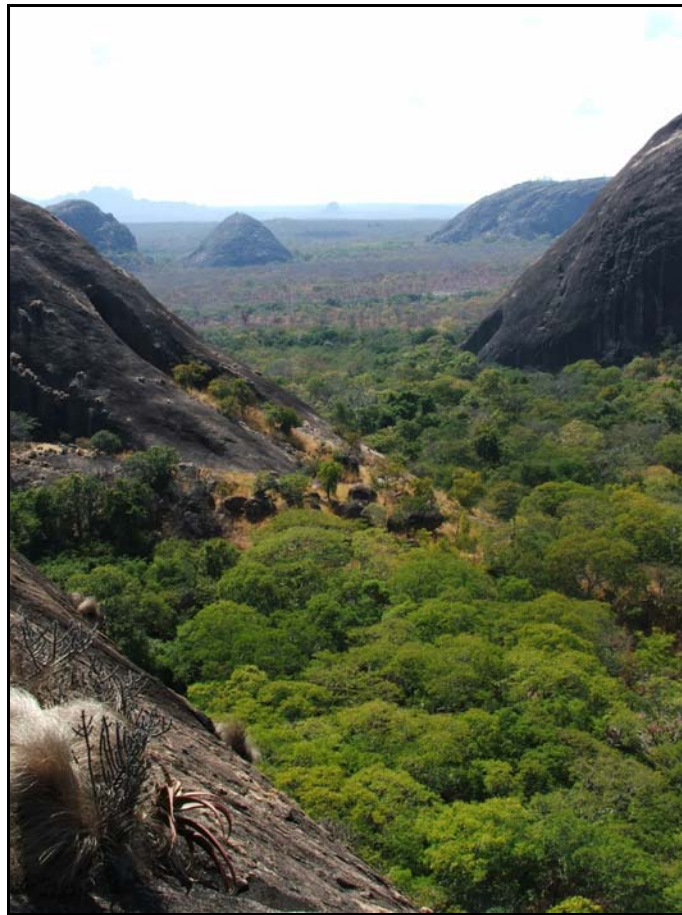


MTWARA RECONNAISSANCE PROJECT
A Reconnaissance to Prioritise Biological Knowledge
for Community Conservation Initiatives
2005



Giulia Wegner
Kim M. Howell, Neil Burgess, Paul Rubio & Eibleis Fanning
(Eds.)

CRITICAL | **ECOSYSTEM**
PARTNERSHIP FUND

FRONTIER
FRONTIER - TANZANIA



**Frontier-Tanzania
Forest Environmental Research Programme**

Mtwara Reconnaissance Project
**A Reconnaissance to Prioritise Biological Knowledge for
Community Conservation Initiatives**
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Wegner, G.
Howell, K. M., Burgess N., Fanning, E. & Rubio, P. (Eds.)

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University of Dar es Salaam
Society for Environmental Exploration**

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2005**

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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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Front cover photograph: granite kopjes protruding from the plain in Ndechela Forest Reserve, Tanzania. Credit: all photographs in this report were taken by Frontier-Tanzania field research team.

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5. ABBREVIATIONS AND ACRONYMS

CMEAMF	Conservation & Management of the Eastern Arc Mountain Forests
CEPF	Critical Ecosystem Partnership Fund
CI	Conservation International
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DANIDA	Danish International Development Agency
EACF	Eastern Arc Mountains and Coastal Forests
EUBS	East Usambara Biodiversity Surveys
FINNIDA	Finnish International Development Agency
FR	Forest Reserve
FT FRP	Frontier Tanzania Forest Research Programme
FTEA database	Flora of Tropical East Africa database
GEF	Global Environment Facility
GJ	Government of Japan
GPS	Global Positioning System
ICBP	International Council for Bird Preservation (now BirdLife International)
IUCN	The World Conservation Union
JICA	Japan Official Development Assistance
LEAP	List of East African Plants
m asl	Metres above sea level
MAF	MacArthur Foundation
MNRT	Ministry of Natural Resources and Tourism
FT-MRP	Frontier Tanzania Mtwara Reconnaissance Project
PDF	Project Development Fund
SEE	Society for Environmental Exploration
SHCP	Southern Highlands Conservation Project
TFCG	Tanzania Forest Conservation Group
TSD	Terra Surveys Limited
Tsh	Tanzanian Shillings
UCBS	Uluguru Component Biodiversity Surveys
UNDP	United Nations Development Programme
WB	World Bank
WCS	Wildlife Conservation Society
WCST	Wildlife Conservation Society of Tanzania
WWF-EARPO	World Wide Fund for Nature - Eastern Africa Regional Programme Office

6. REPORT STRUCTURE

The report begins with an executive summary, which gives an outline of the overall findings of the Mtwara Reconnaissance Project. The introduction contains background information on various aspects of the study, including an overview of the ‘Hotspot’ concept and a description of the Eastern Arc Mountains and Coastal Forests (EACF) hotspot. The various forest types that form the Coastal Forest Mosaic are described with their characteristic floral species composition. Also addressed in this section is the history of conservation initiatives in the EACF hotspot from 1978 to the present day, as well as the role that the Critical Ecosystem Partnership Fund (CEPF), as a funding programme for biodiversity hotspots managed through Conservation International, plays in its conservation. Finally, the aims and objectives of the Mtwara Reconnaissance Project (FT-MRP) are outlined with reference to their contribution to overall conservation aims in the EACF hotspot, and to previous work conducted by Frontier-Tanzania’s Forest Research Programme (FT FRP) in the region.

The next section includes information on the study site itself. The location of the study in relation to the districts that comprise the Mtwara Region is given and information on topography, geology, soils, climate and socio-economics is presented. The conservation status of the forests found in the region and more specifically of the reserves surveyed by this study is discussed, and the reasons behind the creation of the forest reserves are given. A map details the location of the forest reserves, major towns, roads and research camps.

The methods used by the FT-MRP project when carrying out the research are described in the following section, including information on the length of time spent and a summary of the survey effort and sampling intensity carried out in each reserve. This section contains definitions of key terms and categories used in the study and describes the field methods and analysis techniques utilised.

The paper then moves on to describe each forest reserve separately (Kambona, Makonde Scarp I, Makonde Scarp II, Mkunya River, Mtiniko, Mtuli Hinju, Makonde Scarp III, and Ndechela). For each, geographical information, historical background and land-use are listed. Results and discussions are presented separately for Flora, Fauna, Human Resource-Use and Local Management.

A separate section is devoted to summarise and further discuss results for all flora, fauna and human resources-use from the eight forest reserves surveyed, and to compare their biological importance by assessing values of species richness, diversity, forest dependency, endemism and extinction threat. Important Bird Areas, species range extensions and new records from this study are also discussed here.

In the final sections conclusions are made and conservation action for the reserves is prioritised, accompanied by a set of conservation recommendations applicable to all forest reserves studied.

7. EXECUTIVE SUMMARY

G. Wegner

The Critical Ecosystem Partnership Fund (CEPF) is a joint initiative of Conservation International (CI), the Global Environmental Facility (GEF), the Government of Japan (GJ), the MacArthur Foundation (MAF) and the World Bank (WB). The CEPF is designed to safeguard the world's biologically richest and most threatened hotspots, by providing funding and technical support to civil society. The Eastern Arc Mountains and Coastal Forests of Kenya and Tanzania (EACF) region was approved for grant funding in July 2003 and active grant making started in January 2004.

The Forgotten Coastal Forests of Mtwara: A Reconnaissance to Prioritise Biological Knowledge for Community Conservation Initiatives project (abbreviated as the Frontier Tanzania Mtwara Reconnaissance Project – FTFT-MRP) is a CEPF funded initiative implemented by Frontier-Tanzania, a collaboration between the Society of Environmental Exploration and the University of Dar es Salaam, to perform biological research in the least studied of 160 eligible Key Biodiversity Sites of the EACF hotspot (strategic funding direction 3.2). This aim was pursued through pioneering baseline biodiversity surveys and the compilation of indigenous knowledge (strategic funding direction 3.5) in eight relatively unexplored and understudied Coastal Forests of the Mtwara Region (south-eastern Tanzania). These Coastal Forests partially comprise the CI-numbered Key Biodiversity Sites 81, 95 and 102. Research was conducted from April to August of 2005.

OVERVIEW OF THE STUDY

The study sites are located in five districts of the Mtwara Region: Mtwara Rural (Mtiniko FR and Mtuli Hinju FR), Masasi (Makonde Scarp I FR, Kambona FR and Ndechela FR), Newala (Makonde Scarp II FR) and Tandahimba (Makonde Scarp III FR), within 10° 35' 25.9" and 11° 06' 35.6" latitude and 038° 09' 43.1" and 039° 56' 14.7" longitude. These areas were proposed between 1955 and 1977 as sites of protected forest reserve by the government, in recognition of their importance to the local villages and towns as water catchments, for prevention of soil erosion, and for provision of timber and non-timber forest resources. At present, two of the sites are gazetted as Forest Reserves (Kambona and Ndechela) and six are proposed Forest Reserves (Makonde Scarp I, Makonde Scarp II, Makonde Scarp III, Mtiniko, Mtuli Hinju and Mkunya River). The study sites have an elevation range between 120 and 720m asl and cover a total area of 17,812.2ha. Ndechela and Mkunya River are the largest of the study sites, covering 6,216ha and 4,797.3ha each, followed by Mtiniko (1,736ha), Makonde Scarp I (1,748.3ha), II (1,554ha) and III (1,434.7ha), Mtuli Hinju (296.0ha) and Kambona (29.9ha).

Frontier-Tanzania conducted a baseline biological survey in the eight gazetted and proposed forest reserves between the 2nd April and the 17th July 2005. Data were collected through a variety of field methods. Floral surveys were conducted through vegetation plots and opportunistic observation. For the fauna bucket pitfall traps and timed searches were utilised to capture amphibians and reptiles, and sherman traps to capture small mammals, along with opportunistic observation. Birds were surveyed using a combination of mist netting, timed searches and opportunistic observation, and butterflies were captured using canopy traps and through sweep netting. Large mammal signs were recorded along 1km transects and through opportunistic observation. Forest disturbance was assessed through the use of 1km transects, along which the level of pole, timber and large timber cutting was recorded together with any other sign of disturbance.

When identification in the field was not possible botanical specimens were collected for identification and repository at the Herbarium of the University of Dar es Salaam, Tanzania, and at Missouri Botanical Gardens, USA. Faunal specimens that could not be identified in the field were collected for identification and repository at the Department of Zoology and Wildlife Conservation of the University of Dar es Salaam, Tanzania. Butterfly specimens were sent for identification and repository to the Southern Highlands Conservation Programme (SHCP) of the Wildlife Conservation Society, Tanzania. Faunal specimens were sent on loan for further identification to: the British Natural History Museum, UK; the California Academy of Sciences, USA; the Chicago Field Museum, USA; the Zimbabwe Natural History Museum, Zimbabwe; the Copenhagen Zoological Museum, Denmark.

Data from this study are contributed to the Biodiversity Database of the University of Dar es Salaam, Tanzania, the CEPF Conservation Outcomes Database, USA, and the TROPICOS database of the Missouri Botanical Gardens, USA. This report is made available through the CEPF web-site (www.cepf.net) and the Frontier web-site (www.frontier.ac.uk). *The Coastal Forests of Mtwara: a Kiswahili layman's report* (Frontier-Tanzania, 2005) was also produced during the FT MRP for distribution to district natural resources offices, community groups and schools in close proximity to the forest reserves, to act as a tool for environmental education and awareness promotion.

BIODIVERSITY VALUE OF THE STUDY AREA

Findings from this study of the Coastal Forests of the Masasi, Mtwara Rural, Newala and Tandahimba districts, Mtwara Region, show that the eight forest reserves studied are of important environmental value to the surrounding human population, providing it with precious water, abundant forest resources and protection from soil erosion. However, high population growth rate, accompanied by severe poverty and lack of environmental awareness, have resulted in the extensive conversion of these Coastal Forests into farmland, the unsustainable exploitation of their natural resources, and the conspicuous decrease of their biodiversity and endemism.

As a consequence of the high degree of habitat destruction taking place in the area, only small patches of closed-canopy coastal forest remain in the study area. Various types of eastern African closed-canopy coastal forest were identified: *Brachystegia* forest, Legume-dominated dry forest, Mixed dry forest, Mixed scrub forest and Riverine forest. *Brachystegia* forest was the most dominant forest type, occurring extensively on the Makonde escarpment and in the adjacent Mkunya River proposed FR and Kambona FR. Legume-dominated dry forest, the most vulnerable plant community of the Coastal Forests, was found to be rarer, occurring in Mtuli Hinju proposed FR and Ndechela FR. A relatively extensive area of Mixed non-legume-dominated dry forest was found in Mtiniko proposed FR, while in Makonde Scarp II proposed FR Mixed scrub forest constituted a seral stage that resulted from clearance of climax forest and the practice of shifting cultivation. Finally, small patches of Riverine forest were recorded in Kambona FR and Mkunya River proposed FR.

Overall, 265 floral species were detected. Of the 229 species identified to species level, 26 (12%) were endemic to the Swahilian regional centre of endemism *sensu lato*, and 30 (13%) were listed as threatened or potentially threatened (Table 7-a). These figures are not negligible, especially when considering that most Coastal Forest endemics are also likely to face a degree of threat, and this highlights the importance of the Coastal Forests studied as a habitat for the endemic plants found here.

Plant species endemic to the Swahilian region *sensu lato* were *Barleria holstii*, *Ozoroa obovata*, *Monodora grandidieri*, *Cussonia zimmermannii*, *Bombax rhodognaphalon*, *Commiphora zanzibarica*, *Tetracera boiviniana*, *Cleistanthus schlechteri*, *Cynometra*

gillmanii, *Scorodophloeus fischeri*, *Entada stuhlmannii*, *Erythrina schliebenii*, *Xylothea tettensis*, *Gardenia transvenulosa*, *Lamprothamnus zanguebaricus*, *Rytigynia decussata*, *Mimusops schliebenii*, *Cola clavata*, *Sterculia appendiculata*, *Grewia forbesii*, *Grewia lepidopetala*, *Vitex mossambicensis*, *Vitex zanzibarensis*, *Rinorea elliptica* and *Aframomum orientale*.

Five of the species found are listed as threatened on the IUCN Red List (2004), including *Cynometra gillmanii* (Endemic and Critically Endangered), *Gardenia transvenulosa* and *Vitex zanzibarensis* (Endemic and Vulnerable), *Khaya anthothea* and *Mesogyne insignis* (Vulnerable). Another 22 plants are recognised to be potentially threatened by Gereau and Luke (2006), including *Cussonia zimmermannii*, *Bombax rhodognaphalon*, *Commiphora zanzibarica*, *Maytenus mossambicensis*, *Tetracera boiviniana*, *Drypetes natalensis*, *Cassia abbreviata*, *Scorodophloeus fischeri*, *Acacia nilotica*, *Entada stuhlmannii*, *Baphia punctulata*, *Craibia brevicaudata*, *Erythrina schliebenii*, *Millettia impressa*, *Xylothea tettensis*, *Syzygium cordatum*, *Lamprothamnus zanguebaricus*, *Lasianthus kilimandscharicus*, *Rytigynia decussata*, *Cola clavata*, *Vitex mossambicensis*, *Rinorea angustifolia*, *Rinorea elliptica* and *Aframomum orientale*.

Table 7-a Total number and number of strictly endemic and threatened species for the flora and fauna of all forest reserves

Taxa	Total no. of species	No. of strictly endemic species ^a	No. of threatened species listed by IUCN ^b and/or CITES I ^c	No. of potentially threatened species (flora only) ^d
Flora	265	26	5	25
Mammals	59	0	4	-
Birds	159	1	2	-
Reptiles	30	1	0	-
Amphibians	21	1	1	-
Butterflies	71	1	0	-
Total	605	30	12	23

a - Floral endemism refers to the Swahilian region *sensu lato* (Clarke and Robertson, 2000), whereas faunal endemism refers to the Coastal Forests and/or Eastern Arc Mountains, sometimes including other habitats in a few adjacent locations (e.g. Masasi District in S Tanzania, N Mozambique etc) (Burgess and Clarke, 2000)

b - Species listed as Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) in the IUCN Red List (IUCN, 2004)

c - Species listed in CITES Appendix I as threatened with extinction and excluded from international trade (CITES, 2005)

d - Plant species included in the list of Potentially Threatened Plants in the EACF Hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

In terms of fauna, the study yielded 340 species. Birds were the largest contributor to this figure with 159 species detected, followed by butterflies (71), mammals (59) and reptiles (30), while amphibians contributed the lowest number (21) (Table 7-a).

The loss of suitable forest habitat explains the low proportion of forest dependent and endemic faunal species in the study. In total, only four (less than 2%) of the animal species recorded are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains. The proportion of Red List and CITES threatened faunal species was also low, with seven species constituting 2% of all fauna recorded. Therefore, within the context of the EACF hotspot and on a global level these forests are of modest faunal biological importance.

The largest proportion of forest dependent species found were butterflies (9): the Banded evening brown (*Gnophodes betsimena diversa*), the Silver striped charaxes (*Charaxes lasti lasti*), the Flame bordered charaxes (*C. protoclea azota*), *Cymothoe herminia*, the Gold banded forester (*Euphaedra neophron littoralis*), the Forest queen (*Euxanthe wakefieldi*), a Glider species (*Harma theobene blassi*), *Bematistes epaea epitellus* and the Common sailor (*Neptis alta*). Five mammals and seven birds complete the list, including the Moloney’s monkeys (*Cercopithecus mitis* sub sp.), the Red-bellied coastal squirrel (*Paraxerus palliatus*), the Blue duiker (*Cephalophus monticola*), the Natal duiker (*Cephalophus natalensis*), the Suni (*Neotragus moschatus*), the African crowned eagle (*Stephanoaetus coronatus*), the African broadbill (*Smithornis capensis*), the Yellow streaked greenbul (*Phyllastrephus flavostriatus*), the Fischer’s greenbul (*P. fischeri*), the East coast akalat (*Sheppardia gunningi*), the Blue-mantled crested flycatcher (*Trochocercus cyanomelas*) and the Reichenow’s batis (*Batis reichenowi*).

The endemic species found were one bird, one reptile, one amphibian and one butterfly. The Reichenow’s batis (*Batis reichenowi*) is strictly endemic to the Coastal Forests, representing the only example of such strict endemism for this study. The Spotted flat lizard (*Platysaurus maculatus*) is only found in areas of suitable habitat in northern Mozambique and the Masasi district in south-eastern Tanzania. The ‘true’ toad *Mertensophryne micranotis* is geographically restricted to the Eastern Arc lowland and the Coastal Forest Mosaic of south-eastern Kenya and eastern Tanzania. The Silver striped charaxes (*Charaxes lasti lasti*) is restricted in its habitat to the closed-canopy lowland forest of the Eastern Arc and Coastal Forests of Kenya and Tanzania. None of the mammal species recorded by this study are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains. However, it is likely that shrews (*Crociodura* sp.) collected from this survey will yield interesting results once taxonomic verification is accomplished. Two of the mammals and one of the birds found, the Small-eared bushbaby (*Otolemur garnetti* - CITES II), the Lesser pouched rat (*Beamys hindei* - near threatened) and the East coast akalat (*Sheppardia gunningi* - Vulnerable) are not strictly endemic, but are rare species with restricted distribution in the Coastal Forests and a few other habitats in coastal and south-eastern Africa. Despite the relatively high richness of the butterfly communities observed, none of the studied sites were found to be characterised by the unique butterfly fauna found in other Coastal Forests of Tanzania.

Threatened faunal species included four large mammals, two birds and one amphibian. The Chequered elephant shrew (*Rhynchocyon cirnei* - Vulnerable) and the Dwarf squeaker (*Arthroleptis xenodactyloides* - Vulnerable) were the most frequently recorded. The Elephant (*Loxodonta africana* - Vulnerable and CITES I) was only recorded from an old footprint and the extent of its occurrence in the studied area needs further clarification. The Leopard (*Panthera pardus*), a species listed on CITES Appendix I (2005) as threatened with extinction and therefore excluded from international trade, was reported to inhabit sheltered areas of the Makonde Scarp. The East coast akalat (*Sheppardia gunningi* - Vulnerable) was only recorded in Mtiniko proposed FR. The Peregrine falcon (*Falco peregrinus* - CITES I), a species threatened with extinction if trade is not subject to strict regulation, was observed on the cliffs of Makonde Scarp II proposed FR and in Mtiniko proposed FR. Species Red listed with a lower degree of threat were also recorded in various reserves. These included one near threatened mammal species - the Lesser pouched rat (*Beamys hindei*); seven conservation dependent mammal species - the Spotted hyena (*Crocuta crocuta*), the Buffalo (*Syncerus caffer*), the Greater kudu (*Tragelaphus strepsiceros*), the Natal duiker (*Cephalophus natalensis*), the Sable antelope (*Hippotragus niger*), the Suni (*Neotragus moschatus*) and the Klipspringer (*Oreotragus oreotragus*); and three near threatened bird species - the Southern Banded snake eagle (*Circaetus fasciolatus*), a Lovebird (*Agapornis lilianae*), and the Grey-crested helmet shrike (*Prionops poliophus*).

Our findings seem to confirm the designations of five of the forest reserves studied (Mtiniko, Mkunya River, and Makonde Scarp I, II and III proposed FRs) as Important Bird Areas of Tanzania (IBA TZ052 and IBA TZ053). Moreover, if the Reichenow's batis (*Batis reichenowi* - Coastal Forests Endemic) recorded in Mtiniko proposed FR was to be confirmed as a separate species from the Forest batis (*B. mixta*), then the IBA TZ052 would be entitled to become part of a Secondary or Full Endemic Bird Area (EBA).

The study also revealed some interesting range extensions, including the Lesser bushbaby (*Galago moholi* – CITES II), the Grey-crested helmet shrike (*Prionops poliolophus* - near threatened), the Red-headed bluebill (*Spermophaga ruficapilla*) and one sub-species of the Savanna vine snake (*Thelotornis capensis oatesi*). Finally, some of the widespread and common bird species observed are likely to constitute first records for the studied area, among which the Verreaux's eagle (*Aquila verreauxii* - CITES II), the White-naped raven (*Corvus albicollis*), the White-browed sparrow-weaver (*Plocepasser mahali*), the Black saw-wing (*Psalidoprocne holomelas*), the Lesser seedcracker (*Pyrenestes minor*), the African wood owl (*Strix woodfordii* - CITES II) and the Red-faced crombec (*Sylvietta whytii*).

HUMAN RESOURCES USE AND DISTURBANCE

The major threats to the Mtwara Coastal Forests are high population growth rate, severe poverty, and lack of environmental awareness. These factors result in the extensive conversion of the forest into farmland and the unsustainable exploitation of its resources.

Signs of disturbance included agricultural encroachment, timber extraction, fire damage, hunting, bark ringing and paths. However, different types of disturbance affect the forest reserves with varying degrees. Conversion to agriculture was the most destructive form of disturbance recorded. The reserves most affected by agricultural encroachment are Makonde Scarp I (29%), II (42%) and III (43%) proposed FRs. Encroachment into reserves occurs more extensively where the forest boundaries are not clearly demarcated.

Levels of pole cutting were found to be high in comparison to elsewhere in the EACF hotspot. Kambona and Mkunya River FRs are the most severely affected by pole and timber cutting (>90% of 50m sections), followed by Makonde Scarp I, II and III (78-87% of sections). In all studied sites, poles and timber extraction is selective and therefore ecologically destructive. In addition, pit sawing was found to be widespread, with five of the eight study areas containing at least one recently active and several old pit sawing sites. The degree of pole and timber cutting was observed to be linked to the high population growth rate of the Mtwara Region, implying that levels of extraction tend to increase.

