775	W		F	LC	SN		17	Mahenge Scarp; Nawenge; (Nambiga)	FT 2004a&b (& FT 2001)
Euxanthe tiberius	Grose-Smith 1889	W		FF	NT	SN	E		Mahenge Scarp	FT 2004b
Euxanthe wakefieldi	Ward 1873	W		FF	LC	CT		20	Mahenge Scarp	FT 2004b
Hypolimnas anthedon	Doubleday 1845	W		F	LC	SN	1	23	Mahenge Scarp; (Nambiga)	FT 2004b (& 2001)
Junonia sophia	Fabricus 1793	W		f	LC	SN	49&64		New Record	
Junonia terea	Drury 1773	W		F	LC	SN	43		Mahenge Scarp; Nawenge; (Nambiga)	FT 2004a&b (& 2001)
Lachnoptera iole ayresi	Trimen 1879	W		FF	LC	SN	14		New Record	

Species	Author	Range	Details (if restricted)	Habitat	Conservation status (ABRI)	Recording Method	Sali FR (specimen no)	Mselezi FR (specimen no)	Previous records in Mahenge	Source
Neptis kiriakofi	Overlaet 1955	W		f	LC	SN		22	Nawenge	FT 2004a
Neptis nina	Staudinger 1896	NE	Usambaras, Kimboza, Uluguru, Nguu, Nguru, Mwanihana to Mufindi, Ukaguru, Ulanga District & Pugu Hills	FF	LC	SN	35		(Ulanga District)	(Kielland 1990)
Neptis laeta	Overlaet 1955	W		F	LC	SN	51		New Record	
Precis tugela	Trimen 1879	W		F	LC	SN	47b		New Record	
Pseudacraea lucretia	Cramer 1775	W		F	LC	SN		C	Mahenge Scarp; Nawenge	FT 2004a&b
Pseudacraea dolomena	Hewitson 1865	W		FF	LC		30		New Record	
Pseudargynnis hegemone	Godart 1814	W		F	LC	SN	55		Mahenge Scarp	FT 2004b
Salamis parhassus	Drury 1782	W		F	LC	SN	18& 33		Mahenge Scarp	FT 2004b
Salamis temora	Felder 1867	W		F	LC	SN	B		Mahenge Scarp	FT 2004b
Sevenia garega	Karsch 1892	W		F	NE	SN	29		Mahenge Scarp; Nawenge	FT 2004a&b
Sevenia moranti	Trimen 1881	W		F	NE	CT	13	7	Mahenge Scarp; Nawenge	FT 2004a&b
SATYRIDAE										
Bicyclus sp.						CT	42			
Bicyclus campinus	Aurivillius 1901	W		F	LC	SN & CT	25, 32a, 40, 45		Mahenge Scarp; Nawenge; (Nambiga)	FT 2004a&b (& 2001)
Bicyclus campus	Karsch 1893	W		F	NE	CT		6	Mahenge Scarp	FT 2004b
Bicyclus danckelmani	Rogenhofer 1891	NE	Usambaras, Nguru, Nguu, Kanga, Ukaguru, Rubeho, Uluguru, Muhulu, Malundwe, Lulando, Mt Meru & Southern Rift	FF	T	CT	74&86		Muhulu	Kielland 1990

Species	Author	Range	Details (if restricted)	Habitat	Conservation status (ABRI)	Recording Method	Sali FR (specimen no)	Mselezi FR (specimen no)	Previous records in Mahenge	Source
Bicyclus safitza	Westwood 1850	W		f	LC	CT		5 & 26	Mahenge Scarp; Nawenge; (Nambiga)	FT 2004a&b (& 2001)
Bicyclus simulacris	Kielland 1990	NE	Uluguru, Uzungwa, Rubeho, Southern Rift & Northern Malawi	FF	T	CT		14	New Record	
Bicyclus tanzanicus	Condamin 1986	W		f	NE	CT	82	13 & 21	New Record	
Gnophodes betsimena	Boisduval 1833	W		F	LC	SN	28		Mahenge Scarp; Nawenge; (Nambiga)	FT 2004a&b (& FT 2001)
Henotesia perspicua	Trimen 1873	W		f	LC	SN		1	(Nambiga)	(FT 2001)
Ypthimomorpha itonia	Hewitson 1865	W		o	LC	SN	61		New Record	
PAPILIONOIDEA										
PAPILIONIDAE										
Graphium policenes	Cramer 1775	W		FF	LC	SN	7	18	(Nambiga)	(FT 2001)
Papilio dardanus	Brown 1776	W		FF	LC	SN	11		Mahenge Scarp	FT 2004b
Papilio demodocus	Esper 1798	W		f	LC	SN		12	Mahenge Scarp	FT 2004b
Papilio fuelleborni fuelleborni	Karsch 1900	NE	Usambara, Nguru, Nguu, Ukaguru, Rubeho, Uluguru, Udzungwa, Southern Rift & Northern Malawi	FF	NT	SN	83		New Record	
Papilio ophidicephalus	Oberthur 1878	W		F	LC	SN	19	15	Nawenge	FT 2004a
Papilio pelodurus vesper	Le Cref 1924	NE	Usambara, Nguru, Nguu, Rubeho, Uluguru, Uzungwa, Southern Rift & Malawi	FF	LC	SN	65		New Record	
Papilio phorcas	Cramer 1775	W		FF	LC	SN	41&84		New Record	
PIERIDAE										
Appias lasti	Grose-Smith 1889	W		F	LC	SN	2	B	New Record	

Species	Author	Range	Details (if restricted)	Habitat	Conservation status (ABRI)	Recording Method	Sali FR (specimen no)	Mselezi FR (specimen no)	Previous records in Mahenge	Source
Appias sabina	Felder and Felder 1865	W		F	LC	SN	22		New Record	
Catopsilia florella	Fabricius 1775	W		f	LC	SN	48	10	Mahenge Scarp; (Nambiga)	FT 2004b (& 2001)
Eurema floricola	Boisduval 1833	W		FF	LC	SN	23		Mahenge Scarp; Nawenge	FT 2004a&b
Eurema hapale	Mabille 1882	W		f	LC	SN	67		Nawenge	FT 2004a
Eurema mandarinula	Holland 1892	W		F?	LC	SN	78		New Record	
Eurema regularis	Butler 1876	W		F	LC	SN	17		New Record	
Eurema senegalensis	Boisduval 1836	W		F	LC	SN	3	11b&E	Mahenge Scarp	FT 2004b
HESPERIOIDEA										
HESPERIIDAE										
Celaenorrhinus sp.		W				SN		8	New Record	
Celaenorrhinus bettoni	Butler 1902	W		FF	LC	SN	27		New Record	
Eagris sabadius	Gray 1832	W		F	LC	SN	24		New Record	
Pardaleodes incerta	Snellen 1872	W		F	LC	SN		4	New Record	
Tagiades flesus	Fabricius 1781	W		F	LC	SN	26		New Record	
LYCAENOIDEA										
LYCAENIDAE										
Alaena picata	Sharpe 1896	W		F	NT	SN		9	New Record	
Anthene kersteni	Gerstaecker 1871	W		f	LC	SN	59, 66 & 81		New Record	
Axiocerses tjoane	Wallengren 1857	W		f	LC	SN	62		New Record	
Azanus moriqua	Wallengren 1857	W		f	LC	SN	52, 56 & 80		New Record	
Azanus sp.		W				SN	69		New Record	

Species	Author	Range	Details (if restricted)	Habitat	Conservation status (ABRI)	Recording Method	Sali FR (specimen no)	Mselezi FR (specimen no)	Previous records in Mahenge	Source
Cacyreus lingeus	Stoll 1782	W		F	LC	SN	50		New Record	
Eicochrysops hippocrates	Fabricius 1793	W		f	LC	SN	70, 46b & 60		New Record	
Leptotes pirithous	Linnaeus 1767	W		f	LC	SN	37, 54 & 15		(Nambiga)	(FT 2001)
Oboronia beuronica	Karsch 1895	W		F	NT	SN	5	3	New Record	
Tuxentius calice	Hopffer 1855	W		f	LC	SN	53		New Record	
Tuxentius cretosus	Butler 1876	W		f	NE	SN	31, 71		New Record	
Uranothauma delatorum	Heron 1909	W		FF	NE	SN	73		New Record	
Uranothauma falkensteini	Dewitz 1879	W		FF	LC	SN	10		Nawenge	FT 2004a
Uranothauma heritsia	Hewitson 1876	W		F	LC	SN	16		Nawenge	FT 2004a

8b: Summary of butterfly captures
8b i: Sali FR

Zoosite 1:

Trapnight	**No of Canopy trap captures**						**No. of sweep net captures**	**Casual captures**	**No. released**	**No. taken**	**Specimen numbers**
	1	**2**	**3**	**4**	**5**	**6**					
1	0	0	0	0	0	0	8	4	5	7	A-D,1-3
2	0	0	0	0	0	0	11	1	5	7	4-9
3	0	0	0	0	0	0	34	0	22	12	10-20
4	0	0	0	0	1	0	13	0	5	9	21-28, 28b
5	1	0	1	0	0	2	20	1	19	6	29-31, 32a, E
6	0	0	0	0	0	0	17	0	8	9	32b, 33-40
7	1	0	2	0	0	0	20	0	21	2	41, 42
8	0	0	0	0	0	0	12	0	5	7	43-45, 46a, 47a
TOTAL	**2**	**0**	**3**	**0**	**1**	**2**		**135**	**6**	**90**	**59**

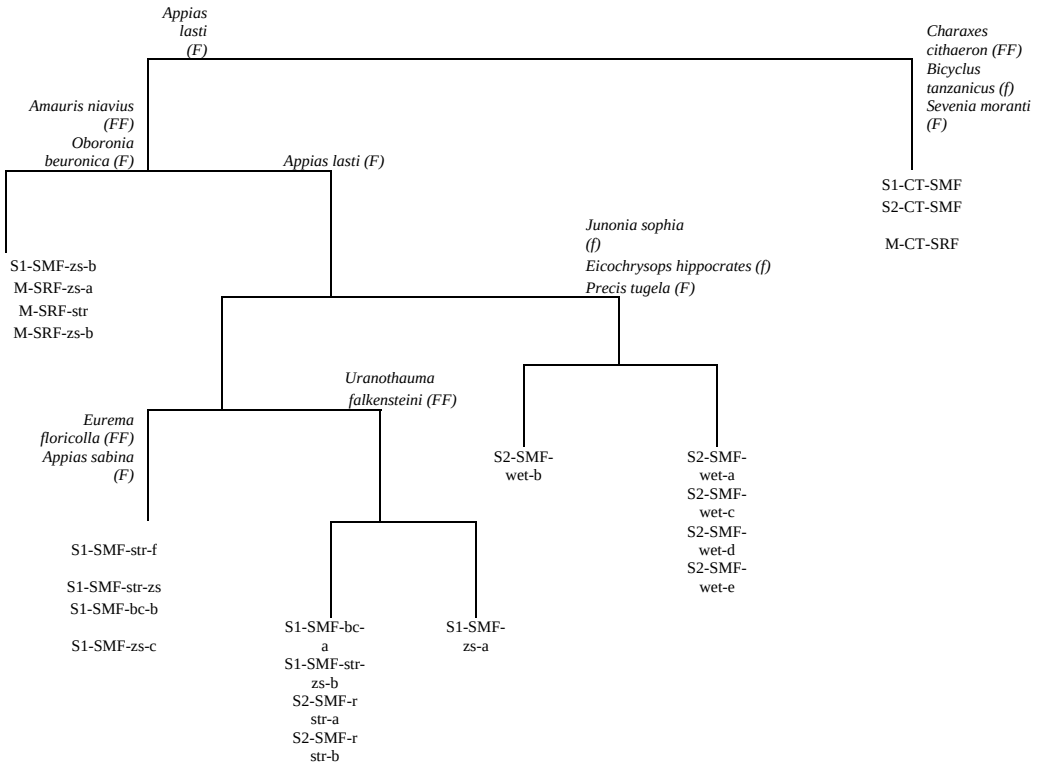
Zoosite 2:

Trapnight	**No of Canopy trap captures**						**No. of sweep net captures**	**Casual captures**	**No. released**	**No. taken**	**Specimen numbers**
	1	**2**	**3**	**4**	**5**	**6**					
1	0	1	0	0	0	0	18	0	14	5	46b, 47b, 48-50
2	1	0	1	0	0	2	20	0	15	9	51-58
3	0	0	1	0	0	0	14	0	7	8	59-64
4	1	1	2	1	0	1	19	0	22	3	65-68
5	1	0	0	1	0	3	25	0	19	11	69-75
6	0	0	0	0	0	2	11	1	9	5	76-79, F
7	0	0	0	0	0	0	17	0	15	2	80-81
8	0	0	0	0	0	2	4	0	1	1	82-86
TOTAL	**3**	**2**	**4**	**2**	**0**	**10**		**128**	**1**	**102**	**44**

8b ii: Mselezi FR

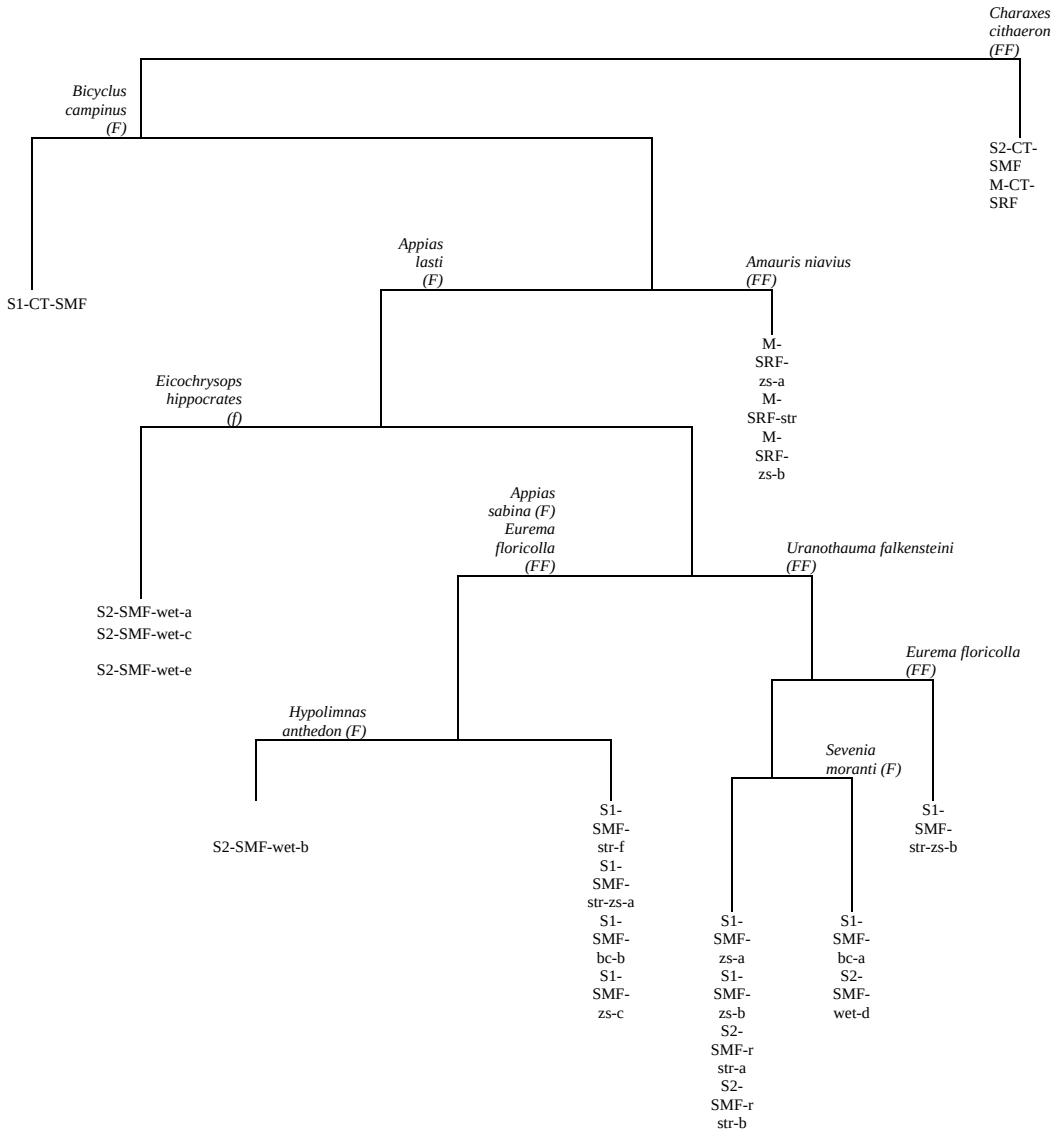
Trapnight	**No of Canopy trap captures**						**No. of sweep net captures**	**Casual captures**	**No. released**	**No. taken**	**Specimen numbers**
	1	**2**	**3**	**4**	**5**	**6**					
1	0	0	0	0	0	0	1	0	0	1	1
2	0	0	1	2	1	1	4	0	3	6	2-7
3	0	0	0	0	2	0	1	0	2	1	as 5
4	0	2	1	0	0	1	3	0	4	3	8,9,11
5	1	0	0	0	2	1	2	0	3	3	12-14
6	1	0	0	0	2	2	2	0	3	4	15,16
7	4	0	0	1	0	1	6	0	11	1	21
8	0	1	1	3	2	3	1		3	3	22-24
TOTAL	**6**	**3**	**3**	**6**	**9**	**9**		**20**	**0**	**29**	**22**

8c i: TWINSPAN analysis of butterfly communities in the Mahenge Mountains based on presence-absence data



S1	: Sali FR Base camp 1	SMF	: Undifferentiated (sub) Montane Forest,	zs	: Zoosite	str-zs	: Stream / Zoosite
S2	: Sali FR Base camp 2	SRF	: Semi Riverine Forest	str	: Stream	wetr	: Wetland
M	: Mselezi FR			bc	: Base camp	str	: Rocky Stream
CT	: Canopy Trap			str-f	: Stream / Forest		

8c ii: TWINSPAN analysis of butterfly communities in the Mahenge Mountains based on species abundance data



Key as 8c i

APPENDIX 9: VEGETATION

9a: Full list of plant species found in Sali & Mselezi Forest Reserves. Information on forest-dependency, endemism, conservation status, taxonomy and nomenclature follows Ahrends *et al.* 2006; Ahrends & Marchant (2006); Beentje (1994); Burgess *et al*. (2007); Clarke (1995); *Flora of Tropical East Africa* (FTEA 1952-); *List of East African Plants* (LEAP; Knox 2000); *List of Potentially Threatened Plants in the EACF hotspot of Kenya and Tanzania* (Gereau & Luke 2003, revised 2006); Lovett *et al.* (2006).

Specimen Number	Family	Species	Author	Local Name	Endemic Status	Conservation Status	Life Form	Habit	Distribution (Lovett *et al*. in press)	Altitude	Sali FR	Mselezi FR	Previous records in Mahenge	Source
2529	Acanthaceae	*Brillantaisia sp. 1*					H			1250	+			
2569	Acanthaceae	*Brillantaisia sp. 2*					H			580		+		
2523	Acanthaceae	*Isoglossa sp.*					S			1250	+			
2458	Acanthaceae	*Justicia interrupta var*.	(Lindau) C.B.Clarke			PT, NE	S	fs		450-1200	+		Mahenge Scarp	Lovett & Pócs 1993
2452	Acanthaceae	*Mellera lobulata*	S.Moore			NE	H	fs		600-1000 (1164)	+	+	NR; (Ulanga)	Tropicos: R. Gereau 1998
2572	Acanthaceae	*Nelsonia canescens*	(Lam.) Spreng.			NE	H			540		+	NR; (Nambiga)	Tropicos: V. Simon *et al*. 1998
	Acanthaceae	*Thunbergia heterochondros**	Vollesen		E	PT, NE	H			230		*	Mselezi	Tropicos: B. Mhoro 1988
	Acanthaceae	*Whitfieldia orientalis**	Vollesen		E	PT, NE	S			2002	*		Sali	Tropicos: Schlieben 1932
2403 & 2455	Achariaceae	*Calancoba welwitschii*	(Oliv.) Gilg			NE	T			800-1900	+		NR	
2446	Alangiaceae	*Alangium chinense*	(Lour.) Harms			NE	T	fg	EA, N, LN, LV. Tropical E., S., C. & Western C. Africa. Asia & Far East.	750-2250	+		NR	
2555	Anacardiaceae	*Sclerocarya birrea ssp. caffra*	(A.Rich.) Hochst. ssp. (Sond.)Kokwaro	Mwembeng'ong'o		NE	T			530		+	NR; (Ulanga)	Tropicos: C.J. Kayombo 1999
	Anacardiaceae	*Sorindeia madagascariensis*	Thouars ex. DC.	Mpili		NE	T	fs	C, EA, N, LN. S.E. Tropical Africa. Mascarenes. Madagascar.	1-1830		+	Nawenge	FT 2004a; Lovett & Pócs 1993

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	Annonaceae	*Annona senegalensis*	Pers.	Mdompi		NE	T	g/w	Widespread in Tropical Africa, also in Madagascar & Comoro Islands.	0-1800		+	Mahenge Scarp; Mselezi	FT 2004b; Tropicos: G. Simon Laizer *et al*. 2006
2568	Annonaceae	*Genus 1, sp. A*	sp. A				T			580		+		
2556	Annonaceae	*Lettowianthus stellatus*	Diels	Mlengalenga	NE	VU	T	fg	C, EA.	450-525 (773)		+	Mahenge Scarp; Nambiga	FT 2004b; Lovett & Pócs 1993
	Annonaceae	*Monanthotaxis dictyoneura**	(Diels) Verdc.		E	PT, NE	C			1000-1200	*		Muhulu; Nawenge; Sali	Tropicos: Schlieben 1932; A. Ntemi Sallu & O. Ngawamba 2003; Schlieben 1932
2515	Annonaceae	*Monanthotaxis sp. 1*					L			1320	+			
2508	Annonaceae	*Monanthotaxis sp. 2*					T			1320	+			
2422	Annonaceae	*Monodora globiflora*	Couvreur ined			PT, NE	T			1261	+		NR	
2456	Annonaceae	*Monodora sp.*					T			1200	+			
2509	Annonaceae	*Sphaerocoryne/Toussaintia sp.*					L			1320	+			
	Annonaceae	*Uvaria acuminata**	Oliv.			PT, NE	S			0-1000		*	Mselezi	Tropicos: S. Bodine *et al*. 2006
2544	Annonaceae	*Uvariodendron sp.*		Nachaya			T			600		+		
2482	Annonaceae	*Xylopia sp.*					T			1310	+			
2420	Apocynaceae	*Carvalhoa campanulata*	K.Schum.			NE	T			1261	+		NR; (Ulanga)	Tropicos: B. Mhoro 1988
2587	Apocynaceae	*Holarrhena pubescens*	(Buch.-Ham)G.Don	Mweruweli		LC	T			730		+	Mahenge Scarp	FT 2004b
2492	Apocynaceae	*Pleiocarpa sp.*					T			1290	+			
	Apocynaceae	*Rauvolfia caffra*	Sond.			NE	T	fs	C, EA, N, LN, LT. Widespread in Tropical & S. Africa	1290	+		Mahenge Scarp; Nawenge	FT 2004b; Lovett & Pócs 1993