Most of the firewood collected from the eight forest reserves was said to be obtained from dead trees and branches. Four of the eight reserves were found to contain ringed¹ and hence dead trees, with Kambona having the highest intensity of bark ringing (9% of sections). However, as population grows the demand for fuelwood and bark may exceed the trees regeneration capacity. Further research to determine the sustainable levels of timber, firewood and bark extraction in the studied area would be needed.

Burning was another particularly destructive form of disturbance observed. The forest reserves most affected are Ndechela FR and Makonde Scarp I and II proposed FRs (≥70% of sections).

¹ Bark ringing is the removal of a circular section of the bark from a tree, either for medicinal use or to kill the tree and make it available as fire wood. This practice causes the disruption of the phloem and/or the xylem vessels contained in the outer tissues of the trunk, resulting in the blockage of photosynthates and/or water translocation and the death of the tree (Bailey, 1999).

Hunting takes place in most of the studied areas to different degrees. Mtiniko and Mtuli Hinju proposed FRs had the highest density of traps recorded (in 5% and 3% of 50m sections respectively). Hunting in Kambona, Makonde Scarp I and Ndechela involves the Chequered elephant shrews (*Rhynchocyon cirnei*), a species listed as Vulnerable, and the Natal duiker (*Cephalophus natalensis*) and the Sable antelope (*Hippotragus niger*), two species listed as conservation dependent in the IUCN Red List (2004).

The study found that all areas suffer from the lack of a clearly demarcated boundary. Similarly, local management initiatives range from absent to ineffective among the forest reserves. Mtuli Hinju proposed FR is the only reserve that currently has an Environmental Committee to patrol the reserve boundaries. In those reserves where management has been interrupted or has not been initiated yet the reasons appeared to be twofold: lack of will and/or lack of funds. The lack of enforcement of national forest legislation in the study site and absence of local by-laws constitute another problem that hampers the management of most of the reserves.

CONSERVATION PRIORITISATION

Among the studied reserves, the most important in terms of biological value are Mtiniko Proposed FR and Ndechela FR.

Mtiniko proposed FR is covered by Mixed dry forest, a forest type unique to the Coastal Forest Mosaic. It is one of the least disturbed and richest with floral species, and contains among the highest numbers of forest dependent, endemic and threatened faunal species for this study. Mtiniko proposed FR is certainly the most important reserve in terms of avifauna, and it has been previously classified as an Important Bird Area (TZ052 - category A1). It hosts the Reichenow's batis (*Batis reichenowi* - Coastal Forests Endemic) the East coast akalat (*Sheppardia gunningi* - Vulnerable), and the Peregrine falcon (*Falco peregrinus* - CITES I), as well as the highest number of forest dependent bird species, including the African broadbill (*Smithornis capensis*), the Yellow streaked greenbul (*Phyllastrephus flavostriatus*), the Blue-mantled crested flycatcher (*Trochocercus cyanomelas*) and the Fischer's greenbul (*Phyllastrephus fischeri*). Mtiniko proposed FR should be immediately gazetted in order to protect the Mixed dry forest and the endemic and threatened species it hosts.

Ndechela FR is comprised of Legume-dominated dry forest, which is the most vulnerable plant community of the Coastal Forest Mosaic, and contains various important plant species such as *Gardenia transvenulosa* (Endemic and Vulnerable). Ndechela FR is also singular for the presence of granite kopjes dramatically protruding from the plain and reaching up to 800m, which contribute to the scenic beauty of this site and create a variety of rocky microhabitats for a rich reptile community. The Spotted flat lizard (*Platysaurus maculatus*) found here is endemic to northern Mozambique and the Masasi district in south-eastern Tanzania. Due to its close proximity to the Lukwika-Lumesule Game Reserve, this reserve contains the highest number of large mammal species recorded, as well as the larger proportion of threatened mammal species. These include the Elephant (*Loxodonta africana* - Vulnerable), the Lion (*Panthera leo* - Vulnerable) and the Chequered elephant shrews (*Rhynchocyon cirnei* - Vulnerable), as well as two species (*Loxodonta africana* and *Panthera pardus*) listed on CITES Appendix I (2005). It would be highly beneficial to designate this area as a National Park incorporating Ndechela FR, the Lukwika-Lumesule Game Reserve and possibly a reserve across the river in Mozambique.

The topographic variation of the Makonde escarpment creates an array of habitats and nesting sites that promote a rich bird community. Together with Mkunya River proposed FR, these reserves have been classified as an Important Bird Area (TZ053 - category A1). The Leopard

(*Panthera pardus*) and the Peregrine falcon (*Falco peregrinus*), species listed on CITES Appendix I (2005), were observed to occur on the Makonde scarp in sheltered areas near the cliff face. Other important species found here are the ‘true’ toad *Mertensophryne micranotis* and the Silver striped charaxes (*Charaxes lasti lasti*), which are both strictly endemic to the lowland forest of the Eastern Arc and Coastal Forests of Kenya and Tanzania. Highly threatened plant species are also present here, such as *Cynometra gillmanii* (Endemic and Critically Endangered), *Gardenia transvenulosa* and *Vitex zanzibarensis* (Endemic and Vulnerable). It would be advisable for the whole of the Makonde Scarp to be protected as one large reserve, including Mkunya River, Makonde scarp I, II and III, the management of the whole area as a continuous conservation site being potentially more effective.

The importance of Mtuli Hinju resides in its Legume-dominated forest and wetland. In this reserve encroachment is among the lowest and a species rich and stable plant community has therefore developed, with important species such as *Mesogyne insignis* (Vulnerable), *Tetracera boiviniana*, *Erythrina schliebenii*, *Xylothea tettensis*, *Rytigynia decussata* and *Cola clavata* (Endemic and Potentially Threatened). Nevertheless, the small size of this reserve constitutes a threat to the continuity of its vulnerable forest type should disturbance ensue.

Kambona FR is threatened by its small size and severe timber extraction that has noticeably reduced the floral species richness. Nevertheless, this reserve harbours some important plant and animal species, such as *Khaya anthotheca* (Vulnerable), *Tetracera boiviniana*, *Erythrina schliebenii* and *Rytigynia decussata* (Endemic and Potentially Threatened), and the Chequered Elephant Shrew (*Rhynchocyon cirnei* - Vulnerable).

Beyond their biological value, all of the forest reserves surveyed are important because they provide the local communities with water sources, protection from soil erosion and natural resources. Priority sites for the conservation of water sources include Mkunya River, Makonde Scarp III and Mtuli Hinju proposed FRs and Kambona FR. Soil erosion and the landslides and floods it can cause at the foot of the Makonde Scarp are a significant threat to the livelihoods of thousands of people. The protection of the forests located along the escarpment (Mkunya River, Makonde Scarp I, II and III) is therefore a priority.

CONSERVATION RECOMMENDATIONS

The conservation approach used should concentrate on developing an effective management plan for the safeguard of the reserves and sustainable use of resources, and on promoting awareness of the values of the forests studied, including their provision of natural resources, their protection of water sources and soil, and their unique biodiversity. Various suggestions to improve conservation practice in the studied reserves are given: gazettement, boundary demarcation, management capacity building, compensation to people who have been relocated outside the reserves, establishment of environmental committees, patrols, enforcement of fines for illegal practices, environmental awareness promotion, tree planting inside and in the vicinity of the reserves, encouragement of sustainable resources extraction, investment in rural development and development of affordable alternative sources of energy.

The Coastal Forests are part of a mosaic system and rely on the stability of the whole system for the continuity of their floral and faunal communities. Adequate conservation measures need therefore to be taken in as many of the Coastal Forests as possible, and efforts should be made to restore and increase connectivity among fragmented forest patches.

However, no conservation plan can be successful if a holistic approach aiming at reducing poverty and limiting population growth in the Mtwara Region is not developed. Only by complementing major efforts to improve the life standards of the local communities can

national law enforcement and environmental awareness promotion succeed in preserving the highly threatened Coastal Forests of the Mtwara Region for the present and future generations. Considering that the majority of the people in the Mtwara Region heavily depend on natural resources from the forest for their livelihoods, improved forest management and sustainable utilisation of natural resources constitute two fundamental elements of any strategy aiming at the mitigation of poverty.

SUMMARY OF FINDINGS

What follows is a brief summary of the findings for each forest reserve separately, including the vegetation types that cover them, the most important plant and animal species found, the main threats that affect them and their conservation priorities.

FOREST RESERVE: KAMBONA FOREST RESERVE

Vegetation types: Eastern African coastal *Brachystegia* forest and Riverine forest

Important plant species: *Barleria holstii*, *Cleistanthus schlechteri*, *Mimusops schliebenii* and *Grewia lepidopetala* are endemic to the Swahilian region *sensu lato*; *Khaya anthotheca* is threatened; *Drypetes natalensis*, *Baphia punctulata*, *Craibia brevicaudata* and *Syzygium cordatum* are potentially threatened; *Tetracera boiviniana*, *Erythrina schliebenii* and *Rytigynia decussata* are endemic to the Swahilian region *sensu lato* and potentially threatened.

Important animal species: *Otolemur garnetti* has a restricted distribution in the Coastal Forests and a few other habitats in coastal eastern Africa; *Beamys hindei* has a restricted distribution in a few forest types in Kenya and Tanzania, including the Eastern Arc Mountains and Coastal Forests; *Rhynchocyon cirnei* and *Arthroleptis xenodactyloides* are threatened.

Main threats: Commercial timber extraction, pole cutting and hunting. The small size (29.9ha) of the reserve and the large surrounding population utilising it.

Conservation priorities:

- Protection of water source
- Protection of *Brachystegia* forest
- Protection of *Khaya anthotheca*
- Protection of *Rhynchocyon cirnei* and *Arthroleptis xenodactyloides*

FOREST RESERVE: MAKONDE SCARP I PROPOSED FOREST RESERVE

Vegetation type: Eastern African coastal *Brachystegia* forest

Important plant species: *Ozoroa obovata*, *Mimusops schliebenii* and *Sterculia appendiculata* are endemic to the Swahilian region *sensu lato*; *Drypetes natalensis* and *Millettia impressa* are potentially threatened; *Vitex zanzibarensis* is endemic and threatened; *Commiphora zanzibarica*, *Erythrina schliebenii*, *Lamprothamnus zanguebaricus*, *Rytigynia decussata* and *Vitex mossambicensis* are endemic to the Swahilian region *sensu lato* and potentially threatened.

Important animal species: *Otolemur garnetti* has a restricted distribution in the Coastal Forests and a few other habitats in coastal eastern Africa; *Beamys hindei* has a restricted distribution in a few forest types in Kenya and Tanzania, including the Eastern Arc Mountains and Coastal Forests; *Arthroleptis xenodactyloides* is threatened; the record of *Galago moholi* represents a range extension for this species.

Main threats: Encroachment of cultivated land, pole cutting and hunting.

Conservation priorities:

- Prevention of soil erosion
- Protection of *Brachystegia* forest
- Protection of *Vitex zanzibarensis* and *Arthroleptis xenodactyloides*
- Protection as an Important Bird Area

FOREST RESERVE: MAKONDE SCARP II PROPOSED FOREST RESERVE

Vegetation type: Eastern African coastal *Brachystegia* forest, Mixed scrub forest and Thicket.

Important plant species: *Monodora grandidieri* and *Grewia lepidopetala* are endemic to the Swahilian region *sensu lato*; *Monanthotaxis trichocarpa*, *Cassia abbreviata*, *Craibia brevicaudata* and *Millettia impressa* are potentially threatened; *Gardenia transvenulosa* and *Vitex zanzibarensis* are endemic and threatened; *Monanthotaxis fornicata*, *Tetracera boiviniana* and *Lamprothamnus zanguebaricus* are endemic to the Swahilian region *sensu lato* and potentially threatened.

Important animal species: *Mertensophryne micranotis* is endemic to the Eastern Arc lowland and the Coastal Forest Mosaic of south-eastern Kenya and eastern Tanzania; *Panthera pardus* and *Falco peregrinus* are listed in CITES Appendix 1; the record of *Thelotornis capensis oatesi* represents a range extension for this species.

Main threats: Encroachment of cultivated land, pole cutting, bark ringing for beehives, and hunting.

Conservation priorities:

- Prevention of soil erosion
- Protection of *Brachystegia* forest
- Protection of *Gardenia transvenulosa* and *Vitex zanzibarensis*
- Protection of *Panthera pardus*, *Falco peregrinus* and *Mertensophryne micranotis*
- Protection as an Important Bird Area

FOREST RESERVE: MKUNYA RIVER PROPOSED FOREST RESERVE

Vegetation type: Eastern African coastal *Brachystegia* forest and Riverine forest

Important plant species: *Cleistanthus schlechteri*, *Mimusops schliebenii*, *Sterculia appendiculata* and *Grewia forbesii* are endemic to the Swahilian region *sensu lato*; *Mesogyne insignis* is threatened; *Drypetes natalensis* and *Millettia impressa* are potentially threatened; *Cynometra gillmanii* is endemic and threatened; *Commiphora zanzibarica*, *Scorodophloeus fischeri*, *Erythrina schliebenii*, *Xylothea tettensis*, *Lamprothamnus zanguebaricus* and *Rytigynia decussata* are endemic to the Swahilian region *sensu lato* and potentially threatened.

Important animal species: *Charaxes lasti lasti* is endemic to the closed-canopy lowland forest of the Eastern Arc and Coastal Forests of Kenya and Tanzania; *Beamys hindei* has a restricted distribution in a few forest types in Kenya and Tanzania, including the Eastern Arc Mountains and Coastal Forests; *Rhynchocyon cirnei* and *Arthroleptis xenodactyloides* are threatened; the record of *Prionops poliophus* and *Spermophaga ruficapilla* represents a range extension for these species.

Main threats: Encroachment of cultivated land, pole cutting, pit sawing, hunting and agriculture.

Conservation priorities:

- Protection of water source
- Prevention of soil erosion
- Protection of *Brachystegia* forest
- Protection of *Cynometra gillmanii* and *Mesogyne insignis*
- Protection of *Rhynchocyon cirnei* and *Arthroleptis xenodactyloides*
- Protection as an Important Bird Area

FOREST RESERVE: MTINIKO PROPOSED FOREST RESERVE

Vegetation type: Eastern African coastal Mixed dry forest

Important plant species: *Monodora grandidieri*, *Cleistanthus schlechteri*, *Grewia lepidopetala* and *Rinorea elliptica* are endemic to the Swahilian region *sensu lato*; *Mesogyne insignis* is threatened; *Drypetes natalensis*, *Craibia brevicaudata* and *Rinorea angustifolia* are potentially threatened; *Bombax rhodognaphalon*, *Tetracera boiviniana*, *Erythrina schliebenii*, *Rytigynia decussata*, *Cola clavata* and *Vitex mossambicensis* are endemic to the Swahilian region *sensu lato* and potentially threatened.

Important animal species: *Batis reichenowi* is endemic to the Coastal Forests; *Charaxes lasti lasti* is endemic to the closed-canopy lowland forest of the Eastern Arc and Coastal Forests of Kenya and Tanzania; *Beamys hindei* has a restricted distribution in a few forest types in Kenya and Tanzania, including the Eastern Arc Mountains and Coastal Forests; *Rhynchocyon cirnei* is threatened; *Sheppardia gunningi* is threatened and restricted in distribution to the Coastal Forests and a few other forest types in Tanzania, Kenya, Malawi, and coastal Mozambique; *Falco peregrinus* is listed in CITES Appendix 1; the record of *Galago moholi* represents a range extension for this species.

Main threats: Timber and pole cutting, pit-sawing and hunting.

Conservation priorities:

- Protection of important remnants of Mixed dry forest
- Protection of *Mesogyne insignis*
- Protection of *Rhynchocyon cirnei*, *Sheppardia gunningi*, *Batis reichenowi* and *Falco peregrinus*
- Protection as an Important Bird Area

FOREST RESERVE: MTULI HINJU PROPOSED FOREST RESERVE

Vegetation type: Eastern African coastal Legume-dominated dry forest

Important plant species: *Cleistanthus schlechteri* and *Grewia lepidopetala* are endemic to the Swahilian region *sensu lato*; *Mesogyne insignis* is threatened; *Maytenus mossambicensis*, *Cassia abbreviata*, *Acacia nilotica*, *Craibia brevicaudata* and *Lasianthus kilimandscharicus* are potentially threatened; *Tetracera boiviniana*, *Erythrina schliebenii*, *Xylothea tettensis*, *Rytigynia decussata* and *Cola clavata* are endemic to the Swahilian region *sensu lato* and potentially threatened.

Important animal species: *Charaxes lasti lasti* is endemic to the closed-canopy lowland forest of the Eastern Arc and Coastal Forests of Kenya and Tanzania; *Rhynchocyon cirnei* is threatened; the record of *Galago moholi* represents a range extension for this species.

Main threats: Pole cutting and pit sawing; the small size (296ha) of the reserve and the large surrounding population utilising it.

Conservation priorities:

- Protection of water source
- Protection of Legume-dominated dry forest
- Protection of *Mesogyne insignis*
- Protection of *Rhynchocyon cirnei* and *Charaxes lasti lasti*
- Protection as an important wetland for birds and amphibians

FOREST RESERVE: MAKONDE SCARP III PROPOSED FOREST RESERVE

Vegetation type: Eastern African coastal *Brachystegia* forest and Thicket.

Important plant species: *Sterculia appendiculata* and *Grewia lepidopetala* are endemic to the Swahilian region *sensu lato*; *Khaya anthotheca* and *Mesogyne insignis* are threatened; *Drypetes natalensis*, *Cassia abbreviata* and *Lasianthus kilimandscharicus* are potentially threatened; *Cussonia zimmermannii*, *Bombax rhodognaphalon*, *Tetracera boiviniana*, *Scorodophloeus fischeri*, *Xylothea tettensis* and *Aframomum orientale* are endemic to the Swahilian region *sensu lato* and potentially threatened.

Important animal species: *Charaxes lasti lasti* is endemic to the closed-canopy lowland forest of the Eastern Arc and Coastal Forests of Kenya and Tanzania; *Beamys hindei* has a restricted distribution in a few forest types in Kenya and Tanzania, including the Eastern Arc Mountains and Coastal Forests; *Arthroleptis xenodactyloides* is threatened.

Main threats: Encroachment of cultivated land, cattle movement, timber and pole cutting and hunting.

Conservation priorities:

- Protection of water source
- Prevention of soil erosion
- Protection of *Brachystegia* forest
- Protection of *Khaya anthotheca* and *Mesogyne insignis*
- Protection of *Arthroleptis xenodactyloides*
- Protection as an Important Bird Area

FOREST RESERVE: NDECHELA FOREST RESERVE

Vegetation type: Eastern African coastal Legume-dominated dry forest.

Important plant species: *Sterculia appendiculata* and *Grewia lepidopetala* are endemic to the Swahilian region *sensu lato*; *Gardenia transvenulosa* is endemic and threatened; *Cassia abbreviata* and *Millettia impressa* are potentially threatened; *Cussonia zimmermannii*, *Commiphora zanzibarica*, *Tetracera boiviniana*, *Scorodophloeus fischeri*, *Entada stuhlmannii* and *Vitex mossambicensis* are endemic to the Swahilian region *sensu lato* and potentially threatened.

Important animal species: *Platysaurus maculatus* is endemic to northern Mozambique and the Masasi district in south-eastern Tanzania; *Rhynchocyon cirnei* and *Loxodonta Africana* are threatened; *Panthera pardus* and *L. Africana* are listed by CITES Appendix I; the record of *Prionops poliophus* represents a range extension for this species.

Main threats: Fire damage, pit sawing and hunting.

Conservation priorities:

- Protection of water source and large timbers
- Protection of Legume-dominated dry forest
- Protection of *Gardenia transvenulosa*
- Protection of *Rhynchocyon cirnei*, *Panthera leo*, *P. pardus*, *Loxodonta africana* and *Platysaurus maculatus*

8. INTRODUCTION

G. WEGNER AND M. J. CUTTS

BACKGROUND TO THE BIODIVERSITY SURVEY

The Forgotten Coastal Forests of Mtwara: A Reconnaissance to Prioritise Biological Knowledge for Community Conservation Initiatives project (abbreviated as the Frontier Tanzania Mtwara Reconnaissance Project – FTFT-MRP) is a CEPF funded initiative implemented by Frontier-Tanzania, a collaboration between the Society of Environmental Exploration and the University of Dar es Salaam, to perform biological research in the least studied of 160 eligible Key Biodiversity Sites of the EACF hotspot (strategic funding direction 3.2). This aim was pursued through pioneering baseline biodiversity surveys and the compilation of indigenous knowledge (strategic funding direction 3.5) in eight relatively unexplored and understudied Coastal Forests of the Mtwara Region (south-eastern Tanzania). These Coastal Forests partially comprise the CI-numbered Key Biodiversity Sites 81, 95 and 102. Research was conducted from April to August of 2005.

THE BIODIVERSITY HOTSPOT CONCEPT

The loss of biodiversity is one of the foremost environmental issues of the modern age. In response to this predicament, in 1988 Norman Myers developed the biodiversity hotspot concept and Conservation International (CI) and the MacArthur Foundation (MAF) adopted it the following year as their central conservation strategy. Central to the notion is that a small number of ecoregions occupying a small portion of the world's landmass hold an exceptionally large share of the world's terrestrial biodiversity and have high concentrations of endemism (Myers *et al.*, 2000).

A four-year study started in 1996 by CI identified 25 hotspots significant to long-term conservation. These hotspots were found to cover 1.4% of the Earth's land surface and yet harbour 44% of the global total of endemic plant species, 35% of the global total of endemic vertebrate species, and 60% of all known plant and vertebrate species. The majority of these hotspots is in tropical developing countries and is subject to human activities and population growth threatening their existence (Myers *et al.*, 2000).

THE EASTERN ARC MOUNTAINS AND COASTAL FORESTS OF TANZANIA AND KENYA (EACF) HOTSPOT

The Eastern Arc Mountains and Coastal Forests of Tanzania and Kenya hotspot (hereafter referred to as the Eastern Arc Mountains and Coastal Forests hotspot – EACF) runs along the coast of eastern Africa from the southern border of Somalia down to the northern border of Mozambique. This covers the whole Tanzanian and Kenyan coasts, including the Indian Ocean islands of Mafia, Pemba and Zanzibar, and comprises the intervening habitats between forest patches. The majority of the hotspot is in the east of Tanzania, moving inland to include the Eastern Arc Mountains and incorporating the water catchment system of the Rufiji River².

² In 2005 a hotspots reappraisal conducted by Conservation International separated the EACF hotspot into two separate entities – the Eastern Afrotropical Hotspot and the Coastal Forests of Eastern Africa Hotspot. The partition was based on the two regions being characterised by separate plant phytocoria differentiated by altitude and climatic regimes and each containing a significant number of strict endemics. However, this report follows CEPF's current definition of the EACF hotspot as a single entity (CEPF, 2005).

The biological importance of the EACF hotspot resides in the high density of its endemic species: because of the small area of the hotspot, the densities of its endemic species are among the highest in the world. Consequently, this hotspot is likely to suffer high plant and vertebrate extinction for a given loss of habitat. Moreover, the fragmentation, variation and small size of forest patches (e.g. no Tanzanian Coastal Forests are larger than 40 km²) make the sites susceptible to invasion by generalists and vulnerable to habitat loss (CEPF 2005; Clarke and Robertson, 2000). Because of the high degree of threat present in the area, the CFEA hotspot has been classified as one of 11 ‘hyperhot’ priorities for conservation investment (Brooks *et al.*, 2002).