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2427	Apocynaceae	*Rauvolfia sp.*					T			1261	+			
2591	Apocynaceae	*Tabernaemontana odoratissima*	(Stapf)Leeuw enberg	Magoli gaduma		NE	T	fg	EA (Ma, Udz). Uganda, C. Africa.	585		+	NR; (Ulanga)	FTEA (1958)
	Apocynaceae	*Tabernaemontana pachysiphon*	Stapf			NE	T	fg	C, EA, N, LN, LT, LV. Widespread in Tropical Africa	15-2000	+		NR	
2543	Apocynaceae	*Voacanga sp.*					T			630		+		
2542	Araceae	*Anchomanes abbreviatus*	Engl.		E	PT, NE	H		Eastern Arc	0-800	+	+	NR	
2520	Araceae	*Culcasia falcifolia*	Engl.			NE	C			500-2100	+		NR	
2558	Araliaceae	*Polyscias sp.*					T			773		+		
2470	Asteraceae	*Bothriocline sp.*					H			1250	+			
2449	Asteraceae	*Solanecio mannii*	(Hook.f.) C.Jeffrey			NE	T			1354	+		NR	
2589	Asteraceae	*Vernonia sp.*		Mtukutu			H			585		+		
2463	Balsaminaceae	*Impatiens confusa subsp. longicornu*	Grey-Wilson		E	PT, NE	H		Eastern Arc	1300-1750 (1260)	+		Muhulu	FTEA & Tropicos: Cribb, Grey-Wilson & Mwasumbi 1979
	Balsaminaceae	*Impatiens joachimii**	G.M. Schulze		E	PT, NE	H			1000-1400	*		Sali	FTEA & Tropicos: Cribb, Grey-Wilson & Mwasumbi 1979
	Balsaminaceae	*Impatiens mahengeensis**	Grey-Wilson		E	PT, NE	H			1100-1300			Muhulu; Sali	FTEA & Tropicos: Cribb, Grey-Wilson & Mwasumbi 1979
	Balsaminaceae	*Impatiens paludicola**	Grey-Wilson		E	PT, NE	H			1300			Muhulu	FTEA & Tropicos: Cribb, Grey-Wilson & Mwasumbi 1979
	Balsaminaceae	*Impatiens saliensis**	G.M.Schulze		E	PT, NE	H			1200	*		Sali	FTEA & Tropicos: Schlieben 1932

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2433	Balsaminaceae	*Impatiens sp.*					H			1500	+			
2462	Balsaminaceae	*Impatiens walleriana*	Hook.f.			NE	H			0-2000	+		NR	
	Bignoniaceae	*Markhamia lutea*	(Benth.) K. Schum			NE	T	fs	C, EA, LT, LV. Widespread in Tropical Africa.			+	Mahenge Scarp	FT 2004b
	Bignoniaceae	*Markhamia zanzibarica*	(Bojer ex DC.) K.Schum.	Mtalanda		NE	T	fg	C, LT. S. & E. Africa.			+	NR; (Ulanga)	Tropicos: C.J. Kayombo 1999
	Bignoniaceae	*Stereospermum kunthianum*	Cham.	Muegeya		NE	T	fg		450-1500		+	Mahenge Scarp	Tropicos: W.J. Kindeketa *et al*. 2006; FT 2004b
	Bombacaceae	*Bombax rhodognaphalon var.*	K.Schum.	Msufi pori	NE	NE	T	fg	C, EA, LN. E. & S.E. Tropical Africa.	20-700		+	Mselezi; Nawenge	Lovett & Pócs 1993
	Boraginaceae	*Cordia africana*	Lam.	Mwambangima		NE	T	g/w	C, EA, N, LN, LT.	450-2100	+	+	NR; (Ulanga)	Tropicos: O.A. Kibure *et al*. 1998
	Burseraceae	*Commiphora africana var.*	(A.Rich.) Engl.			NE	T	g/w		5-1780		+	Mahenge Scarp	FT 2004b; Tropicos: C.J. Kayombo 1999
	Burseraceae	*Commiphora eminii subsp. trifoliolata**	(Engl.) J. B. Gillett		E	PT, NE	T	fg	C, EA, N.	350-1800		*	Mselezi	Tropicos: B. Mhoro 1988
2557	Burseraceae	*Commiphora sp.*					T			773		+		
	Campanulaceae	*Lobelia longisepala**	Engl.		E	PT, NE	H			800-1500			Nawenge	Lovett & Pócs 1993
2450	Caricaceae	*Cylicomorpha parviflora*	Urb.	Mtondolo		PT, NE	T	fs	EA, LN. Kenya, Malawi.	800-1600	+		Nawenge	FT 2004a; Lovett & Pócs 1993
2419	Cecropiaceae	*Myrianthus sp.*					T			1261	+			
2536	Celastraceae	*Maytenus undata*	(Thunb.) Blakelock			NE	T	fg	C, EA, N, LN, LT, LV. Widespread in Tropical & S. Africa, Madagascar, Comoros.	0-3150	+		NR; (Ulanga)	FTEA: Cribb, Grey-Wilson & Mwasumbi 1979; Tropicos: O.A. Kibure (1998)
2519	Celastraceae	*Salacia lehmbachii*	Loes.			NE	T			45-1750	+		NR	

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2522	Celastraceae	*Salacia sp?*					L			1250	+			
	Chrysobalanaceae	*Parinari curatellifolia ssp.*	Planch. Ex Benth.			NE	T	g/w			+		NR	
	Chrysobalanaceae	*Parinari excelsa ssp.*	Sabine	Mgama		NE	T	fs	C, EA, LN, LT, LV. Widespread in Tropical Africa.	1000-2000	+		Muhulu; Nawenge	FT 2004a; Lovett & Pócs 1993
	Combretaceae	*Combretum pentagonum*	M. A. Lawson			NE	T	fg		20-900		+	NR	
	Combretaceae	*Pteleopsis myrtifolia*	(M.A. Lawson) Engl. & Diels	Mnepa		NE	T	fg	C, EA. E. & S. Africa.	0-1600		+	Mahenge Scarp	FT 2004b
2524	Commelinaceae	*Pollia condensate*	C.B.Clarke			NE	H			1250	+		NR	
2506	Connaraceae	*Agelaea pentagyna*	(Lam.)Baill			NE	L			1200	+		NR	
	Convolvulaceae	*Ipomoea microcalyx**	Schulze-Menz		E	PT, NE	C			950	*		Sali	Tropicos: Schlieben 1932
	Cucurbitaceae	*Coccinia schliebenii**	Harms			PT, NE	C			810		*	Mselezi	Tropicos: W.J. Kindekata *et al*. 2006
2472	Cyatheaceae	*Cyathea sp.*					T			1250	+			
2434	Cyperaceae	*Hypolytrum testui?*	Cherm.			NE	H			1000 (1500)	+		NR	
2593	Dracaenaceae	*Dracaena aletriformis*	(Hacq.)Boss			NE	T			693		+	NR	
2399	Dracaenaceae	*Dracaena fragrans*	(L.)Ker Gawl.			NE	S			1300	+		NR	
2436	Dracaenaceae	*Dracaena laxissima*	Engl.			NE	T	fs		1500	+		Nawenge	FT 2004a; Tropicos: R.E. Gereau *et al*. 2006
2448	Dracaenaceae	*Dracaena mannii*	Baker			NE	T	fs	C, EA, LN, LT. Tropical Africa.	1354	+		Nawenge	FT 2004a
2483	Ebenaceae	*Diospyros sp.*					T			1310	+			
2567	Euphorbiaceae	*Acalypha neptunica var.*	Muell.Arg.			NE	T			580		+	NR	
2494	Euphorbiaceae	*Alchornea sp.*					T			1290	+			

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2538	Euphorbiaceae	*Antidesma venosum*	Tul.			NE	T	fg	C, EA, N, LN, LT, LV. Tropical & S. Africa.	0-1830		+	Mahenge Scarp	FT 2004b
	Euphorbiaceae	*Bridelia cathartica*	G. Bertol			NE	T	fg		0-2000		+	Mahenge Scarp	FT 2004b
	Euphorbiaceae	*Bridelia micrantha*	(Hochst.) Baill.	Mkisa		NE	T	fg	C, EA, N, LN, LT, LV. Tropical & S. Africa.	50-2300		+	Muhulu; Nawenge	FT 2004a
2392 & 2511	Euphorbiaceae	*Drypetes natalensis var. natalensis*	(Harv.)Hutch.			NE	T	fs	C, N, LT. Tropical E. & S. Africa	125-1500	+		NR	
2547	Euphorbiaceae	*Drypetes reticulata*	Pax			NE	T	fs	C, EA (UI). E. & S. Africa.	0-500 (630)		+	NR	
2402	Euphorbiaceae	*Drypetes sp. (?)*					T			1261	+			
2445	Euphorbiaceae	*Drypetes sp. (?)*					T			1354	+			
2480	Euphorbiaceae	*Drypetes sp. (?)*					T			1310	+			
2497	Euphorbiaceae	*Drypetes sp. (?)*					T			1290	+			
2428	Euphorbiaceae	*Erythrococca sp. 1*		Mzolol			T			1261	+			
2432	Euphorbiaceae	*Erythrococca sp. 1*					T			1500	+			
	Euphorbiaceae	*Flueggea virosa ssp.*	(Willd.) Voigt			NE	T	fg		0-2300		+	NR; (Nambiga)	Tropicos: C.J. Kayombo 1999
	Euphorbiaceae	*Margaritaria discoidea var.*	(Baill) Webster			NE	T	fg	C, EA, N, LN, LT, LV. Tropical & S. Africa.			+	Mahenge Scarp	FT 2004b
	Euphorbiaceae	*Meineckia grandiflora**	(Verdc.) Brunel ex Radcl.-Sm.		E	PT, NE	S				*		Sali	Tropicos: Cribb 1979
2564 & 2550	Euphorbiaceae	*Pycnocoma? sp. 1*					S			580		+		

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2539	Euphorbiaceae	*Ricinodendron heudelotii ssp. africanum var.*	(Baill.)Heckel ssp. (Muell.Arg.)J.Leon.	Mzolol		NE	T			630		+	NR	
2489	Euphorbiaceae	*Sibangea pleioneura*	Radcl.-Sm.		E	VU	T	fs	EA only (Udz).	950-1220	+		NR	
2532	Gesneriaceae	*Streptocarpus glandulosissimus*	Engl.				H			1250	+			
	Guttiferae (Clusiaceae)	*Allanblackia stuhlmannii*	Engl.		E	VU	T	fs	EAs (EUs, UI, Udz) only.	540-1200	+		Muhulu; Nawenge; Sali	FT 2004a; Lovett & Pócs 1993
	Guttiferae (Clusiaceae)	*Garcinia huillensis*	Oliv.			NE	T	fg		1000-1700	+		NR	
	Guttiferae (Clusiaceae)	*Garcinia semseii**	Verdc.		E	VU	T	fs	EA (Ng Udz)	210-1008			Mahenge Mountains	Burgess *et al*. 2007
	Guttiferae (Clusiaceae)	*Harungana madagascariensis*	Poir			NE	T	fg	C, EA, LN, LT, LV. Tropical Africa. Madagascar.	0-1800	+		Nawenge	FT 2004a
2535	Guttiferae (Clusiaceae)	*Mammea? sp.*					T			1250	+			
2481	Guttiferae (Clusiaceae)						T			1310	+			
2475	Icacinaceae	*Alsodeiopsis schumannii*	Engl.		E	VU	T	fs	EAs (EUs, UI) only.	900-2000	+		NR	
2576	Lamiaceae	*Hoslundia opposita*	Vahl.			NE	S	fg		540		+	Mahenge Scarp	Tropicos: C.J. Kayombo 1999
2531	Lamiaceae	*Platostoma rotundifolium*	(Briq.)A.J. Paton			NE	H			1250	+		NR	
2545 & 2552	Lamiaceae	*Premna schliebenii*	Werderm.	Mkoko		VU	T	g/w	C, EA. Tropical E. Africa.	360-800		+	NR	
2471	Lamiaceae	*Rotheca sansibarense? ssp.*	(Gurke) Steane & Mabb			NE	T			1250	+		NR	
2417	Lamiaceae	*Vitex amaniensis?*	W. Pieper		E	VU	T	fs	EA only (EUs, Ul, Udz).	900-1400	+		NR	

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	Lamiaceae	*Vitex doniana*	Sweet	Mfuru		NE	T	g/w		0-1950		+	Mselezi; Mahenge Scarp; Nawenge	Tropicos: S. Bodine *et al*. 2006; Tropicos: W.J. Kindeketa *et al*. 2006; FT 2004a
2474	Lauraceae	*Beilschmiedia kweo?*	(Mildbr.) Robyns & R.Wilczek		E	VU	T	fs	EA (Eus, Ng, Udz) only.	800-1800	+	+	NR	
2496	Lauraceae	*Cryptocarya liebertiana*	Engl.			NE	T	fs	EA, LN. Malawi	1080-1800	+		NR	
2490 & 2502	Lauraceae	*Ocotea usambarensis*	Engl.	Myowi		NE	T	fs	C, EA, N, LN. Tropical C. & E.Africa.	900-2600	+		NR	
	Leguminosae (Caesalpiniaceae)	*Afzelia quanzensis*	(Welw.)			NE	T	g/w	C,EA,N,LN,LT, LV. Coastal Kenya. W., C. & S. Africa.	0-1340		+	NR; (Nambiga)	FT 2001
2549	Leguminosae (Caesalpiniaceae)	*Cynometra sp.*					T			600		+		
2553	Leguminosae (Caesalpiniaceae)	*Genus 1, sp. A*		Pumbunyama			S			533		+		
	Leguminosae (Caesalpiniaceae)	*Piliostigma thonningii*	(Schumach.) Milne-Redh.	Msekese		NE	T	g/w		0-1830		+	Mahenge Scarp	FT 2004b
2478	Leguminosae (Caesalpiniaceae)	*Zenkerella? sp.*					T			1310	+			
2575	Leguminosae (Mimosaceae)	*Acacia sp.*					T			540		+		
2513	Leguminosae (Mimosaceae)	*Albizia gummifera var.*	(J.F. Gmel.) C.A.Sm.			NE	T	fs	C, EA, N, LN, LT, LV. Tropical Africa. Madagascar.	1320	+	+	Muhulu; Nawenge; Sali	Lovett & Pócs 1993
	Leguminosae (Mimosaceae)	*Newtonia buchananii*	(Baker) G.C.C. Gilbert & Boutique	Mnyasa		NE	T	fs	C, EA, N, LN, LT, LV. Tropical E., C. & S. Africa.	600-2130	+		Muhulu; Sali	Lovett & Pócs 1993

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2415	Leguminosae (Papilionaceae)	*Baphia semseiana?*	Brummitt		E	VU	T	fs	EA only (Ng, Udz).	1261	+		NR; (Ulanga)	FTEA: Haerdi 1959
2397 & 2413	Leguminosae (Papilionaceae)	*Craibia brevicaudata ssp.*	(Vatke) Dunn			NE	T	fg		1261-1300	+		NR	
2408	Leguminosae (Papilionaceae)	*Craibia sp.*					T			1261	+			
	Leguminosae (Papilionaceae)	*Dalbergia melanoxylon*	Guill. & Perr.	Mpingo		LR/nt	T	g/w		0-1350		+	Mahenge Scarp	FT 2004b; Tropicos: C.J. Kayombo 1999
2505	Leguminosae (Papilionaceae)	*Desmodium sp.*					S			1200	+			
	Leguminosae (Papilionaceae)	*Erythrina sacleuxii**	Hua		E		T	g/w	C, EA, S.E. Kenya	0-450			Nawenge	Lovett & Pócs 1993
2573	Leguminosae (Papilionaceae)	*Indigofera sp.*					S			1250		+		
	Leguminosae (Papilionaceae)	*Lonchocarpus bussei*	Harms	Mfungulu		NE	T	g/w		0-1350		+	NR; (Nambiga)	FT 2001
	Leguminosae (Papilionaceae)	*Millettia elongatistyla**	J.B. Gillett		NE	VU	T	fs	C, EA (Ma, Udz, Ulu, Kimboza, Kiono)	250-350			Mahenge Mountains	Lovett *et al*. 2006; FTEA Anderson 1958
2566	Leguminosae (Papilionaceae)	*Millettia sp. 1*					T			580		+		
2581	Leguminosae (Papilionaceae)	*Millettia sp. 2*		Mweneni			T			730		+		
	Leguminosae (Papilionaceae)	*Pericopsis angolensis*	(Baker) Meeuwen			NE	T			900-1650		+	Mahenge Scarp	Tropicos: W.J. Kindeketa *et al.*; FT 2004b
2565	Leguminosae (Papilionaceae)	*Philenoptera capassa*	(Rolfe) Schrire	Mfungulu		NE	T			580		+	NR	
	Leguminosae (Papilionaceae)	*Pterocarpus latifolius*	Poir	Mninga maji		NE	T					+	NR	
	Leguminosae (Papilionaceae)	*Pterocarpus mildbraedii subsp. usambarensis**	Harms subsp. (Verdc.)		E	NE	T		EA only (EUs)	300-600			Mahenge Mountains	Burgess *et al*. (2007)
2534	Leguminosae (Papilionaceae)	*Smithia elliotii var.?*	Baker f.			NE	H			1250	+		NR	

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	Leguminosae (Papilionaceae)	*Xeroderris stuhlmannii*	(Taub.) Mendonça & E.C.Sousa	Mninga maji		NE	T	fg		100-1650		+	Mahenge Scarp	Tropicos: W.J. Kindeketa *et al.*2006; FT 2004b
2528	Loganiaceae	*Mostuea sp. 1*					S			1250	+			
2563	Loganiaceae	*Mostuea sp. 2*					S			580		+		
2592	Marantaceae	*Marantochloa leucantha*	(K.Schum.) Milne-Redh.			NE	H			750-1200 (693)		+	NR	
2571	Melastomataceae	*Dissotis rotundifolia*	(Sm.) Triana	Nakalyeli		NE	H			0-1900		+	NR	
2464	Melastomataceae	*Gravesia pulchra var. pulchra*	(Gilg.) Wickens		E	PT, NE	H		Eastern Arc	1200-1500	+		NR	
2438	Melastomataceae	*Lijndenia sp.*					T			1500	+			
	Melastomataceae	*Memecylon schliebenii**	Markgr.		E	NE	T			1200-1256			Muhulu; Nawenge	FTEA: Schlieben 1932; Lovett & Pócs 1993
2512	Meliaceae	*Genus 1, sp. A*					T			1320	+			
	Meliaceae	*Khaya anthotheca**	(Welw.) C.DC.			VU	T	fg	C, EA, N, LN, LT, LV. Tropical Africa	120-1525		*	Mahenge Scarp; Mselezi; Muhulu; Myoe	Lovett & Pócs 1993
2596	Meliaceae	*Trichilia emetica*	Vahl	Mkangala eundi/Msosonk eleku		NE	T	fg	C, EA, N, LN, LT, LV. Widespread in Africa.	10-1300	+		Nawenge	FT 2004a
2546	Meliaceae	*Turraea sp.*					T			630		+		
2439	Meliaceae/ Sapindaceae	*Genus 1, sp. A*					T			1500	+			
	Melianthaceae	*Bersama abyssinica ssp.*	Fresen			NE	T	g/w			+		Nawenge	FT 2004a; Lovett & Pócs 1993

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2469 & 2485	Monimiaceae	*Xymalos monospora*	(Harv.)Warb			NE	T	fs	EA, N, LN, LT, LV. E. & S. Africa, Cameroon highlands, Equatorial Guinea (Bioko).	900-2700	+		NR	
2577	Moraceae	*Ficus sp. 1*		Mwerevue			T			540		+		
2585	Moraceae	*Ficus sp. 2*		Mkundodi			T			730		+		
2521 & 2588	Moraceae	*Ficus sur*	Forssk.	Mkuyu		NE	T	fg	C, EA, N, LN, LT, LV. Tropical & S. Africa. Yemen.	0-2300	+	+	Mahenge Scarp	FT 2004b
	Moraceae	*Ficus sycomorus*	L.	Mkundodi		NE	T	fg	C, EA, N, LN, LT, LV. E. & S. Africa. Arabian peninsula, Madagascar, Comoros.	0-2200		+	Nawenge	FT 2004a
2594	Moraceae	*Ficus vallis-choudae*	Delile	Mkuyu		NE	T	fg	C, EA, N, LN, LT. Tropical Africa.	450-1800		+	Nawenge	FT 2004a
	Moraceae	*Milicia excelsa*	(Welw.) C.C. Berg	Mvule		NE	T	fg	C, EA, N, LN, LT, LV.	0-1350		+	Mahenge Scarp; Muhulu; Myoe; Nawenge; (Nambiga)	FT 2004b; Lovett & Pócs 1993; FT 2004a; FT 2001
2601	Moraceae	*Treculia africana*	Decne.	Mwaya		NE	T	fs	EA, LT, LV. Tropical Africa. Madagascar.	0-1200	+		Mselezi	Lovett & Pócs 1993
2453, 2578 & 2600	Moraceae	*Trilepisium madagascariensis*	DC.			NE	T	fs	C, EA, N, LN, LV. Tropical & S. Africa, Comoros Islands	540-1800	+	+	Mahenge Scarp; (Nambiga)	FT 2004b; Lovett & Pócs 1993