THE COASTAL FOREST MOSAIC

The Coastal Forests element of the EACF hotspot is referred to as the “Coastal Forest Mosaic”, highlighting the highly variable occurring vegetation, which includes closed-canopy forest as well as other vegetation types (CEPF, 2005). The closed-canopy forest of this mosaic is referred to as the Coastal Forests. This complex mosaic of vegetation types is a consequence of a heterogeneous set of abiotic (climate, geology, topography etc.), biotic (anthropogenic disturbance, termites etc.) and historical (glaciations etc.) factors which may not be repeated at different sites (Clarke and Robertson, 2000). Much of the mosaic has been converted into agricultural land and human settlements, including Mombasa in Kenya and Dar es Salaam in Tanzania (CEPF, 2005).

The Coastal Forest Mosaic has been recognised to constitute a distinct phytocorion³ occurring along the coastal strip of eastern tropical Africa (CEPF 2005; Clarke, 2000). Defining the exact extent of this phyto-region is a difficult task as insufficient data area available, especially from Somalia and Mozambique. Clarke (2000a), treats the Coastal Forest Mosaic as corresponding to the “Zanzibar-Inhambane regional phytocorion” identified by White (1983a), which was later renamed as the “Swahilian regional centre of endemism” with an adjacent “Swahilian/Maputaland regional transition zone” to the south, abbreviated as the “Swahilian region *sensu lato*” (Clarke, 1998). According to this classification, the eastern African Coastal Forest Mosaic extends between the equator in southern Somalia and the estuary of Limpopo River in Mozambique (Clarke, 2000a, pp. 10-17). The CEPF ecosystem profile (2005, p. 10), on the other hand, defines the Coastal Forest Mosaic as corresponding to the “Northern Zanzibar-Inhambane Coastal Forest Mosaic” identified by WWF (2003), excluding Somalia and Mozambique. In this report, we use Clarke’s definition of the Coastal Forest Mosaic as broadly corresponding to the “Swahilian region *sensu lato*”.

Within the Coastal Forest Mosaic, the closed-canopy Coastal Forests extend to 3,172km², making up just 1% of the whole Swahilian region *sensu lato* (Clarke *et al.*, 2000). Nevertheless, the patches of closed-canopy Coastal Forests are characterised by the highest concentration of biodiversity and endemism. In terms of flora, 70% of all endemic species are also present in the closed-canopy Coastal Forests, and of all the species recorded from the Swahilian region *sensu lato* (more than 1356) at least 554 species (42%) are restricted to the closed-canopy Coastal Forests (Clarke *et al.*, 2000).

In the closed-canopy Coastal Forests of Tanzania, 33% of vascular plant species were found to be endemic to the Swahilian region *sensu lato* (Clarke, 2000). Rates of faunal endemism in the Coastal Forest Mosaic vary from 7% (31 species) for mammals to 10% (24 species) for birds, 57% (47 species) for reptiles, 36% (5 species) for amphibians and 19% (75 species) for

³ A phytocorion is an area of plant endemism (encompassing various vegetation types) restricted to a particular geographical area and defined on the basis of its vegetation physiognomy and the richness of its endemic flora (i.e. >1000), whereby a large fraction of the total number of species of higher plants is restricted in distribution to such geographical area (White, 1983a).

butterflies, with 786 known species in eight taxonomic groups being strictly endemic to the closed-canopy Coastal Forests (CEPF, 2005; Burgess and Clarke, 2000).

Closed-canopy Coastal Forests comprise various forest types: dry forest, *Brachystegia* forest, scrub forest, riverine forest, groundwater forest, swamp forest, and coastal-afromontane transition forest. Many assemblages of heterogeneous vegetation make up the rest of the Coastal Forest Mosaic, including woodland, savanna woodland, bushland, thicket and grassland interspersed with farmland under cultivation or fallow, altogether containing more than 500 endemic plant species (CEPF, 2005; Clarke, 2000).

Areas of these closed-canopy Coastal Forests, and especially Caesalpinoidae-dominated dry forest, may be remnants of the original pre-Miocene pan-African lowland forest, which once comprised the now separated blocks of West African Guineo-Congolian Forest and East African Swahilian Coastal Forest. This is demonstrated by the fact that many species that occur in, and often dominate, these forests (such as *Cynometra*, *Scorodophloeus* and *Brachystegia*) are endemic to both the Guineo-Congolian Forests and the Swahilian Coastal Forests (Clarke and Robertson, 2000). It is possible that prior to human intervention Caesalpinoidae-dominated dry forest covered much of the eastern African coastal strip, constituting the climatic vegetation climax for this ecoregion (Clarke and Robertson, 2000).

In terms of species richness, the closed-canopy Eastern African Coastal Forest ranks between the Guineo-Congolian Forest and the Eastern Arc Mountain Forest, containing at least 1050 plant genera and more than 4500 plant species (CEPF 2005; Clarke *et al.*, 2000). The plant communities occurring in the closed-canopy Coastal Forests are highly variable in their assemblage combinations and dominance patterns. In general, however, monospecific canopy dominance is common in these forests, with up to 80% of the entire canopy being composed of only five species (Clarke *et al.*, 2000).

Endemic species in the Coastal Forest Mosaic are often disjunct in their distribution pattern: only a few of the strictly endemic species are distributed throughout the whole range of the Coastal Forests (e.g. *Bombax rhodognaphalon*), but many have disjunct ranges (e.g. *Sheppardia gunningi*) and single site endemism is common. There is also a high turnover of local species between adjacent forest patches, with forests that are only 100km apart differing in up to 70% of their millipedes and 80% of their plants. These distribution patterns indicate that much of the habitat heterogeneity and fragmentation, and the associated degree of biological endemism, are primarily natural and relictual rather than of recent anthropogenic origin. However, habitat fragmentation has also been incremented by widespread forest clearance by humans in the past hundred years (Burgess, 2000). Single site endemism, disjunct distribution and a high degree of species turnover make the prioritisation of the forests in terms of their biodiversity a difficult task (CEPF, 2005)

Severe disturbance is known to reduce the level of endemism in the Coastal Forests. More endemic species were probably present in the forests of coastal eastern Africa and are now extinct following the introduction of repeated fires and widespread forest clearance. The threat of further extinction is unfortunately a serious one for the endemic species of these forests, since in many of them fragmentation and habitat loss may have caused populations of long-lived endemic species (e.g. trees) to become genetically unviable (Clarke *et al.*, 2000; Cronk, 1997).

THE COASTAL FOREST VEGETATION TYPES

The following description for the closed-canopy forest types of the Coastal Forest Mosaic is taken from Clarke and Robertson (2000).

- *Eastern African coastal dry forest*

This is the predominant Coastal Forests type. Prior to human intervention it probably covered much of the eastern African coastal strip, constituting the climatic vegetation climax for this ecoregion, with other vegetation types being subtypes, variants and transitions to dry forest. There are two broad varieties of coastal dry forest: *Legume-dominated* and *Mixed*. Legume-dominated dry forest comprises the bulk of this forest type. It grows on well drained soils but appears not to be limited by edaphic conditions. It is dominated by trees of the family Leguminosae, and one or two species of this family often dominate (between 50-95%) a rather simple vegetation structure that lacks the tree strata typical of other tropical forest types. The subfamily Caesalpinioideae is particularly well represented, especially the genera *Scorodophloeus*, *Cynometra*, *Julbernardia*, *Hymenaea*, *Berlinia*, *Guibourtia*, *Erythrophleum*, *Paramacrolobium* and *Dialium*. Legumes belonging to the genera *Baphia*, *Craibia* and *Millettia* (subfamily Papilionoideae) and *Newtonia* (subfamily Mimosoideae) are frequently associated with members of the Caesalpinioideae. Shrubs are generally frequent and mainly comprise saplings of the canopy species, indicating a climax community, whilst herbs and lianas are usually rare to scarce. The seeds of the Caesalpinioideae are heavy and not dispersed by wind or animal. In southern Tanzania the *Scorodophloeus fischeri* association is frequently found. Mixed non-legume-dominated dry forest is more difficult to classify owing to the absence of a single recurring vegetation community node, instead many associations occur that are sometimes unique to a particular forest area. In the literature 152 trees have been given as dominant or common species in at least one forest area. Lianas and shrubs are also common. This floristic complexity is also matched by structural complexity, with sub canopy tree layers becoming more distinct with increasing moisture availability. Seeds from the species typical of this forest type are wind or animal dispersed, indicating that Mixed dry forest may occur as a regeneration climax in the absence of competition from slower dispersed legume seeds typical of Legume-dominated dry forest.

- *Eastern African coastal Brachystegia forest*

This forest type is dominated by *B. spiciformis* or *B. microphylla*, with *Hymenaea verrucosa* and *Julbernardia magnistipulata* occurring as co-dominants and 19 more tree species recorded as dominant or frequent. This forest type is a variant of the Legume-dominated dry forest and occurs on well-drained, nutrient poor, heavily leached and/or eroded soils, which are archetypal of the Makonde escarpment. It is thought to be a non-fire generated climax community over soils that have become too degraded to support eastern African coastal dry forest. The cause of the soil erosion may be anthropic (clearance and shift-cultivation) or the natural and rapid erosion of the sandstone plateaux and hills of the Makonde Scarp (Burgess and Clarke, 2000) (see Geology and Soil sections). In this forest type *Brachystegia* trees form a closed-canopy over a scarce to dense shrub layer, while grasses are sparsely present to absent. Although the wide tree crowns rarely overlap, this vegetation type satisfies all other physiognomic criteria for classification as a forest. It is this physiognomy, as well as its fire-excluded character and the dominance of Swahilian endemic species, that distinguish this vegetation type from the *Brachystegia* or ‘miombo’ woodland that constitutes the fire-generated climax of the Zambezian regional centre of endemism⁴ (Clarke and Robertson, 2000).

⁴ The *Brachystegia* or ‘miombo’ woodland formations of the Zambezian regional centre of endemism are also dominated by *Brachystegia* sp. (*B. microphylla* or *B. spiciformis*), but they differ from the coastal *Brachystegia* forest of the Swahilian regional centre of endemism in both ecological and physiognomic terms. They are fire-generated climax vegetations characterised by an open canopy and a dense grass layer, and composed of tree and shrub species restricted in distribution to the Zambezian regional centre of endemism (Clarke, 2000).

- *Eastern African coastal scrub forest*

Scrub forest is a common feature of the Coastal Forest Mosaic belt. Most of it constitutes a seral or sub-climax regeneration phase, resulting from and prevented from succession to forest by heavy disturbance, such as seasonal burning or shifting cultivation. The two broad categories are *Mixed scrub forest* and *Maritime scrub forest*. Mixed scrub forest has up to 141 species recorded as dominant or common, and the most frequent include *Azelia quanzensis*, *Bombax rhodognaphalon*, *Brachylaena huillensis*, *Caloncoba welwitschii*, *Combretum schumannii*, *Grewia* sp., *Hymenocardia ulmoides*, *Manilkara sulcata*, *Oldfieldia somalensis*, *Pteleopsis myrtifolia*, *Suregada zanzibarensis* and *Zanthoxylum holtzianum*. This vegetation type is typical of the Makonde plateau, where it can become virtually impenetrable. Maritime scrub forest has species with typically thick coriaceous leaves to prevent desiccation from the strong salt-laden sea breezes, and it can be found at intervals along the coast of eastern Africa. Dominance by one or two species is again rare.

- *Eastern African coastal riverine/groundwater/swamp forest*

These forests are the result of an additional groundwater moisture supply. In strict terms they do not constitute an element of the Swahilian phytocorion, as they are dominated by tree species which are widespread throughout tropical Africa, even though some of the lianas, shrubs and herbs are endemic to the Swahilian region *sensu latu* (White, 1983a). They tend to be similar in species composition; however some species do characterize the separate types. Among dominant species occurring in both riverine and ground water forest the most frequent are *Antidesma venosum*, *Barringtonia racemosa*, *Bridelia micrantha*, *Burttavya nyasica*, *Celtis phillippensis*, *Cordia goetzei*, *Diospyros mespiliformis*, *Ficus scassellatii*, *Ficus sycomorus*, *Garcinia livingstonei*, *Khaya anotheca*, *Kigelia africana*, *Milicia excelsa*, *Mimusops obtusifolia*, *Parkia filicoidea*, *Sorindeia madagascariensis*, *Sterculia appendiculata*, *Syzygium guineense*, *Terminalia sambesiaca* and *Trichilia emetica*. Coastal riverine forest develops along permanent or semi-permanent watercourses and it has a diverse mix of species in the canopy with typically large scattered trees. Coastal groundwater forest is found in areas with a dissected topography where seasonal and permanent drainage courses form from the accumulation of surface and groundwater. It is characterised by large emergent trees of a deciduous type and species from the Moraceae family (e.g. *Antiaris*, *Ficus*, *Milicia* and *Trilepsium*) are prominent, accompanied by frequent shrubs and lianas. Swamp forest is dominated by distinctive monocotyledon species.

- *Eastern African coastal-afromontane transitional forest*

Found in higher locations with high rainfall (1500mm and above), and typically at the base of the Eastern Arc Mountains, this forest type is the closest in physiognomy to lowland rainforest. Multiple tree strata are characteristic, with a denser shrub layer and a greater number of epiphytes and lianas than in other coastal forest types.

- *Woodland and grassland*

The woodland and grassland formations present in the eastern African coastal strip are not climax communities (Holdridge *et al.*, 1971). Instead they are a consequence of widespread and frequent burning and clearance for cultivation that have been repeatedly practiced for many generations. These practices can cause the local extinction of many Swahilian endemic plant species that are unable to regenerate where burning regularly occurs, and have encouraged the incursion of plant species characteristic of the Zambezian regional centre of endemism. In some areas this process has resulted in the Swahilian Coastal Forests being converted into floristically impoverished woodland of Zambezian affinity or further degraded into grassland (Clarke, 2000). Many Swahilian endemic plant species are nonetheless able to tolerate some fire and can be found in these woodland and grassland formations (White, 1993).

CONSERVATION INITIATIVES IN THE EACF HOTSPOT

Interest in the biological value of the EACF hotspot has been relatively recent, with publications, workshops and conferences on the biodiversity and conservation of this area mostly organised by the United Nations Development Programme/Global Environment Facility (UNDP/GEF), the WWF Eastern Africa Regional Programme Office (WWF-EARPO), BirdLife International and the Critical Ecosystem Partnership Fund (CEPF).

The Fourth East African Wildlife Symposium at Arusha in 1978 started a new interest in the biodiversity value of the region. This was followed by a report to the Government of Tanzania, drawing its attention to the biological importance of and threats to the Eastern Arc Mountains. In 1983 the Tanzania Forest Conservation Group (TFCG) was founded to address the issues discussed in the report.

In the same year, a team from the International Council for Bird Preservation (ICBP, now BirdLife International) surveyed the avifauna of Arabuko-Sokoke Forest on the northern coast of Kenya and drew attention to its globally threatened bird species and the state of eastern African Coastal Forests there. More comprehensive surveys followed, drawing attention to different aspects of the coastal belt (for a complete summary refer to Burgess and Clarke, 2000). In 1993 a workshop on the eastern African Coastal Forests was held in Dar es Salaam. This raised the profile of these forests and promoted more definitive conservation action.

In December 1997 there was an international conference on the Eastern Arc Mountains at Morogoro, Tanzania, that addressed the status of the remaining forest and their biodiversity, as well as socio-economic and management issues pertinent to the area. A UNDP/DANIDA project was started at this time, which led to a GEF Project Development Fund (PDF Block A) to specify and address conservation issues in the Eastern Arc Mountains in more detail. From the accrued knowledge a three-way matrix was constructed showing levels of biodiversity, endemism and threat and assessing the effectiveness of previous interventions. This revealed exceptional diversity in the East Usambara, Udzungwa and Uluguru mountains. A PDF Block B proposal supported by UNDP and the World Bank was developed to focus on the Ulugurus.

In February 2002 a workshop on the Eastern Africa Coastal Forest Programme covering Kenya, Tanzania and Mozambique was developed by WWF-EARPO to develop a regional synthesis on Coastal Forests conservation issues (WWF-EARPO, 2002). On 12 March 2003, a CEPF workshop was held in Dar es Salaam, Tanzania, to define and build upon all previous effort. Participants included 48 people from government departments, NGOs, scientific and research institutions, field projects and donor organizations, all of whom worked in or had knowledge of the hotspot. The outputs from the workshop were subsequently incorporated into a consultation process that helped to define the investment priorities for CEPF and avoid duplication of efforts in the hotspot. Along with other research initiatives in the hotspot, the FT-MRP was approved for grant funding in 2004. The eight forest reserves surveyed by the FT-MRP had been included within the eligible Key Biodiversity Sites 81, 95 and 102 by CI in 1996, but these reserves had not been systematically researched before.

More recently (30 May to 1 June 2005) a BirdLife workshop on Biodiversity Monitoring in the Eastern Arc Mountains and Coastal Forests Hotspot was held in Dar es Salaam. This sought to bring key stakeholders together to review, standardise and plan coordinated long-term monitoring in the hotspot.

THE CRITICAL ECOSYSTEM PARTNERSHIP FUND’S INVESTMENT IN THE EACF HOTSPOT

The Critical Ecosystem Partnership Fund (CEPF) is a joint initiative of Conservation International (CI), the Global Environmental Facility (GEF), the Government of Japan (GJ), the MacArthur Foundation (MAF) and the World Bank (WB). The CEPF is designed to safeguard the world’s threatened biodiversity hotspots in developing countries by providing funding and technical support to civil society. The EACF region was approved for grant funding in July 2003 and active grant making started in January 2004, focusing on conserving the EACF hotspot’s 333 globally threatened species.

The total allocation is \$7 million to:

- Increase the ability of local populations to benefit from and contribute to biodiversity conservation, especially in and around the lower Tana River Forests, East Usambaras/Tanga, Udzungwas and Jozani in Zanzibar,
- 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.

AIMS AND OBJECTIVES OF THE FT MRP BIODIVERSITY SURVEY

The conservation value of the eight forest reserves surveyed by the Frontier-Tanzania Mtwara Reconnaissance Project is highlighted by their inclusion within the eligible 160 Key Biodiversity Sites (81, 95 and 102) by CI in 1996. However, these Key Biodiversity Sites were not systematically researched and represent some of the least studied sites of the EACF hotspot. The specific aim of the FT-MRP was therefore to perform biological research in these sites through preliminary baseline biodiversity surveys and the compilation of indigenous knowledge.

The long-term goal of this project is to contribute to the conservation of the biodiversity of the Mtwara Coastal Forests without compromising current livelihoods. This was done by conducting preliminary baseline biodiversity and disturbance surveys. Results from these surveys can be used to promote increased environmental awareness, alternative income generating initiatives and observation of the regulations pertaining to the forest reserves among communities who are in close proximity to the reserves studied.

More specifically, through baseline biodiversity surveys conducted in eight forest reserves in the Mtwara Region the FT MRP aims to contribute to the following conservation outcomes:

- Improved protection and management of the forest reserves studied
- Decrease in illegal and unsustainable activities within the forest reserves (e.g. logging, poaching and encroachment beyond forest reserve boundaries)
- Endemic and threatened species monitored and protected
- Range extensions identified
- Data contributed to the IUCN Red List process

The specific short-term objectives of the FT MRP were:

1. To conduct a preliminary biodiversity survey and compile indigenous knowledge in eight forest reserves, in order to produce baseline information on the following:
 - Flora: species richness, diversity, dominance, relative abundance, composition, endemism, conservation status and range extensions
 - Fauna (mammals, birds, reptiles, amphibians and butterflies): species richness, composition, endemism, conservation status and range extensions
 - Human disturbance and levels of resource extraction
2. To assist in the identification of priority sites most suitable for biodiversity conservation and the provision of environmental services within the studied area;
3. To provide management recommendations for the establishment of sustainable conservation programmes for the studied sites;
4. To provide baseline biological data against which future monitoring may be based, in order to detect changes in the biodiversity status of the studied sites;
5. To raise local awareness of the importance of forest conservation, biodiversity promotion, water sources protection, soil erosion prevention, sustainable use of resources and the interaction of these issues through a layman’s report in Kiswahili for use by district natural resources offices, community groups and schools in close proximity to the studied sites;
6. To raise awareness of the biological values of the lesser known Coastal Forests nationally and internationally, by contributing data to the CEPF Conservation Outcomes Database, the TROPICOS database of Missouri Botanical Gardens and the Biodiversity Database of the University of Dar es Salaam, and through the distribution of this report to national and international government departments and NGOs;
7. To contribute to global biodiversity monitoring and conservation efforts through collaboration with specialists in national and international institutions.

OBJECTIVE LINKAGES TO FRONTIER-TANZANIA FOREST RESEARCH PROGRAMME

FT FRP has been conducting baseline biodiversity surveys within the EACF hotspot since 1989. The aim of FT FRP is to undertake *systematic baseline biological surveys* and to record *local knowledge* in targeted areas of the EACF hotspot, in order to describe the flora and fauna present by assessing the following:

1. Species richness, diversity and composition of vascular flora,
2. Population density of key floral indicator species,
3. Species richness, diversity and composition of vertebrate fauna,
4. Presence/absence of endemic and globally threatened Eastern Arc Mountains and Coastal Forests species.
5. Levels of human disturbance and resource extraction.

FT FRP has developed a comprehensive methodology (Frontier-Tanzania, 1997) for the effective implementation of systematic baseline biological surveys.

Projects undertaken by Frontier-Tanzania in the Eastern Arc Mountains and Coastal Forests hotspot since 1989 are listed in Table 8-a.

Project Name	Location	Key Biodiversity Sites	Time frame	Donor
Coastal Forests Biological Surveys	Coast Region, Lindi Region, Tanga Region, and Chumbe Island-Zanzibar Archipelago, Tanzania (Various Coastal Forests)	65 - Lindi District 37 - Tanga Morogoro 139 - Tanga Pangani	1989-1994	SEE
East Usambara Biodiversity Surveys (EUBS)	East Usambara Mountains, Tanga Region, Tanzania (Amani NR, Bamba Ridge FR, Bombo East I and II FR, Kambai FR, Kwamarimba FR, Kwangumi FR, Longuza FR, Magoroto Forest, Manga FR, Mgambo FR, Mlinga FR, Mlungui Proposed FR, Mpanga Village FR, Mtai FR, Nilo FR, Segoma FR, Semdoe FR)	N/A	Jun 1995 - Jun 2002	FINNIDA, JICA
Mahenge Mountains Biodiversity Surveys	Mahenge Mountains, Morogoro Region, Tanzania (Nawenge FR)	75 - Mahenge Scarp Forest Reserve	Jan 1999 - Apr 2001	SEE
Udzungwa Mountains Biodiversity Surveys	Udzungwa Mountains, Iringa Region, Tanzania (New Dabaga/Ulangambi FR, West Kilombero Scarp)	44 - Udzungwa Mountains	Jan 1999 - Apr 2001	DANIDA
Uluguru Component Biodiversity Surveys (UCBS)	Uluguru Mountains, Morogoro Region, Tanzania (Uluguru North and South FRs)	149 - Uluguru Mountains	Sep 2004 - Apr 2005	UNDP-GEF
Mtwara Reconnaissance Project	Mtwara Coastal Forests, Mtwara Region, Tanzania (Makonde Scarp I, II, and III, Mtiniko, Mtuli Hinju and Mkunya River Proposed FRs; Kambona and Ndechela FRs)	80 - Masasi District 94 - Mtwara District 101 - Newala District	Sep 2004 – Apr 2005	CEPF
Lesser Known Eastern Arc Mountains Biodiversity Surveys	Mahenge, Nguru, Rubeho and Ukaguru Mountains, Morogoro Region, Tanzania (Sali, Mselezi, Kanga, Nguru South, Maboto/Ikwamba, Mamiwa Kisara North and South, and Pala Ulanga FRs)	70 - Mahenge 74 - Mahenge Sali 103 - Nguru Mt 120 - Rubeho Mt 146 - Ukaguru Mt	Oct 2005 – Nov 2007	CEPF

Table 8-a Frontier-Tanzania projects in the Eastern Arc Mountains and Coastal Forests hotspot

Technical reports from work in the Eastern Arc Mountains and Coastal Forests hotspot have been published and are available on Frontier’s Publications List (www.frontier.ac.uk) and the website of the Eastern Arc Mountains Conservation Endowment Fund (EAMCEF - www.easternarc.or.tz).

9. STUDY SITE

M. J. CUTTS

LOCATION

The Mtwara Region is located in south-eastern Tanzania and constitutes 1.9% of the Tanzanian mainland, making it the second smallest region after Kilimanjaro. The Region was created by the separation of Lindi and Mtwara into two separate identities in 1971 and it covers an area of 16,720 km². It is bordered in the north by the Lindi Region, in the east by the Indian Ocean, in the south by Mozambique and the Ruvuma River and in the west by the Ruvuma Region.

The Region has five districts: Mtwara/Mikindani Urban, Mtwara Rural, Masasi, Newala and Tandahimba. The Makonde escarpment, which runs along the base of the Mtwara Region through the Mtwara Rural, Newala, Tandahimba and Masasi districts, covers an area of 73,055ha (Maganga, 2004) and its plateau lies between 700m and 900m asl. Mtwara Rural district is low-lying with much agriculturally modified coastal woodland and forest rising to only 300 metres. Here the Rivers of Maombi and Mbuo drain most of the plateau south into the Ruvuma River. Newala district covers most of the Makonde plateau and the raised area inland of the Mtwara/Mikindani district and south of the Rondo plateau. Here the Kitame, Mkundi and Mutumnudi Rivers flowing off the Makonde plateau, either eastwards to the ocean or southwards into the Ruvuma River, create deep valleys. Tandahimba district is between the districts of Mtwara in the east and Newala in the west (Figure 1).

Of the five districts the areas of study are in Mtwara Rural (Mtiniko and Mtuli Hinju), Masasi (Makonde Scarp I, Kambona and Ndechela), Newala (Makonde Scarp II) and Tandahimba (Makonde Scarp III) (Figure 1).

TOPOGRAPHY

With regards to topography there are two distinct regions: the coastal plain with its complexity of landforms and the basement plain dominated by the Makonde plateau. The coastal plain is generally low-lying with isolated rocky hills and steep river sides. The western half of this plain lies beyond the Makonde plateau with its runoff draining to the south through the tributaries of the Ruvuma River. The basement plain is dominated by the Makonde plateau at 300m to 400m asl. The Maombi and Mbuo Rivers drain most of the Makonde plateau (www.lindi-mtwara-region.com/eng).

GEOLOGY AND SOIL

The Region has two geological zones and hence two geologically determined soil types. The first zone is the coastal sedimentary formation extending 125km from the Indian Ocean to the edge of the Makonde plateau. In this zone sandstone bedrock produces deep, well drained sandy soils of low fertility and low moisture holding capacity. Some areas give rise to marine heavy clay soils or vertisols. Further inland, coastal limestones produce red, well drained and heavy textured soils. The second geological zone extends west of the coastal sediments. It is a zone of pre-Cambrian basement rocks consisting of gneisses and granulites. Soils from this basement are variable, comprising deep, well drained, red clays to the north of Masasi town, coarse grained sandy soils to the south of Masasi town, and well drained, nutrient poor and heavily leached soils on the Makonde escarpment. The red clays are the most fertile soils in the region that best suit the upland crops of the area (www.lindi-mtwara-region.com/eng, 2005).

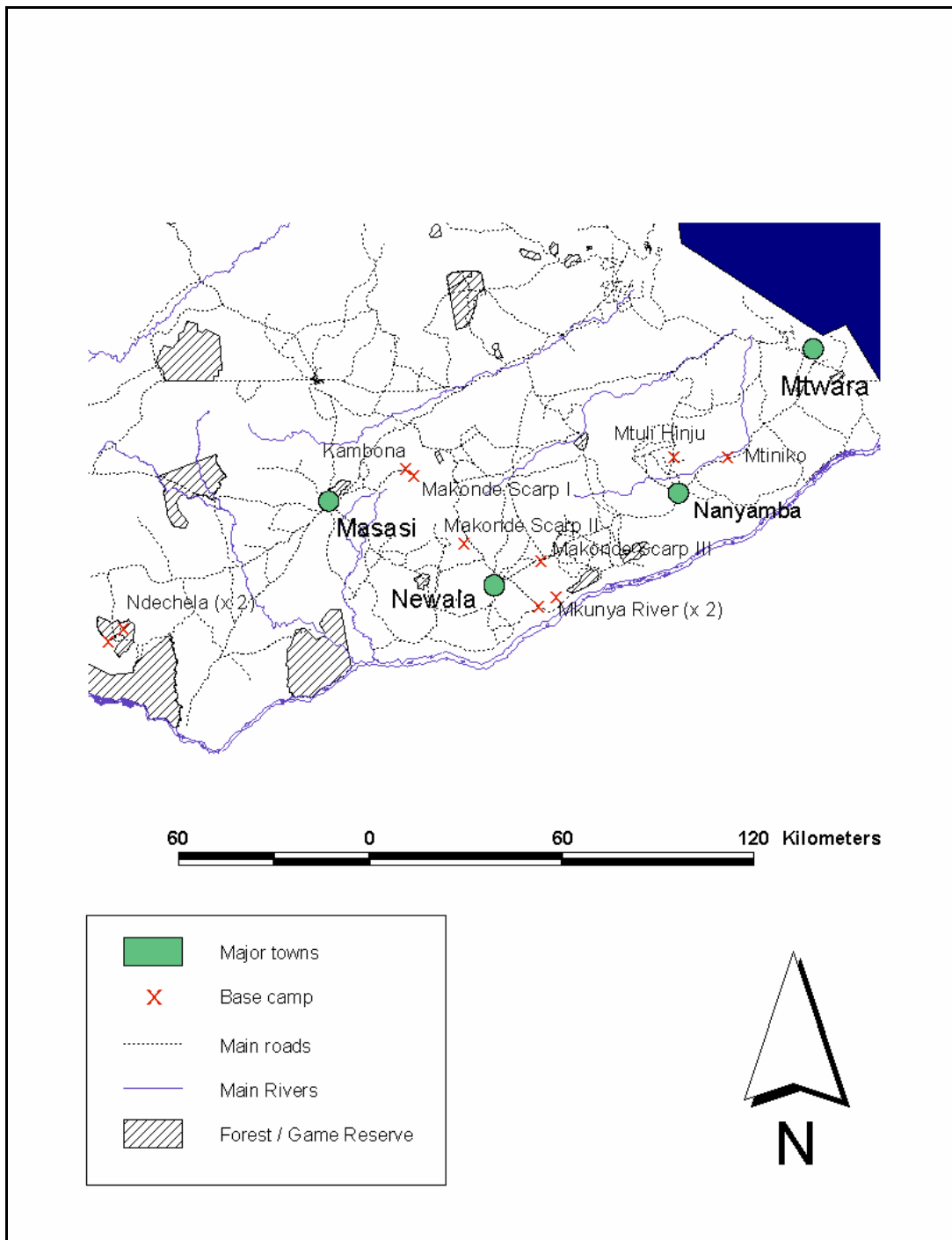


Figure 1 Map of the study region showing the forest reserves studied, major towns, roads and base camps

CLIMATE

Prevailing winds from the Indian Ocean are critical in determining the climate for this region. During the period November/December to April/May the dominant winds come from north-east bringing a hot and humid rainy season. This season has its wettest part in January, but it can reach into February or March. The rest of the year the region is kept drier and cooler by the south-easterly winds. The amount of total annual precipitation varies with altitude. In the Mtwara Region rains vary from 116mm to 935mm on the hills and the plateau, 893mm at Masasi and 1001mm at Newala. Temperatures in coastal Mtwara vary from 27⁰C as the highest monthly mean temperature in December to 23⁰C in July. Relative humidity in coastal Mtwara ranges from 87% in March to 79% in October. Temperatures and humidity are lower inland (www.lindi-mtwara-region.com/eng, 2005).

SOCIO-ECONOMIC CHARACTERISTICS

The population of Mtwara Region was reported to be around 857,977 people in 2000 and it has an average annual growth rate of 4% (Milledge and Kaale, 2005). As most of the south of the country, the Mtwara Region is characterised by one of the highest levels of poverty in Tanzania. The transport and communication infrastructures are scarce and unreliable in relation to the rest of the country. Within the context of a poorly developed local economy and in absence of alternative sources of livelihood, 92% of the people are engaged in agricultural production of food crops and depend heavily upon free forest products and services. Food crops include cassava, millet, sorghum, maize and cow and pigeon peas. The major cash crop is cashew nuts, of which the Mtwara Region is the first national producer, contributing about 50% of the national production (Milledge and Kaale, 2005).

CONSERVATION STATUS OF FOREST RESERVES IN THE MTWARA REGION

About 8.33% of the Mtwara Region is covered by forest, amounting to about 139,295ha (Milledge and Kaale, 2005). Nineteen government gazetted and proposed protective and productive forest reserves (FR)⁵ are found within the Mtwara Region. These forest reserves

⁵ A national forest reserve may be, as stated in the Forest Act 2002 [Acts Supplement No. 14 of June 2002]:

- (a) an area of land covered by forest, reserved or used principally for purposes of sustainable production of timber and other forest produce, known as ‘production forest reserve’;
- (b) an area of land covered by forest, reserved or used principally for the purposes of protection of water sheds, soil conservation and the protection of wild plants, known as ‘protection forest reserve’;
- (c) an area of land covered by forest, reserved principally to protect nature and scenic areas of national or international significance and to maintain and enhance biodiversity and genetic resources in an undisturbed, dynamic and evolutionary state, known as ‘nature forest reserve’.

An area of land is proposed to become a national forest reserve by the Minister of Natural Resources and Tourism (MNRT) responsible for forests. Upon production of a proposal, separate reports are produced by the Director of Forestry, collecting any objections received, the National Forestry Advisory Committee, containing recommendations, and an Investigator appointed by the Minister, investigating any claim arising out of customary or written laws. The Minister then produces a written declaration for the land area within 90 days of receipt of the reports, determining the rights to land and forest produce exercisable within that national reserve. As soon as practicable after the publication of the declaration, the Director shall cause the boundaries of the forest to be visibly demarcated on the ground and a map or plan to be prepared. On and after the coming into force of a declaration of a national forest reserve, the following acts are forbidden within its boundaries: removal, damage or destruction of any produce that is naturally found in the forest; residing on or usage of any of the land for any activity (cultivation, grazing, hunting, fishing, honey collection, mining, construction of roads and other structures, research, for which a permit is required, etc.). The function of managing a national forest reserve is determined by the Director in consultation with the Minister, and may be undertaken by: a Forestry Division, the Executive Agency, a local authority, a village council, a community group, an organization in the private sector, a Non-Governmental Organization or a person holding a concession (Forest Acts Supplement No. 14, 2002).

On all Tanzanian territory, with the exception of private land, village land forest reserves and community forest reserves, a license is required for hunting and harvesting natural forest produces (Forest Acts Supplement No. 14, 2002). These licenses are conferred by the District Wildlife Division and District Natural Resources and Land and Development Office respectively (Mlowe, 2005).

cover a designated area of 17,812ha and comprise vegetation types typical of the Coastal Forests. However, the proportion of closed-canopy forest and other vegetation types within these reserves remains unknown (CEPF, 2005). Another 65,450ha is designated as game reserves, but tourism development has been limited by insufficient infrastructure (Milledge and Kaale, 2005). The CEPF Ecosystem Profile (2005) lists six threatened species from these forest reserves, though many more are believed to inhabit the area.

Eight forest reserves occurring along and nearby the Makonde escarpment were researched in this study. These areas were designated as sites of protected forest reserve by the government in recognition of their importance to local villages and towns as water catchments, for prevention of soil erosion and for provision of resources such as timber, fuel wood, food and medicine (Adkins, 2005). Of these, two reserves are gazetted (Kambona and Ndechela) and six are proposed (Makonde Scarp I, Makonde Scarp II, Makonde Scarp III, Mtiniko, Mtuli Hinju Mkunya River). Kambona was gazetted in 1955 to protect the water source near St. Joseph’s College (now Chidya Secondary School) in Chidya. Ndechela was gazetted in 1958 to protect timber resources and biodiversity. The area covered by Makonde Scarp I and II and Mkunya River was proposed, mapped and demarcated in 1977 to prevent soil erosion on the plateau and scarp and to protect water sources and catchment, but they have not yet been gazetted as full reserves. In 1980 and 1981 a survey was conducted to estimate the cost of compensating people for their relocation from within the forest boundaries, as it is required in fully gazetted reserves, concluding that Tsh 40 million was needed for compensation. Compensation of TSh 1.7 million was made available to Masasi district in 1983-84 but no subsidies were made available to Newala and Tandahimba districts. Mtiniko and Mtuli Hinju were proposed to be forest reserves in 1976 to protect timber and water resources and biodiversity, but they have not yet been fully gazetted. All FRs surveyed are managed by the central government (Table 9-a) (Masasi District Natural Resources Office, 2005).

Table 9-a Protection status and size of forest reserves studied

Forest Reserve	District	Management Body	Protection Status	Size (ha)
Makonde Scarp I	Masasi	Central Government	Proposed	1,748.3
Kambona	Masasi	Central Government	Gazetted	29.9
Ndechela	Masasi	Central Government	Gazetted	6,216
Mtuli Hinju	Mtwara Rural	Central Government	Proposed	296.0
Mtiniko	Mtwara Rural	Central Government	Proposed	1,736
Makonde Scarp II	Newala	Central Government	Proposed	1,554
Mkunya River	Newala	Central Government	Proposed	4,797.3
Makonde Scarp III	Tandahimba	Central Government	Proposed	1,434.7
			Total area	17,812.2

10. SURVEY EFFORT

G. WEGNER AND R. SALTER

For the Mtwara Reconnaissance Project (FT-MRP), fieldwork was conducted from 2nd April to 17th July 2005. A total of 82 days were spent in eight forest reserves conducting field research and community days. The remaining days were spent in nearby towns sorting data, collecting field supplies and liaising with local officials. Each reserve was surveyed for five, seven or fourteen nights depending on the size of the reserve (<1000ha = 5 days, 1000-4000ha = 7 days and >4000ha = 14 days).

Survey work concentrated on investigations of flora, fauna and human disturbance. Quantitative, standardised and repeatable methods were employed to record and analyse data on species richness, diversity, dominance, relative abundance and composition of flora, species richness and composition of specific faunal taxonomic groups (mammals, birds, reptiles, amphibians and butterflies), presence/absence of Coastal Forests and/or Eastern Arc Mountains endemic and globally threatened species, and levels of disturbance and resources extraction.

In total 93 vegetation plots, 93 regeneration plots, 1840 sherman trapping nights, 460 bucket pitfall trapping nights, 52.5 man/hours of timed herpetofauna searches; 200.45 bat net/hours, 134 man/hours of bird mist netting, 100 man/hours of timed bird searches, 138 butterfly canopy trapping days, 37.5 sweep net/hours and 32 disturbance/large mammal transect lines (totalling 31km) were undertaken throughout the eight forest reserves. Opportunistic observations of all taxa and human disturbance were conducted throughout the study. Structured interviews, lasting for up to one hour, were carried out with local groups (including forestry officers and community committees and representatives) in the villages which were in close proximity to the forest reserves. Table 10-a gives a break down of the survey effort employed for each survey technique for each forest reserve (for work site descriptions see Appendices 2-7).

Table 10-a Summary of survey effort

			SAMPLING INTENSITY							TOTAL		
			Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III		Ndechela	
Reserve size (ha)			29.9	1,748.3	1,554	4,797.3	1,736	296.0	1,434.7	6,216	1,7812.2	
Days			5	7	7	14	7	5	7	14	66	
Sampling intensity (% of each FR)			0.5	0.02	0.03	0.02	0.03	0.07	0.03	0.01		
Survey technique (and sampling unit)	FLORA	Vegetation plot (VP) 20m x 20m x no. of plots	Trees, shrubs, herbs, grasses	(4 plots) 1600m ²	(9 plots) 3600m ²	(5 plots) 4800m ²	(21 plots) 8400m ²	(12 plots) 4800m ²	(5 plots) 2000m ²	(9 plots) 3600m ²	(21 plots) 8400m ²	(93) 37200m²
		Regeneration plot (RP) 2m x 2m x no. of plots	Trees, shrubs, herbs, grasses	(4 plots) 16m ²	(9 plots) 36m ²	(5 plots) 48m ²	(21 plots) 84m ²	(12 plots) 48m ²	(5 plots) 20m ²	(9 plots) 36m ²	(21 plots) 84m ²	(93) 372m²
		Opportunistic obs./collection	Trees, shrubs, herbs, grasses	-	-	-	-	-	-	-	-	-
	FAUNA	Sherman traps 40 traps x no. trapping nights	Small mammals	120	200	200	400	200	120	200	400	1840
		Bucket pitfall traps 10 buckets x no. trapping nights	Reptiles, amphibians, rodents	30	50	50	100	50	30	50	100	460
		Bat netting (net-hours) **	Bats	20.25	2.7	6	39	31.5	15	-	86	200.45
		Bird netting (man-hours) **	Birds	-*	20.5	-*	38.5	37.5	24.5	-*	13	134
		Timed bird searches (man-hours)	Birds	15	6	8	16	14	7	18	16	100
		Canopy traps 3 traps x no. trapping days	Canopy dwelling butterflies	9	15	15	30	15	9	15	30	138
		Butterfly sweep netting (sweep-net hours)	Lower storey dwelling butterflies	2	4.5	6	10.5	6	2	4.5	4	37.5
		Timed herpetofauna searches (man-hours)	Reptiles, Amphibians	4	4.5	4.5	17.5	6	4	4.5	7	52.5
		Animal signs transects (m ²) 1000m x 2m either side	Larger mammals	1x500m & 1x600m 4400m ²	(3) 12000m ²	(4) 16000 m ²	(7) 28000 m ²	(4) 16000 m ²	1x1000m & 1x900m 7600 m ²	(3) 12000 m ²	(7) 28000 m ²	(31) 124000m²
	Opportunistic/collection	All animal taxa	-	-	-	-	-	-	-	-	-	
HUMAN DISTURBANCE	Transects (m ²) 1000m x 5m either side	Human disturbance	(1.1) 11000m ²	(3) 30000m ²	(4) 40000m ²	(7) 70000m ²	(4) 40000m ²	(1.9) 19000m ²	(3) 30000m ²	(7) 70000m ²	(31) 310000m²	
	Opportunistic observation	Human disturbance	-	-	-	-	-	-	-	-	-	

*Mist netting was not conducted in these reserves as the camp was located at a distance from the reserves and in order to avoid theft nets could not be left unattended;

**Varying sizes of bird and bat mist-nets were used each time

11. METHODS

G. WEGNER AND R. SALTER

Survey methods were based on those employed by the Frontier-Tanzania Forest Research Programme (FT FRP) and described in full details in the *Technical report No 34: methodology report* (Frontier-Tanzania, 1997).

FLORA

Quantitative, standardised and repeatable methods were employed to record and analyse data on richness, diversity, composition, dominance and relative abundance of floral species, and presence/absence of Coastal Forests and/or Eastern Arc Mountains endemic and globally threatened floral species.

Vegetation data are presented in the form of species lists (Appendices 9-11). Here the family, genus and species are presented along with the author, altitude range, distribution, growth habit, endemic and conservation status and local name where known. Data collected through this study are comparable with data collected by other forest surveys undertaken by FT FRP.

Data collection

Three methods were used to collect data on flora:

- *Vegetation plots*
- *Regeneration plots*
- *Opportunistic collection and observation*

- *Vegetation plots (VPs)*

Three plots (20m x 20m) were sampled at 0m, 500m and 1000m intervals along each 1000m disturbance transect line (see section on Human Resource-Use for a description of disturbance transects). The location of vegetation plots and disturbance transects was recorded using the Global Positioning System (GPS). Inside the vegetation plot, all trees with diameter at breast height (dbh) $\geq 10\text{cm}$, from both the canopy and sub canopy layers, were marked, recorded, counted and identified. Diameter was measured at a standard height of 1.3m above ground level, on the uphill side of the stem. Multi-stem trees with individual stems of dbh $\leq 10\text{cm}$ were recorded if the cumulative dbh was $\geq 10\text{cm}$ (only stems arising from the central stem at or below 1.3m were considered). If the tree had a buttress, the dbh was measured 1.3m above the top of the buttress. Fallen trees that were still alive were processed as above. Dead trees were not counted. Habitat notes were taken for each vegetation plot. The percentage cover for canopy, sub canopy, shrub and ground layers was estimated (Appendix 4). The sampling unit was the vegetation plot. The sampling intensity was calculated as follows:

$$\text{Area of vegetation plot (20m x 20m) x no. vegetation plots per reserve} = \text{total area per forest reserve}$$

- *Regeneration plots (RPs)*

One (2m x 2m) regeneration plot was laid out at the centre of each 20m x 20m vegetation plot. Species from the shrub and ground layers were recorded, counted and identified, including tree saplings with dbh $< 10\text{cm}$, shrubs with dbh $< 10\text{cm}$, and non woody species such as grasses, sedges, mosses, lichens and ferns. Habitat notes were taken for each regeneration plot. The percentage cover for canopy, sub canopy, shrub and ground layers was

estimated (Appendix 5). The sampling unit was the regeneration plot. The sampling intensity was calculated as follows:

$$\text{Area of regeneration plot (2m x 2m) x no. regeneration plots per reserve} = \text{total area per forest reserve}$$

- *Opportunistic collection and observation*

Opportunistic collection and observation of tree, shrub and ground flora were made throughout field work and were accompanied by habitat notes. Opportunistic collections were made to supplement the data collected through the vegetation and regeneration plots and to collect extra plant specimens in order to aid the taxonomic identification of species. The amount of time allocated for such sampling was relative to the size of the forest, its vegetation diversity and the requirements of other field activities.

Specimen collection and curation procedures

When identification in the field was not possible two duplicate specimens of leaves and, when possible, flowers and fruits were retained. Specimen collection procedures followed those of the Missouri Botanical Gardens (Frontier-Tanzania, 1997). All specimens were pressed and dried in the field and then mounted at the Herbarium of the University of Dar es Salaam, Tanzania.

Species identification and repository

George Sangu (Appendix 1) provided the field identification of plant species. When identification in the field was not possible, floral specimens were collected for identification and storage at the Herbarium of the University of Dar es Salaam, Tanzania, and at Missouri Botanical Gardens, USA.

Data analysis

Vegetation data were analysed using various statistical techniques. Data collected through systematic methods were used to determine species richness, dominance and relative abundance in the canopy and sub canopy layers, and species composition for all layers. Data collected through opportunistic methods were used in addition to systematic data to determine species richness in the canopy and sub canopy layers, as well as species composition for all layers. Endemism and conservation status were also determined for all floral species.