Specimen Number	Family	Species	Author	Local Name	Endemic Status	Conservation Status	Life Form	Habit	Distribution (Lovett *et al*. in press)	Altitude	Sali FR	Mselezi FR	Previous records in Mahenge	Source
2447	Myrsinaceae	*Maesa lanceolata*	Forssk.			NE	T	fg	EA, N, LN, LT, LV. Tropical & S. Africa. Madagascar. Seychelles.	360-2550	+		NR	
	Myrtaceae	*Eugenia toxanatolica**	Verdc.		E	NE	T	fs	EA only (WUs, South P, Ma, Udz)				Mahenge Mountains	Lovett *et al*. 2006; FTEA: Cribb *et al*. 1979
	Myrtaceae	*Syzygium guineense ssp.*	(Wild.) D.C.			NE	T		EA, N, LN, LT. Eastern C., & S. Tropical Africa.			+	Muhulu; Nawenge	Lovett & Pócs 1993; FT 2004a
2412	Ochnaceae	*Ochna oxyphylla?*	N.Robson			NE	T	fs		1261-2320	+		NR	
	Octoknemataceae	*Octoknema orientalis**			E	NE	T	fs	EA only (Ng, Ma, Udz).	1000-1200			Mahenge Mountains	Lovett *et al*. 2006
2551	Olacaceae	*Olax dissitiflora*	Oliv.			NE	T	fs	C, EA, LN. S.E. Africa. Madagascar, Comoros.	15-1600		+	NR (Ulanga)	Tropicos: A.S. Mkeya *et al*. 1998
2395	Olacaceae	*Strombosia scheffleri*	Engl.			NE	T	fs	EA, N, LN, LT, LV. Tropical Africa.	800-2500	+		Muhulu; Nawenge	Lovett & Pócs 1993; FT 2004a
2517	Oleaceae	*Chionanthus mildbraedii*	(Gilg. & Schellenb) Stearn			NE	T	fs	EA, N. Kenya, Uganda, C. & Western C. Africa.	1250	+		NR	
2533	Onagraceae	*Ludwigia abyssinica?*	A. Rich.			NE	H			1250	+		NR	
2465	Orchidaceae	*Eulophia horsfallii*	(Bateman) summerh.			NE	H			1000-2100	+		NR	
	Palmae (Arecaceae)	*Phoenix reclinata*	Jacq.			NE	T	fg	C, EA, N, LN, LT, LV.	0-3000	+		NR	
2507	Piperaceae	*Piper capense var. capense*	L. F.			NE	H			1200-2700	+		NR	

Specimen Number	Family	Species	Author	Local Name	Endemic Status	Conservation Status	Life Form	Habit	Distribution (Lovett *et al*. in press)	Altitude	Sali FR	Mselezi FR	Previous records in Mahenge	Source
2421	Pittosporaceae	*Pittosporum viridiflorum ssp. var.*	Sims			NE	T	fg	EA, N, LN, LT, LV. Tropical & S. Africa. Madagascar. S. India	1261	+		NR	
2598 & 2599	Poaceae	*Bambusa sp.1*		Midengi			H			800	+			
2582	Poaceae	*Bambusa sp.2*		Nebenta			H			730		+		
2579	Poaceae	*Genus A, sp. 1*		Mlungu lungu			H			730		+		
2498 & 2527	Poaceae	*Leptaspis cochleata*	Thwaites			NE	H			1250-1290	+		Nawenge	Lovett & Pócs 1993
2504	Poaceae	*Panicum sp.*					H			1200	+			
2597	Poaceae	*Setaria? sp.*					H			800	+			
2574	Poaceae	*Sorghum arundinaceum?*	(Desv.)Stapf			NE	H			540		+	NR	
2476	Podocarpaceae	*Podocarpus latifolius*	(Thunb.) Mirb.			NE	T			900-3350	+		NR	
2404 & 2516	Rhizophoraceae	*Cassipourea gummiflua var.*	Tul.			NE	T	fs	EA, LN, LV. Tropical & S. Africa. Madagascar.	1250-1261	+		NR	
2429	Rubiaceae	*Chassalia parvifolia*	K.Schum.			NE	T	fs		600-2300	+		NR	
2510	Rubiaceae	*Chassalia sp. 1*					S			1320	+			
2401	Rubiaceae	*Chassalia sp. 2*					T			1261-1300	+			
2468	Rubiaceae	*Chassalia sp. 3*					T			1250	+			
2426	Rubiaceae	*Coffea sp.*					T			1261	+			
2435	Rubiaceae	*Craterispermum longipedunculatum?*	Verdc.		E	VU	T		Eastern Arc	1200-1500	+		NR	
2454	Rubiaceae	*Fadogia elskensii var.*	De Wild.				S			1160	+		NR	
2595	Rubiaceae	*Genus A, sp. 1*					T			693		+		
2518	Rubiaceae	*Genus B, sp. 1*					T			1250	+			

Specimen Number	Family	Species	Author	Local Name	Endemic Status	Conservation Status	Life Form	Habit	Distribution (Lovett *et al*. in press)	Altitude	Sali FR	Mselezi FR	Previous records in Mahenge	Source
2396 & 2405	Rubiaceae	*Heinsenia diervilleoides ssp.*	K.Schum.			NE	T	fs	C, EA, N, LN, LT. C. & E. Tropical Africa.	1261-1300	+		NR	
2530	Rubiaceae	*Hymenodictyon floribundum*	(Hochst. & Steud.) Robinson			NE	T			540-2250	+		NR	
2479	Rubiaceae	*Ixora sp.*					T			1310	+			
2418	Rubiaceae	*Keetia sp. 1*					T			1261	+			
2499	Rubiaceae	*Keetia sp. 1*					T			1250	+			
2460	Rubiaceae	*Lagynias rufescens? ssp.*	(E.A.Bruce) Verdc.			NE	T			1160	+		NR	
2406	Rubiaceae	*Lasianthus sp.*					T			1261	+			
2586	Rubiaceae	*Leptactina platyphylla*	(Hiern.) Wernham			NE	T	fg	C, EA, LT, LV. Eastern C. & S. Tropical Africa.	45-1650		+	NR (Ulanga)	FTEA: Haerdi 1959; Tropicos: A. Ntemi Sallu 1998
2407 & 2503	Rubiaceae	*Morinda asteroscepa?*	K.Schum.			VU	T	fs	EA, Malawi	870-1350	+		NR	
2467	Rubiaceae	*Oxyanthus speciosus ssp./var.*	DC			NE	T	fs		1250	+		NR	
2525	Rubiaceae	*Oxythanus sp.*					T			1250	+			
	Rubiaceae	*Parapentas silvatica subsp. silvatica**	(K. Schum.) Bremek		E	PT, NE	H			1000-1650		*	Sali	Tropicos: Schlieben 1932
2442	Rubiaceae	*Pauridiantha paucinervis ssp.*	(Hiern.) Bremek. subsp. (K.Schum.) Verde.			NE	T	fg	EA, N, LN, LT. Tropical Africa, Madagascar.	500-2400	+		NR	
2514	Rubiaceae	*Pauridiantha sp.*					T			1320	+			
2398	Rubiaceae	*Pavetta axillipara/Chassalia*					T			1300	+			
2441	Rubiaceae	*Pavetta lynesii*	Bridson		E	VU	T		EA only (Ul, Udz).	1200-2300	+	+	NR	
	Rubiaceae	*Pavetta pócsii**	Bridson		E	PT, NE	S						Mahenge Scarp	Tropicos: Pócs *et al.*
2424	Rubiaceae	*Pavetta sp.*					T			1261	+			

Specimen Number	Family	Species	Author	Local Name	Endemic Status	Conservation Status	Life Form	Habit	Distribution (Lovett *et al*. in press)	Altitude	Sali FR	Mselezi FR	Previous records in Mahenge	Source
2461 & 2486	Rubiaceae	*Psychotria megalopus*	Verdc.		E	VU	T		Eastern Arc	1140-1850	+		Nawenge	Lovett & Pócs 1993
	Rubiaceae	*Psychotria pandurata**	Verdc.		E	PT, NE	H			300-1000	*		Sali	Lovett & Pócs 1993
2431 & 2451	Rubiaceae	*Psychotria sp. 1*					T			1500	+			
2493	Rubiaceae	*Psychotria sp. 2*					T			1290	+			
2444	Rubiaceae	*Rothmannia urcelliformis*	(Sch. Ex Hiern)Bull ex Robyns			NE	T	fs	EA, N, LT, LV. Tropical Africa.	850-1675	+		NR	
2425	Rubiaceae	*Rytigynia sp.*					T			1261	+			
2501	Rubiaceae	*Tarenna pavettoides ssp.*	(Harv.) Sim.			NE	T	fg		1200	+		NR (Ulanga)	Tropicos: A. Ntemi Sallu 1998
	Rubiaceae	*Tricalysia microphylla**	Hiern		E	PT, NE	S			1200		*	Mselezi	Lovett & Pócs 1993
2437	Rubiaceae	*Tricalysia pallens?*	Hiern.			NE	T	fg	C, EA, LT. Tropical Africa	500-1200	+		NR (Ulanga)	Tropicos: A. Ntemi Sallu 1998
2400	Rubiaceae	*Tricalysia sp. (?)*					T			1300	+			
2409	Rubiaceae	*Tricalysia sp. (?)*					T			1261	+			
2430	Rubiaceae	*Tricalysia sp. (?)*					T			1261	+			
2561	Rubiaceae	*Tricalysia sp. (?)*					T			580		+		
2584	Rubiaceae	*Tricalysia sp. (?)*		Msomo			T			730		+		
	Rubiaceae	*Vangueria infausta ssp.*	Burchell	Mvilu/Msada		NE	T	fg				+	Nawenge; Mahenge Scarps	FT 2004a; Tropicos: C.J. Kayombo 1999
2580	Rutaceae	*Clausena anisata*	(Willd.) Benth.	Kalivumbula		NE	T	fg	C, EA, N, LN, LV. Tropical & S. Africa, Comoros Islands	1-2450	+	+	Mselezi	Tropicos: W.J. Kindeketa *et al.* 2006
2416	Rutaceae	*Vepris stolzii?*	I.Verd.			NE	T	fs	EA, LN, LT. E. & C. Tropical Africa, Angola.	900-2150	+		NR	

Specimen Number	Family	Species	Author	Local Name	Endemic Status	Conservation Status	Life Form	Habit	Distribution (Lovett *et al*. in press)	Altitude	Sali FR	Mselezi FR	Previous records in Mahenge	Source
2473	Rutaceae	*Zanthoxylum leprieurii*	Guill. & Perr.			NE	T	fs	C, EA, LV. Tropical & S. Africa	900-2000	+	+	NR	
2394	Salicaceae	*Rawsonia? sp.(?)*					T			1300	+			
2459	Salicaceae	*Rawsonia? sp.(?)*					T			1160	+			
2488	Salicaceae	*Rawsonia? sp.(?)*					T			1290	+			
2500	Sapindaceae	*Allophylus abyssinicus?*	(Hochst.) Radlk.			NE	T	fg	EA, N, LN. E. & S. Tropical Africa.	100-2500	+		NR	
2570	Sapindaceae	*Aporrhiza paniculata*	Radlk.			NE	T		C, EA, LN, LT. Tropical Africa.	540		+	NR (Ulanga)	Tropicos: R.E. Gereau, C. Davidson & S.R. Christoph 2006
2554	Sapindaceae	*Blighia unijugata*	Baker	Mkalanga		NE	T	fg	C, EA, N, LN, LT, LV. S. & Tropical Africa.	100-1600		+	Mahenge Scarp	FT 2004b
	Sapindaceae	*Deinbollia borbonica*	Scheffler			NE	T	fg		15-500		+	NR (Nambiga)	Tropicos: R.E. Gereau, I.R.H. Hizza & A. Mkeya 1998
2411	Sapindaceae	*Deinbollia kilimandscharica*	Taub.			NE	T	fs	EA, N, LN. E. Tropical Africa.	1261	+		NR	
2548	Sapindaceae	*Haplocoelum foliolosum subsp.foliolosum*	(Hiern)Bullock			NE	T	fg	C, EA, LT, LV. S., E. & C. Tropical Africa, probably S. Africa.	100-2250		+	NR	
2541	Sapindaceae	*Lecaniodiscus fraxinifolius ssp vaughanii*	Baker ssp (Dunkley) Friis	Pampeta		NE	T			0-1080		+	NR	
2526	Sapotaceae	*Chrysophyllum gorungosanum?*	Engl.			NE	T	fs	EA, LN, LT. Cameroon, Eastern C. & E. Tropical Africa.	1300-2250	+		Muhulu; Nawenge	Lovett & Pócs 1993; FT 2004a