No statistical analysis was conducted to compare data among reserves because in this study the sampling intensity was chosen to be roughly proportional to the size of each forest reserve, and therefore dissimilar sampling intensities were applied to each reserve (Table 10-a). Values of species richness and diversity recorded in separate reserves were instead compared through graphs and by taking in consideration a combination of factors, including the size of the reserve, the type of plant communities present, the level of habitat fragmentation and the degree of disturbance.

- *Species richness*

The species richness was calculated for each forest reserve. It was determined by counting the number of species found in all vegetation plots assessed as well as through opportunistic observation. The richness index is given by the following formula:

$$\text{Species richness} = \sum (\text{no. of species in the whole forest reserve})$$

- *Species diversity*

The species diversity was calculated for each forest reserve using a Shannon diversity index (Shannon, 1948). This diversity index takes into account the species richness as well as their proportional abundance, which is obtained by dividing the number of individuals for a specific species by the total number of individuals of all species in the area sampled. Sampling was carried out with an effort to represent all species in each FR. Samples were obtained randomly. The diversity index is given by the following formula:

$$H' = -\sum(P_i \ln P_i)$$

Where:

H' is the Shannon diversity index

P_i is the relative abundance of n species

\ln is the natural log

$H' = 0$ when there is no diversity. Values of H' typically fall between 1.5 and 3.5. The greater the number the greater the diversity (Magurran, 1988).

- *Species relative frequency (RF) or dominance*

The species relative frequency or dominance was calculated for the canopy and sub canopy layers of each homogeneous (i.e. floristically uniform) vegetation assemblage/stand identified within each forest reserve. It was calculated using data collected systematically from the canopy and sub canopy layers and treating the two layers separately. It was calculated only for the five top ranking canopy and sub canopy species. This was because in lowland forests of tropical Africa usually up to five species account for 80% of all canopy trees in any 1ha block of forest (Clarke *et al.*, 2000). The species relative frequency or dominance takes into account the number of plots within which a species occurs relative to the total number of plots sampled, and it is used to classify a vegetation type. It is determined by dividing the number of plots within which a species occurs by the total number of plots sampled, and it is given as a percentage, where the relative frequency is multiplied by one hundred.

$$RF = (p/P) \times 100$$

Where:

RF is the relative frequency of a species

p is the number of plots in which the species occurs.

P is the total number of plots

Plant species were ranked according to their relative frequency. All species with a relative frequency $40\% \leq 60\%$ and $60\% \leq 100\%$ were chosen to represent frequent and dominant species respectively (Mueller-Dombois and Ellenberg, 1974), and were used to classify the vegetation type in which they occurred.

- *Species relative abundance (RA)*

The relative abundance of a species was calculated for the canopy and sub canopy layers of each homogeneous vegetation stand identified within each forest reserve. It was calculated using data collected systematically from the canopy and sub canopy layers and treating the two layers separately. It was calculated only for the five top ranking canopy and sub canopy species. This was because in lowland forests of tropical Africa usually up to five species account for 80% of all canopy trees in any 1ha block of forest (Clarke *et al.*, 2000). The relative abundance of a species takes into account the number of individuals of a species relative to the total number of individuals of all species and is used to classify a vegetation type. It is determined by dividing the number of individuals of a particular species by the total

number of individuals of all species, and it is given as a percentage, where the relative abundance is multiplied by one hundred. The relative abundance is given by the formula:

$$\% \text{ RA} = (\text{ni}/\text{N}) \times 100$$

Where:

RA is the relative abundance of a species

ni/N is the proportional abundance of a species

ni is the number of individuals of a species

N is the total number of individuals of all species

The species were ranked according to their relative abundance. All species with a percentage relative abundance >4% were chosen to represent high abundance species, and to classify the vegetation type in which they occurred.

The comparative relative abundance of individuals in the canopy and sub canopy layers were also calculated and compared in order to help in the identification of the vegetation types. The comparative relative abundance of individuals in the canopy and sub canopy layers is determined by dividing the overall number of individuals of all species occurring in each layer separately by the total number of individuals of all species occurring in the two layers combined, and is given as a percentage, where the relative abundance is multiplied by one hundred.

- *Species composition and vegetation type*

The species composition was analysed by looking at data from homogeneous vegetation assemblages/stands separately. The species composition for the canopy and sub canopy layers was determined by looking at both dominant and frequent species and high abundance species. For the shrub and ground layers the species composition was determined through data recorded in the regeneration plots. Homogeneous vegetation stands within each forest reserve were then classified by comparing their species composition with that of the vegetation types classified in Burgess and Clarke (2000)⁶.

- *Endemism and conservation status*

Endemism and conservation status were determined for all floral species recorded through systematic and opportunistic methods, structured interviews and open discussions in each forest reserve. The endemism of a species was determined by looking at its geographical distribution and the conservation status by using the IUCN Red List (2004) and Gereau and Luke's List of Potentially Threatened plants (2006).

FAUNA

Quantitative, standardised and repeatable methods were employed to record and analyse data on species richness and composition within specific faunal taxonomic groups, and presence/absence of Coastal Forests and/or Eastern Arc Mountains endemic and globally threatened faunal species. Taxa chosen for this study were mammals, birds, reptiles, amphibians and butterflies. These taxonomic groups were chosen according to the practicalities of capture methods, identification techniques utilised and potential information that could be extracted from the data.

⁶ Species dominance could not be used as a parameter to determine the species composition and vegetation types of Kambona FR due to the small size of the reserve and consequently low number of vegetation plots (4) sampled there.

Data on fauna were collected at zoological trap sites (abbreviated as zoosites), each of which was located within 500m from a base camp. Zoosites were chosen to cover the largest range of habitats possible, and one zoosite was placed randomly within each habitat, e.g. one in Riverine forest, one in Open woodland, and one in Grassland. The size of the zoosite was determined by the length of the bucket pitfall line (20m) and the area used to place sherman traps around this line (see following section on sherman trapping for details).

Data on fauna are presented in the form of species lists (Appendices 13-18). Here the order, family, genus and species are presented along with the ecological type, endemic and conservation status. Number of captures and recaptures and specimen record numbers for small mammals, reptiles and amphibians are provided in Appendix 18.

Data collection

Combinations of methods were used to collect data on fauna, including:

- *Bucket pitfall traps*
- *Sherman traps*
- *Timed herpetofauna searches*
- *Bird mist netting*
- *Timed bird searches*
- *Butterfly canopy trapping*
- *Butterfly sweep netting*
- *Bat mist netting*
- *Mammal track and sign transects*
- *Opportunistic collection and observation*

- *Bucket pitfall trapping*

Bucket Pitfall Traps were used to record and sample small rodent and insectivorous mammals, reptiles and amphibians (diurnal, crepuscular and nocturnal) whose habitat is the forest floor. One 50m linear transect was placed randomly within each trap site and ten 1ltr plastic buckets were positioned at 5m intervals. Buckets were sunk into the ground with their rims flush to ground level. Buckets had small holes in the base to allow rainwater to drain from them. A 20m single sheet of plastic (approximately 0.5m high, and no less than 0.2m) was erected as a “drift fence” that ran perpendicular to the ground and crossed the centre of each bucket. A 10-15cm lip of plastic sheeting was left flat on the ground onto which soil and leaf litter was placed to prevent any gap in the drift fence at ground level. Animals moving into the area from either side are channelled along the plastic sheet towards the bucket traps. Buckets were checked twice a day, early in the morning (07:00hr) and in the evening (16:00hr). Data on the taxonomy, sex, breeding status and biometrics of each animal captured, as well as habitat notes and associated vegetation types, were recorded on standardised data sheets. Small mammals that were to be released were identified, measured, described and finally marked by trimming a small patch of fur in order to avoid duplicity of results. Reptiles and amphibians were not marked because sophisticated equipment that was not in the remit of this study would have been required, e.g. Passive Integrated Transponder (Sutherland, 2001). Specimens were retained when the species level could not be ascertained and subsequently sent to in-country and international taxonomic experts (Appendix 1). The sampling unit was the trapping night. The sampling intensity was calculated as follows:

No. of buckets (10) x no. of trapping nights in each zoosite (3, 5 or 10) x no. of zoosites in each reserve = total bucket trapping nights per forest reserve

- *Sherman trapping*

Sherman traps were used to record and sample small rodent and insectivorous mammals (diurnal, crepuscular, and nocturnal) whose habitat is the forest floor or that are adapted to climbing (scansorial). In each zoosite, traps were placed around each bucket pitfall line, approximately 5m apart. Traps were placed in situations in which small mammals are likely to occur, including: the base of large trees; on/under/near rotting logs; on branches; in dense understory; around rocks; and attached to the lower branches of trees (up to 1.3m above ground). Large open spaces with no ground cover were avoided as these are unlikely habitats for the target species. Traps were baited with standard sized toasted coconut and peanut butter baits every evening (around 16:00hr) and checked early the following morning (around 07:00hr). Data on the identification, sex, breeding status and biometrics of each animal captured, as well as habitat notes and associated vegetation types, were recorded on standardised data sheets. Small mammals that were to be released were identified, measured, described, and finally marked by trimming a small patch of fur in order to avoid duplicity of results. Specimens were retained when species level could not be ascertained and subsequently sent to in-country and international taxonomic experts (Appendix 1). The sampling unit was the trapping night. The sampling intensity was calculated as follows:

$$\text{No. of traps (40) x no. of trapping nights in each zoosite (3, 5 or 10) x no. of zoosites in each reserve} = \text{total sherman trapping nights per forest reserve}$$

- *Timed herpetofauna searches*

Timed searches were used to record and sample reptile and amphibian species. Various habitats were searched, including dead wood, leaf litter, leaves surface, tree holes, rocks, streams banks, puddles etc. Searches of various lengths were conducted during both the day and the night where possible (for many sites, searches after dark were not permitted by hired game guards due to the presence of large mammals). Approximately thirty minutes were spent conducting timed searches within each habitat. Data on the survey effort, taxonomy, sex, breeding status, and biometrics, as well as habitat notes and associated vegetation types, were recorded on standardised data sheets. If not taken as specimens, captures were released unmarked. Sound recordings using a Dictaphone were also taken. Sampling was carried out within a standardised effort. The sampling unit was the man/hour. Sampling intensity was calculated as follows:

$$\text{No. of man/hours} = \text{total man/hours per forest reserve}$$

- *Bird mist netting*

Bird mist netting was used to record and sample birds within the zoosites. Mist netting targeted understory and lower canopy bird species. Where possible, the nets were set so that a funnel effect could be obtained using the vegetation. The nets were erected and checked every 15 minutes in the early morning (06:00-09:00hr), and towards dusk (after 16:00hr). Bird mist-nets of varying sizes were utilised each time. Data on the taxonomy and sex, as well as habitat notes and associated vegetation types, were recorded on standardised data sheets. When possible blood and/or tissue samples were taken. Birds that were to be released were identified, described and marked by trimming a small amount off the tail feather to avoid duplicity of results. The sampling unit was the man/hour. Sampling intensity was calculated as follows:

$$\text{No. of man/hours} = \text{total man/hours per forest reserve}$$

- *Timed bird searches*

Various habitats and vegetation types were searched. Searches of various lengths were conducted in the early morning (06:00-09:00hr), and towards dusk (after 16:00hr). Data on the survey effort, taxonomy and sex, as well as habitat notes and associated vegetation types, were recorded on standardised data sheets. The sampling unit was the man/hour. Sampling intensity was calculated as follows:

$$\text{No. of man/hours} = \text{total man/hours per forest reserve}$$

- *Butterfly canopy trapping*

This method sampled fruit-feeding canopy-dwelling butterflies. Blendon style canopy traps (38cm round base x 69cm high) were located in the upper-, mid- and lower-canopy within each zoosite. An attempt was made to sample in a range of different habitats. The traps were baited with standard sized fermented banana baits early in the morning (07:00hr) and checked in the late afternoon (16:00hr). Data on the taxonomy and sex (when possible), as well as habitat notes, associated vegetation types and altitude were recorded on standardised data sheets. If not taken as specimens, captures were released unmarked. The sampling unit was the canopy trapping day. The sampling intensity was calculated as follows:

$$\text{No. of trapping days} \times \text{no. of traps in each zoosite (3)} \times \text{no. of zoosites in each reserve} = \text{total canopy trapping days per forest reserve}$$

- *Butterfly timed sweep netting*

This method sampled butterflies in the forest under storey/scrub/thicket and around ground herbs and grasses. Timed sweep netting was conducted within each vegetation plot. Data on the taxonomy and sex (when possible), as well as habitat notes, associated vegetation types and altitude were recorded on standardised data sheets. If not taken as specimens, captures were released unmarked. The sampling unit was the sweep net/hour. The sampling intensity was calculated as follows:

$$\text{no. of sweep netting hours} \times \text{no. of sweep nets} \times \text{no. of vegetation plots in each reserve} = \text{total sweep net/hours per forest reserve.}$$

- *Bat mist netting*

Bat mist netting was used to record and sample bat species (nocturnal and crepuscular) within the zoosites. Nets were located close to likely bat roost sites and flyways within the forest (e.g. across streams and pools of still water, and across paths and passes between valleys). Where possible, the nets were set so that a funnel effect could be obtained using the vegetation. The net was erected at dusk and constantly attended or checked every 15 minutes. Bat mist-nets of varying sizes were utilised each time (2.5m x 6m, 2.5m x 9m, 2.5m x 10m). Data on the identification, sex, breeding status, and biometrics, as well as habitat notes and associated vegetation types, were recorded on standardised data sheets. The sampling unit was the man/hour. Sampling intensity was calculated as follows:

$$\text{no. of man/hours} \times \text{meters of net erected in each reserve} = \text{total bat mist net/hours per forest reserve.}$$

- *Mammal track and sign transects (indirect observation)*

One kilometre animal sign transects were carried out to record data on large mammal species in each forest reserve. Dung was recorded within a 4m strip (2m either side of the transect). Presence of all other signs (footprints, burrows, scratchings, nests and ground resting sites)

were recorded within a 10m strip (5m either side) of the transect. The transect was subdivided into 50m sections and records were taken separately for each section. Information was gathered on associated habitats and vegetation types along the transect, and ease of visibility for large mammal signs was estimated. Expertise from two professional field assistants was utilised in conjunction with Walker's field guide (1996) for identification of dung and signs. The sampling unit was the mammal transect. Sampling intensity was calculated as follows:

$$\Sigma (\text{no. of 1km transects in each forest reserve}) = \text{total no. of mammal transects per forest reserve}$$

- *Opportunistic collection and observation*

Opportunistic collection and observation of mammals, birds, amphibians and reptiles, and vocalisation recording of amphibians and bush babies were conducted to determine the presence of species otherwise omitted by the systematic survey techniques and to aid the taxonomic identification of species.

- *Climatic data*

A weather station provided with rain gauge and minimum/maximum thermometer was set up at each study site to collect climatic data that can influence analysis and results.

Specimen collection and curation procedures

Specimens for all taxa, with the exception of large mammals and IUCN and CITES listed species, were retained when identification in the field was not possible. For collection and curation procedures see *Technical report No 34: methodology report* (Frontier-Tanzania, 1997).

Species identification and repository

Frontier-Tanzania field team provided the field identification of mammals, herpetofauna, butterflies and animal tracks and signs. Jacob Kiure (Appendix 1) provided the field identification of bird species. When identification in the field was not possible, faunal specimens were collected for identification and repository at the Department of Zoology and Wildlife Conservation of the University of Dar es Salaam, Tanzania. Butterfly specimens were sent for identification and repository to the Southern Highlands Conservation Programme (SHCP) of the Wildlife Conservation Society, Tanzania.

When necessary, faunal specimens were sent on loan for further identification to: the British Natural History Museum, UK; the California Academy of Sciences, USA; the Chicago Field Museum, USA; the Zimbabwe Natural History Museum, Zimbabwe; the Copenhagen Zoological Museum, Denmark. These specimens were incorporated into the collections of the receiving institutions. Once specimens were identified species lists were sent back to the University of Dar es Salaam and frontier-Tanzania.

Data analysis

Faunal data collected through systematic and opportunistic methods were used to determine species richness and species composition. Forest dependence, endemism and conservation status were also determined for all faunal species.

No statistical analysis was conducted to compare data among reserves because in this study the sampling intensity was chosen to be proportional to the size of each forest reserve, and therefore dissimilar sampling intensities were applied to each reserve (Table 10-a). Values of species richness recorded in separate reserves were instead compared through graphs and by taking in consideration a combination of factors, including the size of the reserve, the

structure of the plant communities present, the level of habitat fragmentation and the degree of disturbance.

- *Species richness*

The species richness was calculated for each taxon and for each reserve separately. It was determined by counting the number of species recorded through systematic and opportunistic methods in all zoological trap sites. The richness index is given by the following formula:

$$\text{Species richness} = \Sigma (\text{no. of species in the whole forest reserve})$$

Species richness values were defined as low, intermediate or high in relation to the sampling intensity of the study and the size of the forest reserves.

A species diversity index of fauna was not calculated for this study. As this study was designed as a preliminary biodiversity assessment, data collected were not sufficient to allow the calculation of a relative abundance index, which is used in the calculation of the species diversity index.

- *Forest dependence, endemism and conservation status*

Forest dependence, endemism and conservation status were determined for all faunal species recorded in each forest reserve through systematic and opportunistic methods, structured interviews and open discussions. The endemism of a species was determined by looking at its geographical distribution, and the conservation status by using the IUCN Red List (2004) and CITES Appendices I and II (2005).

HUMAN RESOURCE-USE AND DISTURBANCE

Quantitative, standardised and repeatable methods were employed to record and analyse data on human resources-use and disturbance.

Data collection

Two methods were used to collect data on human resources-use and disturbance:

- *Disturbance transects*
- *Opportunistic collection and observation*

GPS coordinates and description of disturbance transect sites and pit-sawing sites for all forest reserves are given in Appendices 7 and 8.

- *Disturbance transects*

Disturbance transects were used to record the incidence of disturbance caused by various human activities, i.e. clearance for cultivation, pole/timber extraction, bark ringing, burning, hunting and paths. One kilometre disturbance transects were placed randomly at 1km intervals within each forest reserve. The size of the reserve meant that this was not always possible, e.g., Kambona FR is less than 1km at its widest point and shorter transects making up 1km were used instead. The number of transects used varied according to the size of the forest reserves. Transects were subdivided into 50m sections and records were taken separately for each section. Every self-standing tree and sapling (not lianas or creepers) with dbh ≥ 5 cm within 5m either side of the transect line was measured and classified as pole, timber and large timber, and each plant was recorded as live, naturally dead, old cut or new cut (see section on Definition of Key Categories). Pit sawing sites were also recorded. Whether these sites had been recently active at the time of study was determined by the

presence of freshly cut timber. Information was gathered on altitude and GPS coordinates, as well as associated habitats (Appendices 7 and 8). The sampling unit was the disturbance transect. Sampling intensity was calculated as follows:

$$\Sigma (\text{no. of 1km transects in each forest reserve}) = \text{total no. of disturbance transects per forest reserve}$$

- *Opportunistic observation*

Observations of human disturbance were made in each vegetation plot, zoological trap site and throughout each forest reserve to record data on the extent of human activities and complement data collected through systematic disturbance transects.

Data analysis

Data collected through systematic methods were used to determine the relative level of disturbance occurring in an area, and the relative abundance and average no. of individuals per hectare of live, naturally dead and cut poles/timbers/large timbers. Data collected through opportunistic methods were used in addition to systematic data to determine the forms of disturbance occurring in an area.

- *Relative level of disturbance (RLD)*

The level of disturbance was analysed in each forest reserve by calculating the percentage of 50m sections containing various forms of disturbance. The relative level of disturbance takes into account the number of 50m sections containing a form of disturbance relative to the total number of 50m sections recorded along a transect. It is determined by dividing the number of 50m sections containing a form of disturbance by the total number of 50m sections recorded along a transect, and it is given as a percentage, where the relative level of disturbance is multiplied by one hundred. The relative level of disturbance is given by the formula:

$$\% \text{ RLD} = (\text{ni/N}) \times 100$$

Where:

RLD is the relative level of a form of disturbance

ni/N is the proportional abundance of 50m sections containing a form of disturbance

ni is the number of 50m sections containing a form of disturbance

N is the total number of 50m sections along a transect

Although this analysis does not show the intensity of a given form of disturbance within each 50m section, it gives an overall picture of the disturbance occurring within an area.

- *Relative abundance of live, naturally dead and cut poles/timbers/large timbers (RA)*

The relative abundance was calculated for live, naturally dead and cut poles/timbers/large timbers by using data from the disturbance transects. The relative abundance takes into account the number of individuals of one category (live, naturally dead or cut) relative to the total number of individuals from all categories recorded in an area. It is determined by dividing the number of individuals of a particular category by the total number of individuals recorded in an area, and it is given as a percentage, where the relative abundance is multiplied by one hundred. The relative abundance is given by the formula:

$$\% \text{ RA} = (\text{ni/N}) \times 100$$

Where:

RA is the relative abundance of a category

ni/N is the proportional abundance of n category

ni is the number of individuals of a category

N is the total number of individuals of all categories

- *Average no. of individual poles/timbers/large timbers per hectare*

The average no. of individuals per hectare was calculated for live, naturally dead, and cut poles/timbers/large timbers. It is determined by dividing the total number of individuals of one category (live, naturally dead or cut) by the number of hectares covered by the disturbance transects. The average no. of individuals per hectare is given by the formula:

$$\text{Average no. of individuals per ha} = \frac{\text{total no. of individuals of one category}}{\text{total no. of ha covered by the disturbance transects}}$$

COMMUNITY DAYS

Structured interviews and open discussions

Frontier “community days” were held as a means of communicating with inhabitants of the villages within the vicinity of and adjacent to the forest reserves in question. For the FT FRP, community days took the form of structured interviews and open discussions with community groups, forest officers and key informants. The aim of the community days was to collate local and indigenous knowledge about the forest resources, to gain an overview of natural resource use in the reserves, and to obtain information on the attitude of local inhabitants towards the reserves. The following topics were addressed:

- Flora and fauna species occurrence
- Species degree of extraction and utilisation
- Management practices (from the district offices and from community groups)
- Perceived value of and attitudes toward the forest reserves

On average, a minimum of three village elders from each village were asked to participate and interviews lasted for up to one hour in total (Appendix 19). Forest Officers from Mtwara, Masasi, Tandahimba and Newala district natural resources offices contributed to the information collected during this project. Community days took place on the following dates:

- Kambona FR (Chidya and Chiwata villages): 10th April 2005
- Makonde Scarp I proposed FR (Chidya village): 18th April 2005
- Makonde Scarp II proposed FR (Chiwambo juu and Nambungu villages): 1st May 2005
- Mkunya River proposed FR (Chiunjila, Chihanga, Chikwedu and Mpilipili villages): 19th May 2005
- Mtiniko forest proposed FR (Mtiniko village): 14th June 2005
- Mtuli Hinju proposed FR (Mtuli Hinju village): 18th June 2005
- Makonde Scarp III proposed FR (Lidumbe village): 28th June 2005
- Ndechela FR (Ndechela village): 18th July 2005

The information obtained through the community days has contributed to the compilation of *The Coastal Forests of Mtwara: a Kiswahili layman’s report* (Frontier-Tanzania, 2005), which is being distributed to district natural resources offices, community groups and schools in close proximity to the studied sites.