Specimen Number	Family	Species	Author	Local Name	Endemic Status	Conservation Status	Life Form	Habit	Distribution (Lovett *et al*. in press)	Altitude	Sali FR	Mselezi FR	Previous records in Mahenge	Source
2423	Sapotaceae	*Chrysophyllum viridifolium*	J.M.Wood & Franks			NE	T	fs	C, EA. E. & S.E. Africa, south to Natal.	1300-1500	+		NR	
2559	Sapotaceae	*Englerophytum sp.*					T			773		+		
2562	Sapotaceae	*Sideroxylon inerme ssp. diospyroides*	L. ssp. (Baker)J.H.Hemsl.			NE	T	fs	C. Eastern Tropical Africa. Aldabra.	0-900		+	NR	
2457	Sapotaceae	*Synsepalum cerasiferum*	(Welw.) Pennington			NE	T	fs	EA, LT, LV. Tropcial Africa.	1160	+		Muhulu	Lovett & Pócs 1993
2495	Simaroubaceae	*Brucea? Sp.*					T			1290	+			
	Simaroubaceae	*Harrisonia abyssinica*	Oliv.	Maurigana funda		NE	T	fg	C, EA, N, LN, LT, LV. Tropical Africa.			+	Mselezi; Mahenge Scarp	Tropicos: W.J. Kindeketa *et al*. 2006; FT 2004b
2414	Simaroubaceae	*Quassia undulata?*	(Guill. & Perr.)D.Dietr.			NE	T	fs	C, EA. Tropical Africa.		+			
2540	Sterculiaceae	*Cola sp.*		Nalula			T			630		+		
2393	Sterculiaceae	*Cola microcarpa?*	Brenan			NE	T	fs		1300	+		NR	
2590	Sterculiaceae	*Dombeya amaniensis*	Engl.	Luvuwangala	E	VU	S		Eastern Arc	1320		+	Mahenge Scarp; Mselezi	Lovett & Pócs 1993; Tropicos: W.J. Kindeketa *et al*. 2006
	Sterculiaceae	*Dombeya shupangae*	K.Schum.			NE	T			600		+	Mahenge Scarp	FT 2004b
2410	Sterculiaceae	*Leptonychia usambarensis*	K.Schum.		NE	NE	T	fs	C, EA, N.	1261	+		NR	
	Sterculiaceae	*Sterculia appendiculata*	K.Schum. ex Engl.	Mtutuma		NE	T	fg	C. Eastern Tropical Africa.	450		+	Mahenge Scarp; (Nambiga)	FT 2004b; Lovett & Pócs 1993
2491	Theaceae	*Ficalhoa laurifolia*	Hiern.			NE	T	fs	EA, LN, LT. Uganda, C. & S.E. Tropical Africa. Angola	1350-2400 (1290)	+		NR	
	Thymelaeaceae	*Dicranolepis usambarica**	Gilg.		E	PT, NE	T	fs	EA only (Te, Us, South P, Ng, Ul, Ma, Udz)	600-1800			Mahenge Mountains	Lovett *et al*. 2006

Specimen Number	Family	Species	Author	Local Name	Endemic Status	Conservation Status	Life Form	Habit	Distribution (Lovett *et al*. in press)	Altitude	Sali FR	Mselezi FR	Previous records in Mahenge	Source
2440 & 2484	Thymelaeaceae	*Peddiea lanceolata*	Domke		SE	PT, NE	T		Mahenge	1000-1100 (1310)	+		Sali	FTEA: Schlieben (1932)
2537	Tiliaceae	*Grewia lepidopetala?*	Garcke			NE	T			1250	+		NR	
	Tiliaceae	*Triumfetta tomentosa*	Bojer			NE	H	fg		1000-2000		+	NR	
2583	Ulmaceae	*Celtis sp.*					T			730		+		
2560	Ulmaceae	*Chaetacme aristata*	Planch.			NE	T	fg	EA, N, LT, LV. Tropical & S. Africa & Madagascar	900-2100 (773)		+	NR	
	Ulmaceae	*Trema orientalis*	(L.) Blume	Mbesu		NE	T	fg	C, EA, N, LN, LT, LV. Tropical & S. Africa to Madagascar	0-2100		+	Mselezi; (Nambiga)	Tropicos: W.J. Kindeketa *et al*. 2006; Lovett & Pócs 1993
	Verbenaceae	*Lippia javanica*	(Burm.F.) Spreng.			NE	T	g/w		450-2350		+	NR (Ulanga)	Tropicos: C.J. Kayombo (1999)
2443 & 2477	Violaceae	*Rinorea subintegrifolia*	(P.Beauv.) Kuntze			NE	T			300-1800	+		NR	
	Vitaceae	*Cyphostemma muhuluense**	(Mildbr.) Desc.		E	PT, NE	C			1200			Muhulu	FTEA & Tropicos: Schlieben 1932
2466	Zingiberaceae	*Siphonochilus aethiopicus*	(Schweinf.)B.L. Burtt	Hiriki		NE	H			390-1830	+		NR (Ulanga)	Tropicos: A.S. Mkeya 1998
2487							T			1320	+	+		

* Botanical species previously recorded in the Mahenge Mountains and that are of conservation concern, (Burgess *et al.* 2007; FTEA 1952-; Lovett *et al.* 2006; Lovett & Pócs 1993; Tropicos 2007). This included 26 species: *Coccinia schliebenii, Commiphora eminii subsp. trifoliolata, Cyphostemma muhuluense, Dicranolepis usambarica, Erythrina sacleuxii, Eugenia toxanatolica, Garcinia semseii, Impatiens joachimii, Impatiens mahengeensis, Impatiens paludicola, Impatiens saliensis, Ipomoea microcalyx, Khaya anthotheca, Lobelia longisepala, Meineckia grandiflora, Memecylon schliebenii, Millettia elongatistyla, Monanthotaxis dictyoneura, Octoknema orientalis, Parapentas silvatica subsp. silvatica, Pavetta pócsii, Psychotria pandurata, Thunbergia heterochondros, Tricalysia microphylla, Uvaria acuminate, Whitfieldia orientalis.*

Key to Vegetation Species Table:
Life Form: T = Tree, S = Shrub, H = Herb, C = Climber, L = Liana;
Habit: fs = forest specialist, fg = forest generalist, g/w = predominantly woodland and grassland species (Ahrends 2006a);
Endemic Status: SE = Strict Endemic, confined to the Mahenge mountain block, E = Endemic, range restricted to the Eastern Arc Mountains, NE = Near Endemic, range restricted to the Eastern Arc Mountains and at least one other African ecoregion;
Threatened Status: PT = Potentially Threatened (Gereau & Luke 2003, revised 2006); IUCN Red List: VU = Vulnerable, NE = Not Evaluated, LC = Least Concern, LR/nt = Lower Risk Near Threatened;
Key for distribution according to Lovett *et al*. (2006)***:*** Coastal (C), Eastern Arc (EA), Northern (N), Lake Nyasa (LN), Lake Tanganyika (LT), Lake Victoria (LV), Mountains (north to south), Taita Hills (Ta), Pare (P), Usambara (Us), East Usambara (EUs), West Usambara (WUs), Northern Nguru (NNg), Southern Nguru (SNg), Nguu (Ng), Uluguru (Ul), Malundwe (Mal), Ukaguru (Uk), Rubeho (Ru), Udzungwa (Udz), Mahenge (Ma);
Previous Mahenge Record: NR = New Record, NR (Ulanga) = recorded in Ulanga district but not within the Eastern Arc forests of the Mahenge Mountains;
Source: FT = Frontier Tanzania.

9b: Vegetation Plots

9b i: Sali FR

Plot ID	Altitude (masl)	Slope (deg)	Aspect	Topography	Features of interest	Vegetation type	Veg cover (%)			Canopy height (m)
							Canopy layer	Shrub layer	Ground layer	
1		15	NW	GMS		Submontane forest	10-50	>50	>50	10-20
2		20	N	GUS	Roads/tracks	Submontane forest	>50	>50	>50	10-20
3		30	S	MLS	Duiker trail	Submontane forest	>50	>50	10-50	20-30
4		0		GLS	Rocky outcrops	Submontane forest	10-50	10-50	>50	20-30
5	1354	45	E	SUS	Clearings	Submontane forest	10-50	10-50	10-50	10-20
6	1164	34	W	SMS		Submontane forest	10-50	>50	10-50	20-30
7	1380	25-30	S	SMS		Submontane forest	>50	>50	>50	10-20
8	1500	25-30	E	SUS		Submontane forest	10-50	10-50	10-50	20-30
9	1340	15-35	SW & E	GMS-SMS	Stream	Submontane forest	10-50	>50	10-50	>30
10	1160	35-40	E&W	SMS/GU		Submontane forest	>50	10-50	10-50	>30
11					BURNT LAND					
12					BURNT LAND					
13	1310	40-45	S	SMS		Submontane forest	>50	10-50	<10	20-30
14	1320	50	NNW-N	SLS		Submontane forest	>50	10-50	<10	>30
15	1250	25-30	S	SLS		Submontane forest	>50	10-50	>50	10-20
16	1320	45	NE	SMS		Submontane forest	10-50	>50	<10	>30
17		30	E	SUS/ RT		Submontane forest	>50	10-50	<10	20-30
18	1280	40	SW	SUS		Submontane forest	>50	10-50	<10	20-30
19	1290	30	NE	MUS		Submontane forest	>50	>50	10-50	>30
20	1350	15	W	GUS		Submontane forest	>50	10-50	>50	
21	1300	5-10	E	GUS		Submontane forest	>50	<10	<10	
22	1320	5-10	E	GLS	Animal Trails	Submontane forest	10-50	>50	>50	10-20
23	1200	20	N	GLS		Submontane forest	10-50	>50	10-50	20-30
24	1250	5-40	E/W	GLS/SMS		Submontane forest	>50	>50	<10	

9b ii: Mselezi FR

Plot ID	Altitude (masl)	Slope (deg)	Aspect	Topography	Features of interest	Vegetation type	Veg cover (%)			Canopy height (m)
							Canopy layer	Shrub layer	Ground layer	
1	585	30	W	GMS	Road/track	Lowland forest/scrub/wooded grassland	<10	10-50	10-50	<10
2	630	5	N	GMS	Rocky outcrops	Lowland forest/scrub/rocky woodland	<10	<10	<10	<10
3	600	22	W	SMS	Rocky outcrops	Rocky woodland	<10	<10	<10	<10
4	760	35	NE	SUS		Cultivation	<10	<10	<10	<10
5	560	7	SW	GLS		Scrub/thicket/bush	<10	>50	>50	<10
6	533	0	-	VF		Scrub/thicket/bush	<10	>50	>50	<10
7	540	3	E	GLS		Cultivation	<10	<10	10-50	<10
8	670	35	E	SUS	Rocky outcrops	Rocky woodland	10-50	10-50	10-50	10-20
9	730	30	N	SMS		Open lowland woodland	<10	>50	10-50	10-20
10	580	5	N and S	GLS	Rocky outcrops	Rocky dry woodland	10-50	<10	>50	20-30
11	773	50	E	SUS	Rocky outcrops	Dry rocky evergreen lowland woodland	10-50	>50	<10	20-30
12	693	30	E	SUS	Rocky outcrops	Rocky dry evergreen woodland	>50	10-50	10-50	20-30