DEFINITION OF KEY CATEGORIES

Various criteria were used to evaluate the uniqueness of the biodiversity of the reserves studied and its vulnerability to disturbance, including species' growth habit (for plants only), forest dependency (for animals only), distribution, endemism, conservation status and presence of Important Bird Areas, as well as presence of live, naturally dead and cut poles, timbers and large timbers.

Information on and definition of these categories were taken from various sources. Information on growth habit, habitat and distribution of flora was taken from Iverson (1991b), Bailey (1999), the *Flora of Tropical East Africa* (FTEA) (all published families), and the *List of East African Plants* (LEAP) (Knox, 2000). The forest dependency and endemic status of fauna were gleaned from the *Coastal forests of Eastern Africa* (Burgess and Clarke, 2000). The conservation status of flora and fauna was obtained from the IUCN *Red List of Threatened Species* (IUCN, 2004), the *List of Potentially Threatened Plants in the EACF hotspot of Kenya and Tanzania* (Gereau and Luke, 2006) and CITES (2005). Other information, including taxonomy and nomenclature, was sourced from the following references:

All taxa:	Burgess & Clarke (2000)
Mammals:	Kingdon (2003, 1989 and 1974)
Birds:	Sinclair & Ryan (2003), Stevenson & Fanshawe (2002) and Zimmerman <i>et al.</i> (1996)
Reptiles:	Spawls <i>et al.</i> (2002), Howell (1993)
Amphibians:	Channing (2001), Schiötz (1999) and Passmore & Carruthers (1995)
Butterflies:	Davenport (2001), Larsen (1996) and Kielland (1990)
Plants:	FTEA (all published families), LEAP (Knox, 2000), Gereau & Luke (2006)

Mammals

For the purpose of this study mammals have been categorised as follows:

- **Small mammal:** mammals captured by using sherman and bucket pitfall traps, including mice, rats and shrews (not including elephant shrews)
- **Large mammal:** any other mammal recorded (including elephant shrews)

Growth habit – flora (based on Bailey, 1999)

- **S** – shrub
- **T** – tree
- **C** – climber
- **H** – herb
- **B** – bamboo

Forest dependency – flora and fauna (based on Iverson, 1991b, and Mlingwa *et al.*, 2000)

- **F** – ‘Forest dependent’ or ‘specialist’ species: species 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 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: species that may occur in undisturbed primary or closed-canopy forest, but are able to exist in clearings, fragmented and secondary forest, woodland and at the forest edge; these species may still depend upon the forest for some of

their resources, such as nesting sites, thus they may also be adversely affected by forest destruction.

- **O** – ‘Non-forest’ or ‘forest visitor’ species: species that may occur in primary or secondary forest or at the forest edge but are usually recorded in open habitats and are not dependent upon the forest (e.g. species that have been recorded in bushland, heathland, thicket, secondary scrub, grassland, rocky outcrops, swamps, wasteland and cultivation).

Distribution – flora (based on the FTEA index of collecting localities - Polhill, 1988)

- **T1** – Kagera, Mwanza, and Mara regions
- **T2** – Arusha and Manyara regions
- **T3** – Tanga and Kilimanjaro regions
- **T4** – Kigoma and Rukwa regions
- **T5** – Dodoma and Singida regions
- **T6** – Dar es Salaam, Coastal and Morogoro regions
- **T7** – Mbeya and Iringa regions
- **T8** – Lindi, Mtwara and Ruvuma regions
- **K7** – Kenya Coastal regions
- **R** – Rare: plant species present in less than two out of the eight FTEA vegetation regions of Tanzania (based on the LEAP - Knox, 2000)

Endemism – flora and fauna

- **Strict endemic** – species with limited ranges in the Coastal Forests alone or in the Eastern Arc Mountains and Coastal Forests, sometimes including other habitats in a few adjacent locations (e.g. Masasi District in south-eastern Tanzania, northern Mozambique etc).
- **Broad endemic** – species with limited ranges in a large region that includes part or all of the Coastal Forest Mosaic (e.g. south-eastern Tanzania, coastal eastern Africa, south-eastern Africa etc).

Endemic status flora (based on Clarke and Robertson, 2000)

- **E** – Endemic: species with limited ranges in the Swahilian region of endemism *sensu lato*⁷

Endemic status fauna (adapted from Burgess *et al.*, 2000a):

- **CF** – Species with limited ranges in the Coastal Forests
- **EACF** – Species with limited ranges in the Eastern Arc and Coastal Forests hotspot
- **SE Tanzania** – Species with limited ranges in south-eastern Tanzania
- **E Africa** – Species with limited ranges in eastern Africa
- **SE Africa** – Species with limited ranges in south-eastern Africa

⁷ This is a phytocorion consisting of a “Swahilian regional centre of endemism” with an adjacent “Swahilian/Maputaland regional transition zone”, together referred to as the “Swahilian region *sensu lato*”. It extends between the Limpopo River in Somalia and the equator in Mozambique (Clarke, 1998) and represents the new nomenclature for the “Zanzibar-Inhambane regional phytocorion” identified by White (1983a). Clarke defines the Coastal Forest Mosaic as corresponding to this phytocorion (Clarke, 2000a, pp 10-17).

Extinction threat – flora and fauna

- **Threatened species** = Species listed as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) in the IUCN Red List (2004), or in CITES Appendix I (2005), or as Potentially Threatened (PT) by Gereau and Luke (2006).

Conservation status – IUCN (2004). Versions 3.1 (2001) and 2.3 (1994)

- **CR** = Critically Endangered; *extremely* high risk of extinction in the wild (ver 3.1, 2001)
- **EN** = Endangered; *very* high risk of extinction in the wild (ver 3.1, 2001)
- **VU** = Vulnerable; high risk of extinction in the wild (ver 3.1, 2001)
- **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 (ver 3.1, 2001)
- **LC** = Least Concerned; taxa that do not qualify for conservation dependent or near threatened. Widespread and abundant taxa are included in this category (ver 3.1, 2001)
- **DD** = Data Deficient; lack of adequate information to make a direct or indirect assessment of a taxon's risk of extinction based on distribution and/or population status (ver 3.1, 2001)
- **NE** = Not Evaluated; not yet assessed against the criteria (ver 3.1, 2001)
- **LR nt** = Lower Risk, 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 (ver 2.3, 1994)
- **LR cd** = Lower Risk, conservation dependent; 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 (ver 2.3, 1994)
- **LR/lc** = Lower Risk, least concerned; taxa that do not qualify for conservation dependent or near threatened. Widespread and abundant taxa are included in this category (ver 2.3, 1994)

Conservation status – CITES (2005)

- **CITES Appendix I** = species threatened with extinction which are or may be further endangered by trade and are therefore excluded from international trade.
- **CITES Appendix II** = species which although not necessarily yet threatened with extinction may become so unless trade is subject to strict regulation, thus export permits are required.
- **CITES Appendix III** = species identified as needing and/or subject to regulation for the purpose of preventing or restricting exploitation

Conservation status – Gereau and Luke (2006)

- **PT** = Plants included in the *List of Potentially Threatened Plants in the EACF hotspot of Kenya and Tanzania*

Important Bird Areas (IBAs) (based on BirdLife International, 2005)

A site qualifies as an IBA if it fulfils one of the following criteria's:

A1. Globally threatened species = the site is known, estimated or thought to hold a population of a species categorized by the IUCN Red List as Critically Endangered, Endangered or Vulnerable. In general, the regular presence of a Critically Endangered or Endangered species, irrespective of population size, at a site may be sufficient for a site to qualify as an IBA. For Vulnerable species, the presence of more than threshold numbers at a site is necessary to trigger selection. The site may also qualify under this category if it holds more than threshold numbers of other species of global conservation concern in the Near Threatened, Data Deficient and, formerly, in the no-longer recognised Conservation Dependent categories. Thresholds are set regionally, often on a species by species basis.

A2. Restricted-range species = the site forms one of a set selected to ensure that, as far as possible, all restricted-range species of an EBA or SA are present in significant numbers in at least one site and, preferably, more. The term 'significant component' is intended to avoid selecting sites solely on the presence of one or more restricted range species that are common and adaptable within the EBA and, therefore, occur at other chosen sites. Sites may, however, be chosen for one or a few species that would be otherwise under-represented, e.g. because of particular habitat requirements.

A3. Biome-restricted species = the site forms one of a set selected to ensure, as far as possible, adequate representation of all species restricted to a given biome, both across the biome as a whole and, as necessary, for all of its species in each range state. The 'significant component' term in the category definition is intended to avoid selecting sites solely on the presence of one or a few biome-restricted species that are common, widespread and adaptable within the biome and, therefore, occur at other chosen sites. Additional sites may, however, be chosen for the presence of one or a few species that would be otherwise under-represented, e.g. for reasons of particular habitat requirements.

A4. Congregations = this applies to:

- 'Waterbird' species as defined by Delaney and Scott (2002). The site is modelled on criterion 6 of the Ramsar Convention for identifying wetlands of international importance.
- Seabird species not covered by Delaney and Scott (2002). Quantitative data are taken from a variety of published and unpublished sources. The site is modelled on criterion 5 of the Ramsar Convention for identifying wetlands of international importance. Where quantitative data are good enough to permit the application of A4i and A4ii, the use of this criterion is discouraged. The site is known or thought to exceed thresholds set for migratory species at bottleneck sites. Thresholds are set regionally or inter-regionally, as appropriate.

Poles, timbers and large timbers

- **Poles** – 5≥15cm dbh and ≥2m relatively straight trunk
- **Timbers** – 15≥50cm dbh and ≥3m relatively straight trunk
- **Large timbers** – dbh ≥50cm and ≥3m relatively straight trunk
- **Live** – Every self-standing tree and sapling (not lianas or creepers) with dbh ≥5cm
- **Naturally dead** – Death not caused by human disturbance
- **Freshly cut stems** (approximately within the past 3 months) – New cut stems recognised by a cream coloured slash. However the colour of the slash may depend on the species cut
- **Old cut stems** (approximately more than 3 months old) – Old cut stems recognised by a black coloured slash

12. KAMBONA FOREST RESERVE



Status	Gazetted Forest Reserve
Management Body	Central Government
Location	Masasi district. The reserve is located 10 kilometres outside of Masasi town (where the District Forestry Office is located) and 23 kilometres up a dirt road to the Chidya village and school. It is situated between the villages of Chiwata and Chidya and next to Chidya Secondary School. Next to the school is a maize mill factory and directly next to this is where the boundary of the reserve starts.
Area	29.9ha
Altitude	670-700m asl
Topography	Lowland plain
Temperature	Min: 19°C, Max: 30°C (recorded 9-11 April, start of dry season)
Rainfall	Average 0mm (recorded 9-11 April, start of dry season)
Soil type	Sandy-loam
Vegetation type	Eastern African coastal <i>Brachystegia</i> forest and Riverine forest
Land Use	The forest reserve protects a water source used by the local villages and schools in the area. Chidya Secondary School has an electric pump system taking water from the source to the school site, but this is currently not in use. Timber is extracted on a commercial basis. Pole cutting, bark removal and root digging take place on a subsistence level. Hunting is widespread.
History and Status	Kambona FR was surveyed, mapped and demarcated in 1955 to protect the spring located near St. Joseph's College (now Chidya Secondary School) in the village of Chidya. At this time the reserve covered 134.8ha, however this has been reduced by encroachment to 29.9ha in 1963.

Maps

Topographical map: Ndanda South sheet 306/1, East Africa 1:50 000, 1968. From the Institute of Mapping, Dar es Salaam (from Series Y742, Edition 1-TSD).

Land use and cover map: Masasi sheet SC-37-10/11, 1996. From the Institute of Resource Planning, UDSM.

METHODS

Survey work was conducted over five days (7-11 April 2005). Four vegetation plots (1600m²), four regeneration plots (16m²), and one zoosite were carried out, incorporating 120 sherman trapping nights, 30 bucket trapping nights, four man/hours of timed herpetofauna searches, 20.25 bat mist net/hours, 15 man/hours of timed bird searches, nine canopy trapping days, two butterfly sweep net/hours, two animal sign transects of 600m and 500m respectively (totalling 4,400m²), two disturbance transects of 600m and 500m respectively (totalling 11,000m²), and opportunistic observations (see Appendices 2 to 8 for GPS coordinates and work site descriptions). Ornithological work was conducted on separate days (12-14 July 2005). Bird mist netting was not conducted in this reserve as the camp had to be located at a distance from the forest (as requested by the inhabitants of Chidya village) and nets could not be left unattended due to threat of theft. Full 1000m transects could not be completed due to the small size of the reserve. Habitat notes were taken for vegetation plots (Appendices 4 and 5) and zoological trap sites (Appendix 6). Structured interviews and open discussions were conducted with the environmental committee of the two villages of Chidya and Chiwata. Twenty-two people attended the meeting. For a detailed break down of survey effort see Table 10-a.

RESULTS

In Kambona FR 79 plant species belonging to 36 families were recorded. Nine percent of the total number of floral species are endemic to the Swahilian region *sensu lato* and 10% are listed as threatened (IUCN, 2004) or potentially threatened (Gereau and Luke, 2006) (Table 12-a; Appendices 9 and 10).

One hundred and seven faunal species were found representing 54 families. Of these species 5% are forest dependent, none are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains and 2% are listed as threatened by IUCN (2004) and/or CITES (2005) (Table 12-a; Appendices 13-17).

Table 12-a Summary of fauna and flora recorded in Kambona FR

Taxa	No. of families	No. of species ^c	No. of forest dependent species ^d	No. of wide-spread species	No. of strictly endemic species: ^e and ^f	No. of threatened species: ^g and ^h	No. of PT species ⁱ
Mammals	16	22	2	22	0*	1	-
Birds ^a	25	57	1	57	0	0	-
Reptiles	4	4	0	4	0	0	-
Amphibians	4	5	0	5	0	1	-
Butterflies	5	19	2	19	0	0	-
Total for animals	54	107	5	107	0	2	-
Flora ^b	36	79	0	72	7	1	7
Combined Total	90	186	5	179	7	3	7

a - Includes birds seen on the forest boundary edge

b - All trees, shrubs, herbs, grasses and ferns

c - Includes information collected from all systematic survey work, opportunistic observations, structured interviews and open discussions

d - Species dependent on and associated with primary or closed-canopy forest, not forest edge or secondary forest

e - Faunal species with limited ranges in the Coastal Forests alone or the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a), sometimes being found also in other habitats in a few adjacent locations (e.g. Masasi District in S Tanzania, N Mozambique etc.)

f - Floral species restricted to the Swahilian region *sensu lato* (Clarke and Robertson, 2000)

g - Species listed as Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) in the IUCN Red List (IUCN, 2004)

h - Species listed in CITES Appendix I as threatened with extinction and excluded from international trade (CITES, 2005)

i - Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

*The identification of *Crociodura* sp. may increase this number. We await verification

FLORA

In Kambona FR two homogeneous vegetation stands were observed: *Brachystegia* forest and Riverine forest.

- *Species richness and diversity*

During the survey 79 floral species were recorded. Out of these, 37 species were recorded from four vegetation plots, 22 species from four regeneration plots and 20 species through opportunistic collection. More specifically, 35 trees, 20 shrubs, 18 herbs and six grasses were recorded (Appendix 9). A value of 3.37 was calculated for the Shannon diversity index.

- *Species relative abundance*

In the canopy layer *Pteleopsis myrtifolia* contributed 7% of all the vegetation sampled, and *Brachystegia spiciformis*, *Brachystegia longifolia* and *Terminalia sambesiaca* contributed 5% each (Table 12-b).

Table 12-b Species number of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the canopy layer in *Brachystegia* forest in Kambona FR

Family	Genus	Species	No. of indiv. in all plots	%RA	Rank RA
COMBRETACEAE	<i>Pteleopsis</i>	<i>myrtifolia</i>	3	7	1
FABACEAE (CAES)	<i>Brachystegia</i>	<i>spiciformis</i>	2	5	2
FABACEAE (CAES)	<i>Brachystegia</i>	<i>longifolia</i>	2	5	2
COMBRETACEAE	<i>Terminalia</i>	<i>sambesiaca</i>	2	5	3
FABACEAE (PAP)	<i>Pterocarpus</i>	<i>angolensis</i>	1	2	3
Total¹	3	4	10	24	
Total²	12	19	40	100	

%RA = Percentage relative abundance

Total¹ = Total for top five species; Total² = Total for all canopy layer species in the reserve

In the sub canopy layer *Bauhinia petersiana* contributed 20%, *Diplorhynchus condylocarpon* 12% and *Bauhinia tomentosa* 5% of all individuals sampled (Table 12-c).

Table 12-c Species number of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the sub canopy layer in *Brachystegia* forest in Kambona FR

Family	Genus	Species	No. of indiv. in all plots	%RA	Rank RA
FABACEAE (CAES)	<i>Bauhinia</i>	<i>petersiana</i>	8	20	2
APOCYNACEAE	<i>Diplorhynchus</i>	<i>condylocarpon</i>	5	12	2
FABACEAE (CAES)	<i>Bauhinia</i>	<i>tomentosa</i>	2	5	3
FABACEAE (PAP)	<i>Lonchocarpus</i>	<i>capassa</i>	1	2	4
BIGNONIACEAE	<i>Markhamia</i>	<i>acuminata</i>	1	2	3
Total¹	4	4	17	41	
Total²	12	19	40	100	

%RA = Percentage relative abundance

Total¹ = Total for top five species; Total² = Total for all species in sub canopy layer in the reserve

When looking at the overall number of trees recorded in both the canopy and sub canopy layers, the sub canopy layer contributed a higher number of individuals (63%) than the canopy layer (37%) to the overall number of adult trees in this reserve.

The structure of the Riverine forest does not include a sub canopy layer. Here, *Syzygium cordatum* and *Bridelia cathartica* covered about 18% and 12% respectively and *Bridelia micrantha* and *Milicia excelsa* about 7% each of all the vegetation sampled in this vegetation type (Table 12-d).

Table 12-d Species number of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the canopy layer in Riverine forest in Kambona FR

Family.	Genus	Species	No. of indiv. in all plots	% RA	Rank RA
MYRTACEAE	<i>Syzygium</i>	<i>cordatum</i>	5	18	1
EUPHORBIACEAE	<i>Bridelia</i>	<i>cathartica</i>	3	12	2
EUPHORBIACEAE	<i>Bridelia</i>	<i>micrantha</i>	2	7	3
MORACEAE	<i>Milicia</i>	<i>excelsa</i>	2	7	3
MORACEAE	<i>Ficus</i>	<i>natalensis</i>	1	3	4
Total¹	3	4	5	47	
Total²	12	17	20	100	

%RA = Percentage relative abundance

Total¹ = Total for top five species; Total² = Total for all canopy layer species in the reserve

- *Species composition and vegetation types*

Two homogeneous vegetation stands were observed, whose species composition and relative abundance confirmed to be **eastern African coastal *Brachystegia* forest** and **eastern African coastal Riverine forest** (Clarke and Robertson, 2000).

In the *Brachystegia* forest the canopy layer was dominated by *Pteleopsis myrtifolia*, *Brachystegia* sp. (*B. spiciformis* and *longifolia*) and *Terminalia sambesiaca*, together making 22% of all individuals recorded in this layer. In the sub canopy layer *Bauhinia petersiana*, *Diplorhynchus condylocarpon* and *Bauhinia tomentosa* were the most abundant, together constituting 37% of all individuals. Other species recorded included *Pterocarpus angolensis*, *Julbernardia globiflora*, *Albizia gummifera*, *Albizia versicolor* in the canopy layer and *Lonchocarpus capassa*, *Markhamia acuminata*, *Swartzia madagascariensis*, *Markhamia obtusifolia* and *Kigelia africana* in the sub canopy layer. The shrub layer was comprised of species from the genus *Combretum* and species such as *Salacia madagascariensis*, *Ochna holstii*, *Strychnos cocculoides*, *Strychnos madagascariensis*, *Flacourtia indica*, *Pseudolachnostylis maprouneifolia* and *Croton pseudopulchellus*, which were found extensively together with saplings of the canopy species mentioned above. The herbaceous layer was constituted by grasses such as *Sporobolus* sp. and *Themeda triandra*, together with herbs such as *Dicoma tomentosa*, *Crotalaria* sp., *Maerua* sp., *Tephrosia* sp. and *Jasminum* sp.

The Riverine forest occurs along the water source situated at the centre of the reserve and extending further south. Within this vegetation type the dominant species in the canopy layer included *Syzygium cordatum*, *Bridelia cathartica*, *Bridelia micrantha* and *Milicia excelsa*, which together constituted 44% of the individuals sampled. Other canopy species recorded in Riverine forest included *Ficus natalensis*, *Apodytes dimidiata*, *Albizia gummifera* and *Syzygium cumini*, which were recorded through opportunistic sampling. The shrub layer was observed to be characterised by *Antidesma venosum*, *Grewia lepidopetala*, *Barringtonia racemosa* and *Lasianthus* sp. In the herbaceous layer sedges from the family Cyperaceae, such as *Cyperus* sp., were recorded together with *Bidens pilosa* and species from the genus *Vernonia* and *Conyza*.

- *Endemism and conservation status*

Seven of the species recorded were found to be endemic to the Swahilian region *sensu latu*, including *Barleria holstii*, *Cleistanthus schlechteri*, *Mimusops schliebenii*, *Grewia lepidopetala*, *Tetracera boiviniana*, *Erythrina schliebenii* and *Rytigynia decussata* (Clarke and Robertson, 2000) (Appendix 10), amounting to 9% of the total number of species recorded (Figure 2).

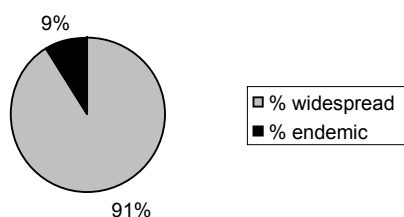


Figure 2 Percentage floral species endemic to the Swahilian region *sensu lato* and those that are widespread in Kambona FR

Eight among the species recorded are recognised to be threatened (IUCN, 2004) or potentially threatened (Gereau and Luke, 2006) (Table 12-e), amounting to 10% of the total number of species recorded.

Table 12-e Threatened and potentially threatened plant species in Kambona FR

Family	Species name	Conservation status	Habit
DILLENIACEAE	<i>Tetracera boiviniana</i>	PT	S/T
EUPHORBIACEAE	<i>Drypetes natalensis</i>	PT	T
FABACEAE (PAP)	<i>Baphia punctulata</i>	PT	T
FABACEAE (PAP)	<i>Craibia brevicaudata</i>	PT	T
FABACEAE (PAP)	<i>Erythrina schliebenii</i>	PT	T
MELIACEAE	<i>Khaya anthotheca</i>	VU	T
MYRTACEAE	<i>Syzygium cordatum</i>	PT	T
RUBIACEAE	<i>Rytigynia decussata</i>	PT	S

PT = Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

T= Tree, S= Shrub, B= Bamboo, C= Climber, H= Herb

FAUNA

Although the identification of about 90% of the species recorded is certain, the identification of a few specimens remains tentative whilst awaiting taxonomic verification.

Mammals

- *Species richness and composition*

A total of 22 mammals representing 16 families were recorded (Appendix 13).

For the *small mammals* eight species were recorded in total from 13 captures (excluding three recaptures) that took place during 120 sherman trapping nights and 30 bucket pitfall trapping nights. The Lesser pouched rat (*Beomys hindei*) was the most commonly found species, accounting for 58% of captures. There was only one capture of the Multimammate rat (*Mastomys natalensis*), the Strict-footed woodland mouse (*Grammomys dolichurus*), and the Pygmy mouse (*Mus minutoides*). Two species of the White-toothed shrew (*Crocidura* sp.) were recorded out of three captures (Appendix 18).

No *bats* were recorded during 20.25 bat mist net/hours.

For the *larger mammals*, 14 species representing 14 families were recorded during sign transects totalling 1.1km, through opportunistic observations and from local knowledge (Appendix 13). No one species was recorded on more than two separate occasions during the survey. All of the larger mammals were recorded by indirect observation, such as vocalisations and dung, with exception of the Red-bellied coastal squirrel (*Paraxerus palliatus*). Species found included the Small-eared bushbaby (*Otolemur garnetti*), the Suni (*Neotragus moschatus*), the Chequered elephant shrew (*Rhynchocyon cirnei*) and the Red-bellied coastal squirrel (*Paraxerus palliatus*). From interviews it was learnt that the Leopard (*Panthera pardus*), Lion (*Panthera leo*), Spotted hyena (*Crocuta crocuta*) and Jackal (*Canis adustus*) occasionally move through the forest. *Panthera pardus* and *P. leo* were sighted by local residents in 2004 and *Crocuta crocuta* in 2005.

- *Forest dependence, endemism and conservation status*

Two species were found to be forest dependent, although many of the species recorded often frequent and some favour a forest habitat. None of the species found are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains, yet two are rare species with a restricted distribution in eastern Africa. Only one of the species recorded is listed as threatened (Table 12-f).

Table 12-f Forest dependent, endemic and threatened mammal species in Kambona FR

Species	Common name	Forest dependent	Endemic	Threatened
<i>Otolemur garnetti</i>	Small-eared galago	-	CF, a few other habitats in coastal E Africa	-
<i>Rhynchocyon cirnei</i>	Chequered Elephant shrew	-	-	VU
<i>Paraxerus palliatus</i>	Red bellied coastal squirrel	F	-	-
<i>Beamys hindei</i>	Lesser pouched rat	-	EACF, a few other forest types in Kenya and Tanzania	-
<i>Neotragus moschatus</i>	Suni	F	-	-

F= Forest dependent or specialist (Burgess *et al.*, 2000a)

CF= species with limited ranges in the Coastal Forests alone; EACF= species with limited ranges in the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

Birds

- *Species richness and composition*

Fifty-seven bird species representing 25 families were observed in Kambona FR during 15 man/hours of timed bird searches. Species included the Southern banded snake eagle (*Circaetus fasciolatus*) and the Pale batis (*Batis soror*) (Appendix 14).

- *Forest dependence, endemism and conservation status*

One species, the Blue-mantled crested flycatcher (*Trochocercus cyanomelas*), is forest dependent. No strictly endemic or threatened species were observed in this reserve.

Reptiles

- *Species richness and composition*

Four species of reptiles representing four families were recorded from four captures that took place during 30 bucket pitfall trapping nights and four man/hours of herpetological searches (Appendices 15 and 18). Tracks of the Southern rock python (*Python natalensis*), the White-

throated savannah monitor (*Varanus albigularis*) and the Leopard tortoise (*Geochelone pardalis*) were observed, and the Tropical plated lizard (*Cordylus tropidosternum*) was also recorded.

- *Forest dependence, endemism and conservation status*

No species were found to be forest dependent, strictly endemic or threatened.

Amphibians

- *Species richness and composition*

Five species of amphibian representing four families were recorded from 23 captures that took place during 30 bucket pitfall trapping nights and during four man/hours of herpetological searches, and through opportunistic observations. Species included *Arthroleptis stenodactylus*, *Arthroleptis xenodactyloides*, *Hyperolius puncticulatus*, *Bufo* sp. and *Xenopus muelleri* (Appendices 16 and 18).

- *Forest dependence, endemism and conservation status*

No species were found to be forest dependent or strictly endemic. *Arthroleptis stenodactylus* and *A. xenodactyloides* are known to favour forest habitats, while *Bufo* sp., *Hyperolius puncticulatus* and *Xenopus muelleri* are regarded as non-forest dwelling species (Howell, 1993). *A. xenodactyloides* is listed as Vulnerable (IUCN, 2004).

Butterflies

- *Species richness and composition*

Nineteen species of butterfly representing five families were recorded from 24 captures that took place during nine canopy trapping days and two sweep net/hours (Appendix 17).

- *Forest dependence, endemism and conservation status*

Two Nymphaloida species, *Bematistes epaea epitellus* and the Flame bordered charaxes (*Charaxes protoaclea azota*), are forest dependent. No species were found to be strictly endemic or threatened.

Fauna's strict endemism

None of the faunal species recorded in Kambona FR are endemic to the Coastal Forests and/or Eastern Arc Mountains.

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

Twenty-two 50m long and 10m wide sections were sampled along two disturbance transects of 600m and 500m respectively (totalling 11,000m²), to record levels of pole/timber cutting, fire, bark ringing and path densities. Out of twenty-two 50m sections, 21 (95%) were subject to some form of disturbance, 21 (95%) showed signs of pole/timber cutting, six (27%) were bisected by one or more paths, two (9%) showed signs of fire damage and a further two (9%) were subject to bark ringing (Figure 3). No traps were sighted in any section. Information on resource use is summarised in Table 12-h.

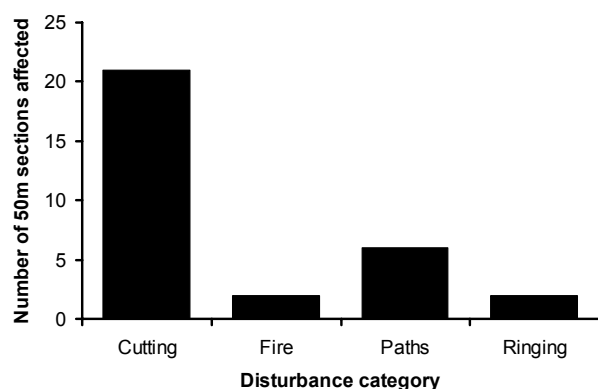


Figure 3 Number of 50m sections (from a total of 22) affected by different forms of human disturbance along transects in Kambona FR

Agricultural encroachment

Disturbance transects did not reveal any cultivation in the forest reserve. On the eastern, northern and southern sides of the reserve the boundary is not clearly demarcated. On the southern part of the reserve there are new farms (established within the last five years) where vegetables are grown for sale in Masasi town. Mango (*Mangifera indica*) and cashew nut (*Anacardium occidentale*) trees were observed within the boundaries.

Poles and timbers

Discussions and field observations identified 16 species used for timber in Kambona FR. Field observations detected four main species harvested for timber: *Azelia quanzensis*, *Milicia excelsa*, *Pterocarpus angolensis* and *P. rotundifolius*. Discussions identified a further 14 that are commonly used for timber. Nine species are commonly cut for poles as determined from disturbance transects (Table 12-h). No currently active or old pit sawing sites were recorded.

- *Relative abundance and average no. of live, dead and cut individuals per ha*

The study indicates that 30% of poles and 7% of timbers are cut within Kambona FR (Table 12-g).

Table 12-g Summary of pole, timber and large timber cutting in Kambona FR

	Total transect length in m	Total no. of indiv. sampled	Total no. (and % RA) of live indiv.	Average live indiv. per ha	Total no. (and % RA) of dead indiv.	Average dead indiv. per ha	Total no. (and % RA) of cut indiv.	Average cut indiv. per ha
Poles	1,100	735	503 (68)	457	15 (2)	14	217 (30)	197
Timbers	1,100	277	249 (90)	226	8 (3)	7	20 (7)	18
Large timbers	1,100	39	37 (95)	34	2 (5)	1.8	0 (0)	0

Fuel wood

Residents mentioned 21 different tree species that are used for fuel wood in Kambona FR (Table 12-h). The residents stated that fuel wood is mainly collected from dead trees.

Tools and utensils

Species used to make items such as handles for hoes, wooden spoons and ropes are listed in Table 12-h. Bark ringing (to extract bark for rope making) was observed on two separate occasions.

Edible non-timber forest products

From discussion, 13 species were identified that supply food to the local inhabitants (Table 12-h). The roots of *Dioscorea hirtiflora* were found to be an important source of carbohydrate exploited for sale on local markets.

Medicinal plants

Discussions with the local elders revealed 12 species that are used as medicinal plants (Table 12-h).

Table 12-h Plant species utilised in Kambona FR as identified by field observations, structured interviews and open discussions. Local names, where known, are presented in Appendix 9

FAMILY	Species	Poles	Timber	Fuel wood	Tools	Rope	Food	Medicine
ANACARDIACEAE	<i>Sclerocarya birrea</i>			X			X	X
ANNONACEAE	<i>Annona senegalensis</i>	X		X		X	X	
APOCYNACEAE	<i>Landolphia buchananii</i>						X	
BOMBACACEAE	<i>Ceiba pentandra</i>		X					
CAOMBRETACEAE	<i>Pteleopsis myrtifolia</i>			X				
CHRYSOBALANACEAE	<i>Parinari curatellifolia</i>		X				X	
DIOSCOREACEAE	<i>Dioscorea hirtiflora</i>						X	
EBENACEAE	<i>Diospyros kirkii</i>		X					
FABACEAE (CAES)	<i>Azelia quanzensis</i>	X	X	X	X			X
FABACEAE (CAES)	<i>Bauhinia tomentosa</i>							
FABACEAE (CAES)	<i>Brachystegia longifolia</i>			X	X			
FABACEAE (CAES)	<i>Brachystegia microphylla</i>	X		X		X		X
FABACEAE (CAES)	<i>Brachystegia spiciformis</i>			X	X			
FABACEAE (CAES)	<i>Cassia petersiana</i>	X						X
FABACEAE (CAES)	<i>Hymenaea verrucosa</i>		X					
FABACEAE (CAES)	<i>Julbernardia globiflora</i>		X	X	X	X		
FABACEAE (CAES)	<i>Piliostigma thonningii</i>		X	X		X		
FABACEAE (CAES)	<i>Scorodophloeus fischeri</i>		X					
FABACEAE (CAES)	<i>Swartzia madagascariensis</i>			X	X			
FABACEAE (MIM)	<i>Albizia amara</i>		X					
FABACEAE (MIM)	<i>Albizia gummifera</i>	X	X	X		X		
FABACEAE (MIM)	<i>Albizia versicolor</i>	X	X	X	X			

FAMILY	Species	Poles	Timber	Fuel wood	Tools	Rope	Food	Medicine
FABACEAE (PAP)	<i>Dalbergia melanoxylon</i>		X	X	X			
FABACEAE (PAP)	<i>Millettia stuhlmannii</i>		X					
FABACEAE (PAP)	<i>Lonchocarpus bussei</i>	X		X	X			X
FABACEAE (PAP)	<i>Lonchocarpus capassa</i>			X	X			X
FABACEAE (PAP)	<i>Pterocarpus angolensis</i>		X	X	X			X
FABACEAE (PAP)	<i>Pterocarpus rotundifolius</i>		X					
FLACOURTIACEAE	<i>Flacourtia indica</i>			X		X	X	
HYMENOCARDIACEAE	<i>Hymenocardia ulmoides</i>			X	X	X		X
LOGANIACEAE	<i>Strychnos cocculoides</i>	X		X	X		X	X
MELIACEAE	<i>Khaya anthotheca</i>		X		X			
MORACEAE	<i>Ficus sur</i>			X			X	
MORACEAE	<i>Milicia excelsa</i>		X		X			X
MYRTACEAE	<i>Syzygium cordatum</i>			X			X	
MYRTACEAE	<i>Syzygium cumini</i>						X	
RUBIACEAE	<i>Vangueria infausta</i>						X	
RUTACEAE	<i>Zanthoxylum chalybeum</i>							
SAPOTACEAE	<i>Bequaertiodendron natalense</i>	X			X			X
STERCULIACEAE	<i>Cola greenwayi</i>				X			
STERCULIACEAE	<i>Sterculia appendiculata</i>		X					
VERBANACEAE	<i>Vitex doniana</i>				X		X	X

Hunting

A diverse range of species from a variety of families are hunted in and around Kambona FR, including toads, civets, bush babies, elephant shrews and pythons (Appendix 12). All hunted species were said by residents to have declined over the last 10 years. Twenty years ago Buffalo and Eland were present and hunted, and are now absent from Kambona FR. Among the species hunted the Chequered elephant shrews (*Rhynchocyon cirnei*) is listed as Vulnerable and the Natal duiker (*Cephalophus natalensis*) is listed as conservation dependant in the IUCN Red List (2004) (Appendix 12).

Local management

No management takes place in Kambona FR. Although it has been gazetted (since 1963) no patrols of the reserve take place and there is no enforcement of laws concerning illegal hunting and extraction of timber.

DISCUSSION

FLORA

Kambona FR is comprised of *Brachystegia* forest and Riverine forest.

In the *Brachystegia* forest the canopy layer is dominated by *Pteleopsis myrtifolia*, *Brachystegia* sp. (*B. spiciformis* and *B. longifolia*) and *Terminalia sambesiaca*. However, disturbance has resulted in clearance of many canopy trees, such as *Brachystegia spiciformis*, *Julbernardia globiflora*, *Albizia gummifera* and *A. versicolor*, these being the species most affected by bark ringing (Gauslaa, 1989; Lind and Morrison, 1974). Sub canopy trees have taken over to cover the gap left by the removal of canopy trees and now dominate in terms of relative abundance, a phenomenon that has been previously observed during a study in Pugu Forest Reserve, Coast Region (Ndangalasi, 1997.) Even though disturbance from timber extraction and bark ringing has changed the physiognomy of the canopy layer into a more open configuration, the presence of Swahilian endemic species and the sparse character of the grass layer still distinguish this vegetation type from the ‘miombo’ *Brachystegia* woodland of the Zambezi regional centre of endemism (Clarke and Robertson, 2000). The understory vegetation in this reserve is sparse; further study would be necessary to determine whether the sparsity of the shrub layer is a natural incidence of the *Brachystegia* forest here, as described by Clarke and Robertson (2000), or a consequence of disturbance.

A small pocket of forest located around a natural spring at the centre of the reserve is comprised of species that are characteristic of coastal Riverine Forest, such as *Syzygium cordatum*, *Bridelia cathartica*, *Bridelia micrantha*, *Milicia excelsa* and *Ficus natalensis*. Here sub canopy trees have taken over to cover the gap left by the removal of canopy trees.

The species richness in this forest reserve is relatively low (79), being caused by the intense level of selective timber and bark extraction taking place. However, the Shannon diversity index ($H^1=3.37$) is high. This reflects a community in succession (Magurran, 1988), where a relatively high number of species (particularly understory species) can colonise the area and reach high rates of population growth following the removal of more competitive canopy trees (Ndangalasi, 1997). If this forest could be allowed to fully regenerate, and canopy and sub canopy species to achieve their potential population size, then the species diversity would be expected to decline.

Despite its small size, Kambona FR harbours some important plant species, among which various species endemic to the Swahilian region *sensu lato* (*Barleria holstii*, *Cleistanthus schlechteri*, *Mimusops schliebenii*, *Grewia lepidopetala*, *Tetracera boiviniana*, *Erythrina schliebenii* and *Rytigynia decussata*). One species occurring here, the African mahogany (*Khaya anthotheca*), yields a very valuable termite resistant timber that is marketed for joinery and cabinet work (Schulman *et al.*, 1998), and is listed as Vulnerable by IUCN (2004). If the extraction of timber from Kambona FR is not regulated this and other species may become locally rare.

FAUNA

Despite its small size, a comparatively high number of faunal species (107) were recorded in Kambona FR, and this may reflect the relatively low level of encroachment affecting this reserve (Zullini, 2003; Begon *et al.*, 1996) (See Human Resource-Use and Local Management section).

Small mammals

For the small mammals the overall number of species (6) and individuals (13) captured was low. The most commonly captured species was the Lesser pouched rat (*Beamys hindei* - near threatened) accounting for 58% of all captures. *Beamys hindei* is endemic to a few forest types in Kenya and Tanzania, including the coastal and mountain forests of the EACF hotspot. Until recently it was regarded as one of the rarest rodents in Africa (Groombridge, 1994) but it is now known to be more widespread. Our survey in Kambona FR seems to support this evidence, since this reserve holds a relatively large population of this species (see Results section and Appendix 18). Two species of White-toothed shrew (*Crocidura* sp.) were recorded. The shrews of the Coastal Forests of Tanzania are poorly known and already there are five unidentified species that have been collected from these forests, each from a separate site (Burgess and Clarke, 2000). It is likely that shrews collected from this study will yield interesting results once taxonomic verification is accomplished.

Bats

No bats were recorded in this reserve, which may be a result of the low number of netting hours carried out and the small size of the reserve.

Large mammals

For the large mammals a moderate number of species (14) were recorded and no one species was recorded more than twice. This suggests that the populations of all species are suppressed due to the small size of the reserve and disturbance from timber extraction, fire and hunting, whereby species ecological requirements (e.g. shelter, prey) may not be sufficient to support larger populations. In this reserve only the Red-bellied coastal squirrel (*Paraxerus palliatus*) and the Suni (*Neotragus moschatus* - conservation dependent) were found to be forest dependent, while the Small-eared bushbaby (*Otolemur garnetti* - CITES II) is a forest dwelling species endemic to the Coastal Forests and a few other habitats in coastal eastern Africa (Burgess *et al.*, 2000). These species are likely to be under local threat from further degradation of the forest reserve. Most of the other large mammals recorded only occasionally frequent the forest and therefore will be less affected by encroachment. Nonetheless, these species may need the reserve as a corridor between suitable patches of habitat or for alternative sources of food or shelter. Predators such as the Lion (*Panthera leo* – Vulnerable, CITES II) and the Spotted hyena (*Crocuta crocuta* - conservation dependent) were reported to occur in this forest by inhabitants of adjacent villages and farms. These species are able to utilise different habitats and to adapt well to changes in their environment, and so are likely to be less threatened by further forest degradation. Nevertheless, any reduction in habitat will reduce the visits of these animals as shelter and populations of preyed animals are likely to decrease. Further research would need to be conducted to assess the extent of reliance of large mammals and predators on Kambona FR. *Panthera pardus* was reported to occur here and in the adjacent Makonde Scarp I and II proposed FRs. This species is listed on CITES Appendix I (2005) as a species threatened with extinction and therefore excluded from international trade, and if its presence in these reserves will be confirmed then its protection will be necessary. The finding of the Chequered elephant shrew (*Rhynchocyon cirnei*), a species listed as Vulnerable (IUCN, 2004), confirms the Coastal Forests to be a globally important area for this genus, closely followed by the Eastern Arc Mountains (Burgess *et al.*, 2000a). *Rhynchocyon* species are forest-dwellers that rely on dense vegetation cover to produce the thick leaf litter they require for foraging and nest construction (Rathbun, 2005). *R. cirnei* may therefore become locally threatened should further habitat destruction ensue.

Birds

In Kambona FR the low number of bird species recorded (57), especially forest dependent species (1), may be a consequence of the small size of this reserve (29.9ha), the short period of time spent studying it (Table 10-a), and the sparse understory of the *Brachystegia* forest occurring in this reserve (Mlingwa *et al.*, 2000). This reserve was found to contain the Southern banded snake-eagle (*Circaetus fasciolatus*). This is a near threatened bird species (IUCN, 2004) whose presence in the adjacent Makonde Scarp and Mkunya River forests demarcated them as the Newala District Coastal Forests IBA (TZ053 - category A1) (BirdLife International, 2005). If more than a threshold population of *C. fasciolatus* was found to be present in Kambona FR than this reserve could be classified as a component of the Newala District Coastal Forests IBA. Further research would be required to confirm this.

Reptiles

Despite the presence of a water source in Kambona FR, the number of reptile species (4) and individuals (4) captured was low. Low numbers may reflect the low sampling intensity applied to this reserve (Table 10-a) but also continuous disturbance by people collecting water from the spring. Apart from one species found in *Brachystegia* forest all records came from a small patch of Riverine forest around the water source, but none of the species recorded are forest dependent. None of the species found are endemic or threatened either. The Tropical girdled lizard (*Cordylus tropidosternum*) is an arboreal species that shelters and forage in holes and under the bark of trees, and consequently this species may become locally threatened by further loss of well-wooded habitats. Conducting further research in the wet season may however reveal more comprehensive results.

Amphibians

For the amphibians a low number of species (5) were recorded from a relatively high number of captures (23). Again, low numbers may reflect the low sampling intensity in this reserve (Table 10-a) and continuous disturbance by people collecting water from the spring. The high capture rate was due to an intensive search around the spring, where dense vegetation and moist humus soil create an ideal breeding ground for these species (Howell, 1993). The Squeakers (*Arthroleptis stenodactylus* and *A. xenodactyloides*) are forest dwelling species that were commonly captured in *Brachystegia* forest. These species favour a forested habitat as they rely on the presence of damp soil and loose leaf mould protected from shrub and canopy cover to lay their eggs (Howell, 1993). Consequently, the Dwarf squeaker (*Arthroleptis xenodactyloides*) is listed as Vulnerable (IUCN, 2004) and both species may become locally threatened by further loss of forest habitat. No other species recorded are forest dwelling or forest dependent. The intrusion into *Brachystegia* and Riverine forest by species that normally inhabit transient open situations is known to be a recurrent characteristic encouraged by the heterogeneous pattern of the Coastal Forest Mosaic, whereby such species breed in their open habitat but enter the enclosed habitat for refuge, especially during dry periods (Poynton, 2000). Many species recorded here are water dependent, and therefore the quality of the water source and the forest cover protecting it are vital to their continued presence.

Butterflies

For the butterflies there was a moderate number of species (19) and individuals (24) captured. An important butterfly community was found in a small pocket of Riverine forest surrounding the water source, which contained a large proportion of all the species recorded and two forest dependent species from the order Nymphaloidae, *Bematistes epaea epitellus* and the Flame bordered charaxes (*Charaxes protoclea azota*). This indicates the importance of the Riverine forest for butterflies and the vulnerability of forest dependent species. Butterfly species recorded in the remaining *Brachystegia* forest are non-forest dwellers, reflecting the absence in this reserve of a dense shrub layer (see Flora section).

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

Timber extraction is the only commercial activity that takes place in Kambona FR. Other activities, such as pole cutting, bark removal and root digging take place on a subsistence basis. Pole cutting was the largest form of disturbance. Both pole cutting and timber extraction are selective, focusing on species that produce high quality timber primarily used for making furniture, such as the Gum copal (*Hymenaea verrucosa*), the African teak (*Pterocarpus angolensis*), the Snake bean tree (*Swartzia madagascariensis*) and the Pod mahogany (*Azelia quanzensis*). This is destructive for the ecology of this forest reserve and for the threatened species harvested here (e.g. *Scorodophloeus fischeri*).

At present encroachment is low. It is likely that the mango (*Mangifera indica*) and cashew nut (*Anacardium occidentale*) trees detected in the reserve were planted before Kambona was gazetted and so overall encroachment levels were low at the time of the study. The residents proved to be aware that the forest should be conserved to protect the spring, which they rely on as a water source, and to preserve it from the threats of soil erosion. Thus the boundaries of the forest reserve, although not well marked, are largely respected by the inhabitants. However, the fast growing business of vegetable sales (predominately tomatoes) encourages farmers to expand their cultivated land so as to increase production and, with the lack of a clear boundary on the eastern, northern and southern sides of the reserve, it is possible that farms will encroach into the reserve. Moreover, non-timber resources within the forest are said to have been significantly depleted despite the knowledge that it is illegal to harvest within the forest boundaries.