9c: Regeneration Plots

9c i: Sali FR

Regen Plot ID	Cover (%)					Dominance (%)				Soil Texture	Soil Colour	Trees < 10 cm DBH
	Herbs	Bare soil	Litter	Rocks	Other (dead wood/debris)	Grasses	Forbs	Mosses/lichens	Ferns			
1	50	5	95	0	5	0	50	0	0	Loam	Brown	4,4,2,4,1,1
2	40	5	95	0	5	0	0	0	0	Loam	Dark brown	2,3,1,3,1
3	50	5	90	5	10	0	5	0	5	Loam	Brown	11,4,2,2
4	0	10	70	0	10	5	15	0	10	Loam	Brown	16,2,1,4
5	10	15	50	10	0	0	25	10	10	Loam	Dark brown	14,1
6	5	10	80	0	0	0	10	0	10	Loamy clay	Dark brown	1,3,5,1,1
7	75	5	70	0	5	0	65	0	2	Loam	Red/brown	1,2,1,2
8	85	1	8	0	0	0	90	0	1	Loam	Dark brown	2,3,1,2
9	15	5	10	10	0	65	5	0	5	Sand	Brown	1,1
10	10	5	70	0	5	20	0	15	0	Loamy clay	Dark brown	4
11	25	75	5	0	0	0	15	0	5	Sandy clay	Brown/dark grey	20,27
12	BURNT LAND											
13	50	5	95	0	0	0	15	0	30	Loam	Brown	5,1,1,3,7
14	5	2	96	5	0	5	50	0	5	Loam	Dark brown	3,6,1,1
15	6	3	90	0	0	1	4	0	2	Loam	Dark brown	2,10,3,1
16	0	1	92	0	0	1	1	0	1	Loam	Dark brown	2,3,2,1
17	0	2	97	81	0	1	5	0	1	Loam	Dark brown	1,1,1,1
18	0	1	96	0	0	0	1	0	0	Loam	Dark brown	1,3,8
19	15	5	95	0	0	0	10	0	2	Loam	Brown	10,3,2,6
20	5	2	95	0	0	0	5	0	5	Loam	Dark brown	2,1,1,1
21	5	15	80	20	0	0	5	5	5	Loamy-clay	Dark brown	1,1,1,1,1,1
22	40	0	95	20	0	0	30	0	0	Loam	Brown	2,3,1
23	80	15	85	0	0	0	75	0	5	Loamy clay	Dark brown	5,1,1,1,2
24	0	0	95	0	0	50	0	0	2	Loam	Dark brown	2,2,3,4,10

9c ii: Mselezi FR

	Cover (%)					Dominance (%)				Soil Texture	Soil Colour	Trees < 10 cm DBH
	Herbs	Bare soil	Litter	Rocks	Other (dead wood/debris)	Grasses	Forbs	Mosses/lichens	Ferns			
1	3	2	80	70	0	51	0	0	0	Loam	Black	
2	0	60	15	25	0	0	0	0	0	Loamy clay	Brown	
3	HIGH ROCKS, MOSTLY INACCESSIBLE											
4	NO TREES											
5	15	80	5	0	0	3	0	0	0	Loam	Brown	2,4,6,1,3
6	4	1	10	0	0	90	0	0	0	Loam	Brown	3,2,4,3,2,1
8	0	2	93	4	0	0	0	0	0	Loam	Dark brown	1,2,3,1
9	1	30	35	10	0	0	0	0	0	Loam	Dark brown	1,3,1
10	43	1	93	0	0	15	0	0	0	Loam	Black	9
11	5	2	82	90	0	0	0	0	0	Loam	Black	4,7,1
12	30	25	93	40	0	1	0	0	0	Loam	Dark brown	1,1

APPENDIX 10: TRANSECTING DATA

Each transect is 1000m lenth x 10m width = 10,000m^2

10a: Sali FR

Transect no.	Total Live Poles (LP)	Average LP per 50m	Total Dead Poles (DP)	Average DP per 50m	Total Old Cut Poles (OCP)	Average OCP per 50m	Total New Cut Poles (NCP)	Average NCP per 50m	Total Live Timbers (LT)	Average LT per 50m	Total Dead Timbers (DT)	Average DT per 50m	Total Old Cut Timbers (OCT)	Average OCT per 50m	Total New Cut Timbers (NCT)	Average NCT per 50m
1	618	30.90	21	1.05	3	0.15	0	0.00	335	16.75	12	0.60	0	0.00	0	0.00
2	181	9.05	6	0.30	0	0.00	0	0.00	289	14.45	37	1.85	0	0.00	0	0.00
3	442	22.10	23	1.15	0	0.00	0	0.00	247	12.35	47	2.35	0	0.00	0	0.00
4	219	10.95	15	0.75	0	0.00	0	0.00	378	18.90	30	1.50	0	0.00	0	0.00
5	590	29.50	14	0.70	0	0.00	0	0.00	412	20.60	17	0.85	0	0.00	0	0.00
6	443	22.15	14	0.70	0	0.00	1	0.05	351	17.55	22	1.10	0	0.00	0	0.00
7	693	34.65	28	1.40	1	0.05	0	0.00	309	15.45	22	1.10	0	0.00	0	0.00
8	471	23.55	13	0.65	1	0.05	0	0.00	350	17.50	17	0.85	0	0.00	0	0.00
Total	**3657**	**182.85**	**134**	**6.70**	**5**	**0.25**	**1**	**0.05**	**2671**	**133.55**	**204**	**10.20**	**0**	**0.00**	**0**	0.00

10b: Mselezi FR

Transect no.	Total Live Poles (LP)	Average LP per 50m	Total Dead Poles (DP)	Average DP per 50m	Total Old Cut Poles (OCP)	Average OCP per 50m	Total New Cut Poles (NCP)	Average NCP per 50m	Total Live Timbers (LT)	Average LT per 50m	Total Dead Timbers (DT)	Average DT per 50m	Total Old Cut Timbers (OCT)	Average OCT per 50m	Total New Cut Timbers (NCT)	Average NCT per 50m
1	207	10.35	28	1.4	6	0.3	1	0.05	175	8.75	40	2	9	0.45	1	0.05
2	287	14.35	93	4.65	92	4.6	375	18.75	96	4.8	41	2.05	1	0.05	21	1.05
3	116	5.8	15	0.75	97	4.85	1	0.05	47	2.35	4	0.2	36	1.8	3	0.15
4	95	4.75	15	0.75	37	1.85	61	3.05	92	4.6	25	1.25	15	0.75	9	0.45
Total	**705**	**35.25**	**151**	**7.55**	**232**	**11.6**	**438**	**21.9**	**410**	**20.5**	**110**	**5.5**	**61**	**3.05**	**34**	0

APPENDIX 11: COMMUNITY KNOWLEDGE

11a: Community Questionnaire

1. Personal Details
2. What do you know about this FR?
3. The forest is reserved for which purposes?
4. Are there any animals living in the forest?
5. How has the forest changed in the past 10, 20 or 30 years?
6. What climatic changes have you become aware of?
7. What type of meat do you eat?
8. Where do you get firewood from?
9. Why do you think people burn the forest?
10. Where do you get building materials?
11. What traditions do you have that are related to the FR?
13. What are your views on the utilization of the FR with respect to its conservation?
14. Do you plant trees? If yes, what types of tree do you plant?
15. Do you keep livestock? Where do they get food?
16. Do you have an Environmental Committee in your village? Is it useful?

11b i: Participants in the Sali Village Community Day

	Name	Title
1	Trifon K. Msiagi	Member, Village government
2	Moses D. Liheta	Teacher, Sali Primary School
3	Novatus Ntyangizi	Village Executive Officer
4	Philip Mbutila	Teacher, Sali Primary School
5	Rupaino Solly	Head Teacher, Sali Primary School
6	Felician Liheto	Village Chairman
7	Benignus Katyawa	Teacher, Sali Primary School
8	Dastani Kidole	Teacher, Sali Primary School
9	Kuni Beti	Farmer
10	Akwirini Chiboko	Farmer
11	Wolfgang Gulera	Member, Village government
12	Aaron Uteki	Member, Village government
13	Ambross Mkoko	Farmer
14	Zakleo Gurala	Farmer
15	Nathanael Ngendes	Farmer
16	Difonzi Makeshu	Farmer
17	Boniface Gasper	Farmer
18	Cosmas Libana	Farmer
19	Didephones Utenzi	Farmer
20	Salutaris Sada	Farmer
21	Anjerilo Mbangile	Member, Village government
22	Martine Soli	Farmer
23	Greyson Tengeneza	Farmer
24	Pefrectus Mfundili	Farmer
25	Eustela Kayumba	Farmer
26	Angelina Masogola	Farmer
27	Ritha Baridi	Farmer
28	Bernard Soli	Farmer
29	Leonidas Ng'wandu	Farmer
30	Simon Ntendagi	Farmer
31	A. J Zombe	Farmer
32	B. Ndyali	Farmer
33	A. Bangimoto	Farmer
34	Aloyce Katyawa	Farmer
35	Lea Mzena	Farmer
36	Christomi Ntyangiri	Farmer
37	Saluwa Mtendagi	Farmer
38	Agostina Bangimoto	Farmer
39	Beata Chinkumbi	Farmer
40	Elseus Goha	Farmer
41	Ruphino Liheta	Farmer
42	Wendrini Mtwangili	Farmer
43	Damian Mgaya	Farmer
44	Plasdu Liheta	Farmer
45	Christopher Solly	Farmer
46	Erasto Wililo	Farmer
47	Mapilo Chapandula	Councilor – Sali ward
48	Rasso Mtendagi	Chairman – Kibosho Hamlet
49	Eusebi Mtendagi	Farmer
50	Agata Mkota	Farmer

11b ii: Participants in the Mselezi Village Community Day

	Name	Title
1	Metron Kayawa	Member, Village government
2	Cosmas Mpanganyao	
3	Angelus Magaya	Member, Environmental Committee
4	Anatory Mhala	Member, Village government
5	Mhala Mhala	
6	Kanyanja Makasinde	
7	Daudi Mkukuna	
8	Anton Mpangayao	
9	Prosperi Mhala	
10	Prokopy Mgongolena	
11	Jeremia Manyuka	
12	Athanas Mpangayao	
13	Bernad Kayawa	
14	Rock Athumani	Chairman – Mpangayao Hamlet
15	Bona Njimila	
16	Maria Sangusanga	Member, Environmental Committee
17	Agnes Legulegu	
18	Geroveva Mhala	
19	Fransisca Uhaya	
20	Mwajuma Koya	
21	Emiliana Liyeti	
22	Salisia Mhilu	
23	Adelina Mpangayao	
24	Kristina Koya	
25	Condva Meputa	Member, Environmental Committee
26	Honesta Athumani	
27	Ana Evumba	
28	Emandina Mesudi	
29	Geradina Madona	
30	Nicolata Mandogoya	
31	Kamila Nguruwi	Member, Environmental Committee
32	Benadeta Mbena	
33	Bonita Kavira	Secretary, BORDER
34	Raphael Kavira	Member, Village government
35	Mashaka Salumu	Member, Environmental Committee
36	Onesmo Kadinda	
37	Filipo Mhadisa	
38	Faustin Mhadisa	
39	Daudi Zimamoto	
40	George Kikoti	
41	Sixbert Mholowa	
42	Juma Koya	
43	Manfred Mongo	
44	Kevin Mhela	
45	Isaya Mhela	
46	Beni Kanjanja	
47	Angelo Manyi	
48	Juma Mwalo	
49	Andrew Koyo	
50	Wille Kilemalile	
51	Mwl. Deograthino P. Mushi	
52	Andrew Likwachala	Member, Environmental Committee
53	Mwl. Theofrida Chilumba	
54	Evarist Munji	
55	Herman Koya	
56	Alex Mkukuma	
57	Jonas Mtanga	Chairman, BORDER

	Name	Title
58	Felician Lyaupe	Chairman, Environmental Comittee
59	Jerome Mhilu	Village Executive Officer Isongo
60	Genes Mgendera	Village Chairman
61	Matiala Mpangayao	Member, Environmental Committee
62	Kalolina Mguba	
63	Oportuna Shigumbi	
64	Agripina Ngolongolo	
65	Oliva Shimwaga	
66	Sabastian Mchenji	
67	Edigasta Magumba	
68	Ana Shipangapoli	
69	Salome Ngolongolo	
70	Adolphina Mwammale	Ward Executive Officer Isongo
71	Salumu Mpanga	
72	Sophia Iddi	Forest Officer
73	Octavian Nkawamba	Ag. District Catchment Manager

11c: WWF-TPO Workshop Agenda

Capacity Building and Awareness Raising for local communities surrounding Sali and Mselezi Forest Reserves in Ulanga District, Morogoro Region.

Outputs

1. Awareness on Issues for Sali and Mselezi FRs
2. Community Action Plans on conservation of Sali and Mselezi FRs
3. Skills on making wood energy saving stoves
4. Awareness of alternative livelihood activities

Day I Arrival Nov. 18, 2006

Day 2 Nov 19, 2006		
TIME	**ACTIVITY**	**RESPONSIBLE**
8:00-9:00	Registration and housekeeping announcements	Stuart
9:00-9:30	Welcome note and self introductions	Stuart
9:30-9:40	Workshop Objectives and Participants Expectations	Stuart /Kimaryo
9:30-10:00	Official opening of the workshop	DNRO - Ulanga
10:00-10:30	Tea /coffee Break	All
10:30-11:30	Conservation Philosophy: Why conservation? For Who?	Chengullah
11:30-1:00	Environmental Problems: • Local Issues and problems in perspective - (from group work and findings of the Frontier study) • National pespective	Chengullah/Stuart
1:00-2:00	Lunch break	All
2:00-5:30	• Forest values: Cultural, Social and Biological contexts • Forest Resources Governance Issues (Mahenge –Sali & Mselezi)	Chengullah DNRO & DCFO
5:30	Wrap up, Evaluation and closure for day one	Chengulla/Stuart
Day 3 Nov 20, 2006		
8:00-12:00	Study visit & training on making efficient wood saving stoves & demonstration of alternative livelihood activities	Chengullah
12:00-2:00	Lunch	
2:00-3:00	Community Action Plan preparations (CAP) to address the identified problems	Trainer
3:00 - 4:30	Group presentations and plenary discussions	Chengulla/Stuart
4:30-5:30	Wrap up, Evaluation and way forward	Facilitators
5:30	Workshop closure	DCFO
Day 4 Departure Nov 21, 2006		

11d: WWF-TPO Workshop List of Participants

	Name	Title
1.	Zuberi Mheta	Member, VCCC Isongo
2.	Theogonus Pulapula	Member, VCCC Isongo
3.	Bonitha Kavira	Member, VCCC Isongo
4.	Pascali Magoba	Member, VCCC Isongo
5.	Asmini Bori	Teacher, Mpangayao
6.	Onesmo Kadinda	Secretary, VCCC Isongo
7.	Peter Msangameno	Member, VCCC Mselezi, Former Game Officer
8.	Rafaela Mtanga	VEO Isongo
9.	Eusebi Mtendagi	Chairperson, VCCC Sali
10.	Faustina Koya	Member, VCCC, Mpangayao
11.	Benignus Katyawa	Teacher, Sali
12.	Abdallah Zombe	Teacher, Sali
13.	Claudia B. Mfundiri	Secretary, VCCC Sali
14.	Christom A. Ntyangiri	Member, VCCC Sali
15.	Rafaela F. Katyawa	Member, VCCC Sali
16.	Ambaros S. Mkoko	Member, VCCC Sali
17.	Novatus A. Ntyangiri	VEO Sali
18.	Elias Ngomango	Teacher, Mpangayao
19.	Janeth Senyagwa	Member, VCCC Sali
20.	Domina Kuyaswa	Member, VCCC Isongo
21.	Mihadi Kinyasi	Catchment Forest Officer
22.	Octavian C. Nkawamba	Ag. District Catchment Forest Officer, Ulanga
23.	Sofia Iddi	Catchment Forest Officer
24.	Mwinshehe S. Kulita	District Natural Resources Officer, Ulanga

11e: Community Action Plans

11e i: Sali Village

TARGETS	ACTIVITIES	STRATEGIES		
Provide environmental education	Convene a public meeting to assemble environmental motivation groups	Convene public meetings to educate the community	Village Chairman Village Executive Environmental Committee Community	Nov-07 and continuing
Prevent shifting cultivation	Public meeting	Provide forest and agricultural education Start training farm/plot	WEO Chairman VEO Agricultural Officers Hamlets Administration Environmental Committee	Jan-07 and continuing
Prevent fire damage	Prevent all activities that can cause fire damage	Provide education about the effects of fire damage through public meetings and campaigning Prepare the road to prevent fire damage Conduct patrols Supervise the use of bylaws	WEO Village Chairman Village Executive Environmental Committee Community School administration	Jul-07 and continuing
Prevent random logging	Prevent logging activities and encourage tree nurseries	Convene a public meeting to encourage tree planting and emphasise the effects of illegal logging Start tree nurseries	Village Chairman Village Executive Environmental Committee Community	Nov-06 Apr-07
Prevent illegal fishing	Prepare the law and procedures for supervising implementation Dig the fish ponds	Convene a public meeting, to explain about the effects of poison on the water organisms and humans; and how to stop destruction Start conducting patrols Make bylaws to supervise implementation Educate and encourage the community to dig the fish ponds	Village Chairman Village Executive Environmental Committee Community	Jan-07 and continuing Jan-07

11e i: Isongo Village

TARGETS	ACTIVITIES	STRATEGIES		
Plant trees	Start a tree nursery	Locate an area for a nursery and prepare compost and manure Find tree seeds Sow tree seeds and nurture seedlings Motivate the community to prepare an area for planting of trees Distribute tree seedlings to the community for them to grow	Village Chairman Village Executive Environmental Committee Community Teachers and Students Forestry Officers for District and Mselezi FR Natural Resources District Officer	Jan-07 and continuing
Control fire damage	Stop all activities causing fire damage	Provide education about the effects of fire damage via a village meeting Prepare the road to help prevent fire damage Enforce the related bylaws	Village Chairman Village Executive Environmental Committee Community Teachers and Students Forestry Officers for District and Mselezi FR Natural Resources District Officer	Jan-07 and continuing
Encourage joint farming initiatives	Identify the better areas for cultivation	Convene a public meeting in order to discuss agricultural activities in the village	Village Chairman Village Executive Environmental Committee Community School Administration Agriculture Officers	Jan-07 and continuing
Control the mining of gemstones and sand	Prepare laws and procedures in order to control situation	Convene a public meeting to discuss how to prevent the problem Make bylaws to help supervise occurrence	WEO VEO Chairman Environmental Committee Community School Administration Religious Institutions	Jan-07 and continuing

TARGETS	ACTIVITIES	STRATEGIES		
Prevent illegal hunting	Prepare laws and procedures in order to supervise its occurrence	Convene a public meeting to discuss how to prevent the problem Make bylaws to supervise occurrence	Village Chairman Village Executive Environmental Committee Community	Jan-07 and continuing
Prevent destruction of water sources	Prevent cultivation activities around the water sources	Provide education on how to conserve the water sources through a village meeting Supervise the uses of bylaws	Chairman VEO Specialist	Jan-07 and continuing
	Prevent logging of trees like Mikuyu and Migunga that grow in water courses	Provide education on how to conserve trees Continue to plant trees that help conserve the water sources Supervise the uses of bylaws	Water Committee H/ Village	
	Prevent planting of exotic trees around the water sources	Remove exotic trees from around the water sources Supervise the uses of bylaws	Chairman VEO Specialist Water Committee H/ Village	Jan-07 and continuing
Provide environmental education	Public meetings	To convene a public meeting for providing environmental education for the community	Village Chairman Village Executive Environmental Committee Community	Mar-07 and continuing

BIODIVERSITY RESEARCH AND AWARENESS IN THE LESSER-KNOWN EASTERN ARC MOUNTAINS (BREAM)

Funded by the Critical Ecosystem Partnership Fund (CEPF), the Biodiversity Research and Awareness in the lesser-known Eastern Arc Mountains (BREAM) project is an initiative of Frontier Tanzania; in partnership with the WWF-Tanzania Program Office and the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism; in collaboration with Missouri Botanical Gardens, USA; Michele Menegon and Francesco Rovero of the Museo Tridentino Di Scienze Naturali, Trento, Italy; and Andrew Perkin of the Nocturnal Primate Research Group, Oxford Brookes University, UK. The BREAM project aims to increase knowledge and assist in the conservation of the lesser-known Eastern Arc Mountain forests, through biodiversity surveys, human resource-use assessments and community and institutional capacity building and awareness raising.

THE CRITICAL ECOSYSTEM PARTNERSHIP FUND (CEPF)

The Critical Ecosystem Partnership Fund is a joint initiative of Conservation International, the Global Environmental Facility, the Government of Japan, the MacArthur Foundation and the World Bank. The CEPF is designed to safeguard the world's threatened biodiversity hotspots in developing countries by providing funding and technical support to civil society.

FRONTIER TANZANIA FOREST RESEARCH PROGRAMME (FT FRP)

The Society for Environmental Exploration and the University of Dar es Salaam have been conducting collaborative research into environmental issues since July 1989 under the title of Frontier Tanzania, one component of which is the Frontier Tanzania Forest Research Programme (FT FRP). Biological field surveys were conducted in the Coastal Forests of Tanzania from 1989 to 1994; in the East Usambara Mountains in collaboration with EUCAMP, Tanga, from 1995 to 2002; in the Udzungwa Mountains in collaboration with MEMA, Iringa, from 1999 to 2001; in the Mahenge Mountains in 2003; in Mpanga/Kipengere Game Reserve in collaboration with WWF-TPO, Dar es Salaam, in 2003; in the Uluguru Mountains in collaboration with CARE-Tanzania, Dar es Salaam, in 2004; and in the Mtwara Coastal Forests, funded by CEPF, Washington, in 2005.

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