Hunting in Kambona is widespread with a large number of species being targeted. All hunted species are said by residents to have declined over the last 10 years as pressure on the forest's resources increased. Among the species hunted the Chequered elephant shrews (*Rhynchocyon cirnei*) is listed as Vulnerable and the Natal duiker (*Cephalophus natalensis*) is listed as conservation dependant in the IUCN Red List (2004), while the Small-eared bushbaby (*Otolemur garnetti* - CITES II) is a rare species with restricted distribution in coastal eastern Africa. Measures must be taken to try to protect these globally important species from being overexploited. Possible solutions are discussed in the Conservation Recommendations section.

13. MAKONDE SCARP I PROPOSED FOREST RESERVE



Status	Proposed Forest Reserve
Management Body	Central Government
Location	Masasi district. The proposed area starts south east of Chidya village and about an hour and a half walk along a distinct path from Chidya Secondary school. The proposed site then continues across to below Mjembe village.
Area	1,748.3ha
Altitude	600-640m asl
Topography	Lowland plain and gentle lower slope
Temperature	Min: 19°C, Max: 37°C (recorded 17-21 April, start of dry season)
Rainfall	Average 0.4mm (recorded 17-21 April, start of dry season)
Soil type	Sandy-loam
Vegetation type	Eastern African coastal <i>Brachystegia</i> forest
Land Use	The reserve was proposed to preserve the soil on the plateau and scarp and to protect a water source and catchment. Land is used for agriculture (shifting cultivation is common practice) and timber is extracted on a commercial basis. Hunting occurs.
History and Status	Signs of destruction on the escarpment were noticed and documented in the 1940's (Maganga, 2004). Makonde Scarp I was agreed to be a proposed forest reserve in 1976, the same year as funding for boundary beacons was made available. In 1977 some residents were moved from the escarpment and relocated. In 1980-81 complaints by people who had been moved off their original properties were acknowledged, concluding that Tsh 40 million was needed for compensation. Compensation of TSh 1.7 million was made available to Masasi district in 1983 and 1984 but no subsidies were made

available to Newala and Tandahimba districts. Presently the site is not yet fully gazetted and there are no boundary markers. There is no staff, effective capacity or resources to enforce protected area legislation and regulations.

Maps

Topographical map: Ndanda South sheet 306/1, East Africa 1:50 000, 1968. From the Institute of Mapping, Dar es Salaam (from Series Y742, Edition 1-TSD).

Land use and cover map: Masasi sheet SC-37-10/11, 1996. From the Institute of Resource Planning, UDSM.

METHODS

Survey work was conducted over seven days (15-21 April 2005). Nine vegetation plots (3600m²), nine regeneration plots (36m²), and one zoosite were carried out, incorporating 200 sherman trapping nights, 50 bucket trapping nights, .5 man/hours of timed herpetofauna searches, 2.7 bat mist net/hours, 20.5 man/hours of bird mist netting, six man/hours of timed bird searches, 15 canopy trapping days, 4.5 butterfly sweep net/hours, 4three animal sign transects (totalling 12,000m²), three disturbance transects (totalling 30,000m²), and opportunistic observations (see Appendices 2 to 8 for GPS coordinates and work site descriptions). Ornithological work was conducted on separate days (16-18 July 2005). Habitat notes were taken for vegetation plots (Appendices 4 and 5) and zoological trap sites (Appendix 6). Structured interviews and open discussions were conducted with the environmental committee of the two villages of Chidya and Chiwata. Twenty-two people attended the meeting. An interview was also conducted with Mr Swalele, a hunter from Chidya village who had been involved with boundary demarcation in 1982. For a detailed break down of survey effort see Table 10-a.

RESULTS

In Makonde Scarp I proposed FR 73 plant species were recorded from 19 families. Twelve percent of the total number of floral species are endemic to the Swahilian region *sensu lato* and 11% are listed as threatened (IUCN, 2004) or potentially threatened (Gereau and Luke, 2006) (Table 13-a; Appendices 9 and 10).

One hundred and thirty eight faunal species were found representing 66 families. Of these species 6% are forest dependent, none are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains and less than 1% are listed as threatened (IUCN, 2004) and/or CITES (2005) (Table 13-a; Appendices 13-17).

Table 13-a Summary of fauna and flora recorded in Makonde Scarp I proposed FR

Taxa	No. of families	No. of species ^c	No. of forest dependent species ^d	No. of wide-spread species	No. of strictly endemic species: ^e and ^f	No. of threatened species: ^g and ^h	No. of PT species ⁱ
Mammals	19	26	3	23	0*	0	-
Birds ^a	32	78	2	76	0	0	-
Reptiles	6	9	0	9	0	0	-
Amphibians	4	5	0	5	0	1	-
Butterflies	5	20	3	17	0	0	-
Total for animals	66	138	8	130	0	1	-
Flora ^b	16	73	0	66	9	1	7
Combined Total	82	211	8	196	5	2	7

a - Includes birds seen on the forest boundary edge

b - All trees, shrubs, herbs, grasses and ferns

c - Includes information collected from all systematic survey work, opportunistic observations, structured interviews and open discussions

d - Species dependent on and associated with primary or closed-canopy forest, not forest edge or secondary forest

e - Faunal species with limited ranges in the Coastal Forests alone or the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a), sometimes being found also in other habitats in a few adjacent locations (e.g. Masasi District in S Tanzania, N Mozambique etc.)

f - Floral species restricted to the Swahilian region *sensu lato* (Clarke and Robertson, 2000)

g - Species listed as Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) in the IUCN Red List (IUCN, 2004)

h - Species listed in CITES Appendix I as threatened with extinction and excluded from international trade (CITES, 2005)

i - Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

*The identification of *Crocidura* sp. may increase this number. We await verification

FLORA

In Makonde Scarp I FR one single homogeneous vegetation stand was observed, which was identified as *Brachystegia* forest regenerating following past disturbance and extensively interrupted by cultivated and fallow farmland in all parts of the reserve.

- *Species richness and diversity*

A total of 73 species were recorded. Out of these, 37 species were found in nine vegetation plots and 15 species in nine regeneration plots. The other 15 species were recorded from opportunistic collections made within the reserve. More specifically, 29 trees, 19 shrubs, 13 herbs, and six grasses were recorded (Appendix 9). A value of 2.95 was calculated for the Shannon species diversity index.

- *Species dominance*

Within the *Brachystegia* forest species from the genus *Brachystegia* (*B. spiciformis* and *B. microphylla*) dominated at the canopy level, both occurring in 67% of the plots and therefore ranking as the most dominant species. Other frequent species were *Pterocarpus angolensis* (56%), *Pteleopsis myrtifolia* (44%) and *Brachystegia longifolia* (22%) (Table 13-b).

Table 13-b Species frequency, dominance, rank dominance, no. of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the canopy layer in *Brachystegia* forest in Makonde Scarp I proposed FR

Family	Genus	Species	F	% RF (Dominance)	Rank dominance	No. indiv. in all plots	% RA	Rank RA
FABACEAE (CAES)	<i>Brachystegia</i>	<i>spiciformis</i>	6	67	1	46	22	1
FABACEAE (CAES)	<i>Brachystegia</i>	<i>microphylla</i>	6	67	1	13	6	3
FABACEAE (PAP)	<i>Pterocarpus</i>	<i>angolensis</i>	5	56	2	12	5	4
COMBRETACEAE	<i>Pteleopsis</i>	<i>myrtifolia</i>	4	44	3	16	7	2
FABACEAE (CAES)	<i>Brachystegia</i>	<i>longifolia</i>	2	22	4	6	2	5
Total¹	3	3	5			93	42	
Total²	16	27	36			201	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

The sub canopy layer is dominated by *Combretum paniculatum*, which occurs in 67% of the plots. *Combretum zeyheri* was also frequent, being present in 44% of the plots (Table 13-c).

Table 13-c Species frequency, dominance, rank dominance, no. of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the sub canopy layer in *Brachystegia* forest in Makonde Scarp I proposed FR

Family	Genus	Species	F	% RF (Dominance)	Rank dominance	No. of indiv. in all plots	%RA	Rank RA
COMBRETACEAE	<i>Combretum</i>	<i>paniculatum</i>	4	67	1	10	6	2
COMBRETACEAE	<i>Combretum</i>	<i>zeyheri</i>	3	44	2	15	4	3
APOCYNACEAE	<i>Diplorhynchus</i>	<i>condylocarpon</i>	6	33	3	14	7	1
FABACEAE (CAES)	<i>Bauhinia</i>	<i>petersiana</i>	2	22	4	6	2	4
COMBRETACEAE	<i>Combretum</i>	<i>molle</i>	2	22	4	4	1	5
Total¹	3	3	5			49	20	
Total²	16	27	36			201	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

- Species relative abundance*

In the canopy layer 30% of the trees recorded were individuals from the genus *Brachystegia* (*B. spiciformis*, *B. microphylla* and *B. longifolia*). *Pterocarpus angolensis* and *Pteleopsis myrtifolia* constitute about 5% and 7% each. In the sub canopy layer *Combretum zeyheri*, *Diplorhynchus condylocarpon* and *Combretum paniculatum* were the top three species, together making up 17%.

When looking at the overall number of trees recorded in both the canopy and sub canopy layers, the canopy contributed a higher number of individuals (68%) than the sub canopy layer (32%) to the overall number of adult trees in this reserve.

- Species composition and vegetation types*

In Makonde Scarp I proposed FR one single homogeneous vegetation stand was observed, which from the species composition and trees' dbh was recognised to be **degraded eastern African coastal *Brachystegia* forest** (Clarke and Robertson, 2000; Lowe and Clarke, 2000).

The species composition of the forest was characterised by *Brachystegia spiciformis* and *Brachystegia microphylla* from the canopy layer and *Combretum paniculatum* from the sub canopy layer as both dominant and most abundant species, contributing 28% and 6% of the total number of individuals in their respective layers. Other species occurring in the canopy layer included *Pterocarpus angolensis* and *Pteleopsis myrtifolia*, which ranked as frequent, and *Brachystegia longifolia*, *Julbernardia globiflora*, *Millettia stuhlmannii*, *Pterocarpus rotundifolius* and *Acacia nigrescens*. In the sub canopy layer we also found *Diplorhynchus condylocarpon*, *Combretum zeyheri*, *C. molle*, *Bauhinia petersiana*, *Cussonia arborea*, *Craibia brevicaudata* and *Lonchocarpus bussei*. The shrub layer was observed to be comprised of saplings of the dominant species from the canopy and sub canopy layers, and shrub species such as *Salacia madagascariensis*, *Strychnos usambarensis*, *Strychnos madagascariensis*, *Ochna holstii*, *Catunaregam spinosa*, *Vangueria infausta*, *Vangueriopsis* sp. and various species from the genus *Combretum*. The herbaceous layer was observed to be comprised of grasses, particularly *Sporobolus* sp., *Themeda triandra*, *Digitaria* sp. and *Panicum maximum*. Herbs found in association with these grasses were *Dicoma tomentosa*, *Hypoestes* sp., *Jasminum* sp., *Jussiaea repens*, *Vernonia* sp. and species from the genus *Bidens*. These herbs were recorded as dominant on the edge of cultivated land and open areas where grasses had been removed by fire or cultivation.

Most of the tree species recorded range from small to medium size class, the average dbh recorded being 15cm and only three plots having trees with a single stem measuring >30 cm dbh.

- *Endemism and conservation status*

Nine of the species recorded were found to be endemic to the Swahilian region *sensu lato*, including *Ozoroa obovata*, *Mimusops schliebenii*, *Sterculia appendiculata*, *Vitex zanzibarensis*, *Commiphora zanzibarica*, *Erythrina schliebenii*, *Lamprothamnus zanguebaricus*, *Rytigynia decussata* and *Vitex mossambicensis* (Clarke and Robertson, 2000) (Appendix 10) and this amounts to 12% of the total number of species recorded (Figure 4).

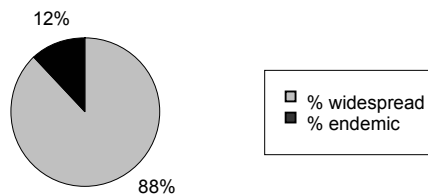


Figure 4 Percentage floral species endemic to the Swahilian region *sensu lato* and those that are widespread in Makonde Scarp I proposed FR

Eight of the species recorded are recognised to be threatened (IUCN, 2004) or potentially threatened (Gereau and Luke, 2006), amounting to 11% of the total number of species recorded (Table 13-d).

Table 13-d Threatened and potentially threatened plant species in Makonde Scarp I proposed FR

Family	Species name	Conservation status	Habit
DILLENIACEAE	<i>Tetracera boiviniana</i>	PT	S/T
FABACEAE (CAES)	<i>Cassia abbreviata</i>	PT	T
FABACEAE (PAP)	<i>Craibia brevicaudata</i>	PT	T
FABACEAE (PAP)	<i>Millettia impressa</i>	PT	C
RUBIACEAE	<i>Lamprothamnus zanguebaricus</i>	PT	S/T
RUBIACEAE	<i>Rytigynia decussate</i>	PT	S
VERBENACEAE	<i>Vitex mossambicensis</i>	PT	S/T
VERBENACEAE	<i>Vitex zanzibarensis</i>	VU	S

PT = Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

T= Tree, S= Shrub, B= Bamboo, C= Climber, H= Herb

FAUNA

Although the identification of about 90% of the species recorded is certain, the identification of a few specimens remains tentative whilst awaiting taxonomic verification.

Mammals

- *Species richness and composition*

A total of 26 mammals representing 19 families were recorded (Appendix 13).

For the *small mammals* six species representing five families were recorded in total from six captures (not counting eight recaptures) that took place during 200 sherman trapping nights and 50 bucket pitfall trapping nights. Species found were the Multimammate rat (*Mastomys natalensis*), the Lesser pouched rat (*Beamys hindei*) and one species of the White-toothed shrew (*Crocidura* sp.), which were captured in equal numbers of individuals (2) (Appendix 18).

One species of *bat*, the Slit-faced bat (*Nycteris grandis*), was recorded from one capture during 2.7 bat mist net/hours.

For the *larger mammals*, 19 species representing 13 families were recorded during sign transects totaling 3km, and through opportunistic observations and structured interviews. No one species was recorded on more than two separate occasions during the survey. With the exception of the Red-bellied coastal squirrel (*Paraxerus palliatus*), which was sighted in two occasions, all large mammals were recorded by indirect observation, such as vocalizations and dung. Species found included the Small-eared bushbaby (*Otolemur garnetti*), the Southern Africa bushbaby (*Galago moholi*)⁸, the Blue duiker (*Cephalophus monticola*) and the Suni (*Neotragus moschatus*). From interviews it was learnt that the Leopard (*Panthera pardus*), Lion (*Panthera leo*), Spotted hyaena (*Crocuta crocuta*) and Jackal (*Canis adustus*) occasionally pass through the forest. *Panthera pardus* and *P. leo* were last sighted by local inhabitants in 2004 and *Crocuta crocuta* in 2005.

- *Forest dependence, endemism and conservation status*

Three of the species found are forest dependent, although many species often frequent and some favour this habitat (Table 13-e). None of the species found are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains, yet two are rare species with a restricted distribution in eastern Africa. No threatened species were recorded.

⁸ The field identification of *Galago moholi* was undertaken by Frontier-Tanzania research team.

Table 13-e Forest dependent, endemic and threatened mammal species in Makonde Scarp I proposed FR

Species	Common name	Forest dependent	Endemic	Threatened
<i>Otolemur garnetti</i>	Small-eared galago	-	CF, a few other habitats in coastal E Africa	-
<i>Beamys hindoi</i>	Lesser pouched rat	-	EACF, a few other forest types in Kenya and Tanzania	-
<i>Cephalophus monticola</i>	Blue duiker	F	-	-
<i>Cephalophus natalensis</i>	Natal duiker	F	-	-
<i>Neotragus moschatus</i>	Suni	F	-	-

F= Forest dependent or specialist (Burgess *et al.*, 2000a)

CF= species with limited ranges in the Coastal Forests alone; EACF= species with limited ranges in the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

Birds

- *Species richness and composition*

Seventy-eight species from 32 families were recorded in total during 25.5 man/hours of mist netting and six man/hours of timed bird searches. Ten species were detected through mist netting from a total of 13 captures and 68 species through timed searches. Species recorded included the African crowned eagle (*Stephanoaetus coronatus*), the African broadbill (*Smithornis capensis*), the Livingstone's flycatcher (*Erythrocerus livingstonei*) and the Pale batis (*Batis soror*) (Appendix 14).

- *Forest dependence, endemism and conservation status*

Two forest dependent species, the African crowned eagle (*Stephanoaetus coronatus*) and the African broadbill (*Smithornis capensis*) were observed. No strictly endemic or threatened species were recorded in Makonde Scarp I.

Reptiles

- *Species richness and composition*

Nine species of reptile representing six families were recorded from eight captures that took place during 50 bucket pitfall trapping nights and 4.5 man/hours of herpetological searches (Appendices 15 and 18). Most reptiles were found around the base camp where the land was disturbed by clearance for cultivation.

- *Forest dependence, endemism and conservation status*

All reptiles were recorded in cultivated land within the forest reserve. None of the species recorded are forests dependent, and only the Rufus egg-eater (*Dasyplepis medici*) is known to favour the forest habitat. No species were found to be strictly endemic or threatened.

Amphibians

- *Species richness and composition*

Five species of amphibian representing four families were recorded from 42 captures that took place during 50 bucket pitfall trapping nights and 4.5 man/hours of herpetological searches. Species included *Arthroleptis stenodactylus*, *A. xenodactyloides* and *Breviceps mossambicus* (Appendices 16 and 18). *Arthroleptis* sp. made up 95% of captures.

- *Forest dependence, endemism and conservation status*

No species were found to be forest dependent or strictly endemic. *Arthroleptis stenodactylus* and *A. xenodactyloides* are known to favour forest habitat, while *Breviceps mossambicus* is

regarded as a non-forest dwelling species (Howell, 1993). *Arthroleptis xenodactyloides* is listed as Vulnerable (IUCN, 2004).

Butterflies

- *Species richness and composition*

Twenty species of butterfly representing five families were recorded from 30 captures that took place during 15 canopy trapping days and 4.5 sweep net/hours (Appendix 17).

- *Forest dependence, endemism and conservation status*

One species from the family Nymphalidae, the Forest queen (*Euxanthe wakefieldi*), is forest dependent. No species were found to be strictly endemic or threatened.

Fauna's strict endemism

None of the faunal species recorded in Makonde Scarp I proposed FR are endemic to the Coastal Forests and/or Eastern Arc Mountains.

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

Through disturbance transects levels of pole cutting, fire damage, path densities and other forms of disturbance were recorded. Out of sixty 50m sections eight (13%) were found to be free of any form of disturbance. Pole or timber cutting were evident in 47 (78%) sections, 42 (70%) showed signs of fire disturbance, 21 (29%) had been cultivated, five (8%) contained one or more paths cutting through and one (2%) was subject to bark ringing (Figure 5). No traps were detected in any section. Forest resource use is summarised in Table 13-g.

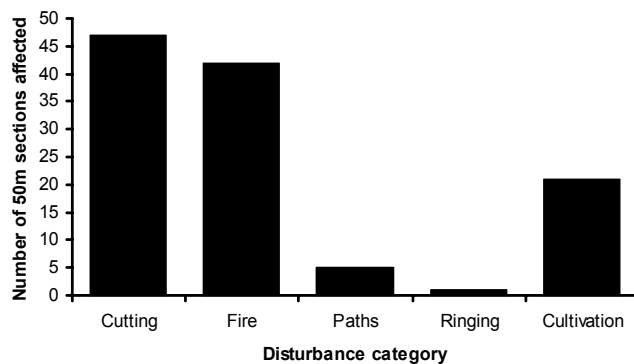


Figure 5 Number of 50m sections (from a total of 52) affected by different forms of human disturbance along transects in Makonde Scarp I proposed FR

Agricultural encroachment

During the survey crops were encountered in all parts of the reserve. Encroachment is so extensive that one cannot walk far within the reserve without crossing cultivated land.

Poles and timbers

Through disturbance transects it was observed that the four main species harvested for timber are *Azelia quanzensis*, *Milicia excelsa*, *Pterocarpus angolensis* and *P. rotundifolius*. Discussions with local communities identified another 12 species that are used for timber and eight species that are used to supply poles (Table 13-g). Evidence of old and recent pit sawing was observed inside the proposed reserve, targeting commercially valuable species (*Azelia quanzensis*, *Pterocarpus angolensis* and *P. rotundifolius*).

- *Relative abundance and average no. of live, dead and cut individuals per ha*

The survey indicates that 21% of all poles, 8% of all timbers and 9% of all large timbers are cut. All cut timber and poles were old apart from one fresh timber cut (Table 13-f).

Table 13-f Summary of pole, timber and large timber cutting in Makonde Scarp I proposed FR

	Total transect length in m	Total no. of indiv. sampled	Total no. (and % RA) of live indiv.	Average live indiv. per ha	Total no. (and % RA) of dead indiv.	Average dead indiv. per ha	Total no. (and % RA) of cut indiv.	Average cut indiv. per ha
Poles	3,000	2182	1688 (77)	563	36 (2)	12	458 (21)	257
Timbers	3,000	447	297 (66)	99	14 (3)	5	36 (8)	12
Large timbers	3,000	11	10 (91)	3	0 (0)	0	1 (9)	0.03

Fuel wood

Residents indicated that collected fuel wood comes from 18 tree species (Table 13-g) and mostly from dead trees or branches.

Tools and utensils

Through discussion it was determined that various species were used in Makonde Scarp II to make items such as cooking utensils, tool handles and ropes (Table 13-g).

Edible non-timber forest products

A total of nine plant species were said by the inhabitants of the area to provide food. The roots of *Dioscorea hirtiflora* were found to be an important source of carbohydrate exploited for sale on local markets (Table 13-g).

Medicinal plants

Twenty-one species were recorded to be used for medicinal purposes (Table 13-g, Appendix 11).

Table 13-g Plant species utilised in Makonde Scarp I proposed FR as identified by field observations, structured interviews and open discussions. Local names, where known, are presented in Appendix 9

Family	Species	Poles	Timber	Fuel wood	Tools	Ropes	Food	Medicine
ANACARDIACEA	<i>Sclerocarya birrea</i>						X	X
ANNONACEAE	<i>Annona senegalensis</i>	X					X	X
APOCYNACEAE	<i>Landolphia buchananii</i>						X	
ARALIACEAE	<i>Cussonia zimmernanii</i>							X
BOMBACACEAE	<i>Ceiba pentandra</i>		X	X				
CHRYSOBALANACEAE	<i>Parinari curatellifolia</i>						X	
COMBRETACEAE	<i>Pteleopsis myrtifolia</i>		X	X				
DILLENIACEAE	<i>Tetracera boiviniana</i>							X
DIOSCOREACEAE	<i>Dioscorea hirtiflora</i>						X	
EBENACEAE	<i>Diospyros kirkii</i>		X					X
FABACEAE (CAES)	<i>Afzelia quanzensis</i>		X	X	X			X

Family	Species	Poles	Timber	Fuel wood	Tools	Ropes	Food	Medicine
FABACEAE (CAES)	<i>Bauhinia petersiana</i>					X		X
FABACEAE (CAES)	<i>Bauhinia tomentosa</i>					X		X
FABACEAE (CAES)	<i>Brachystegia spiciformis</i>	X	X	X		X		
FABACEAE (CAES)	<i>Hymenaea verrucosa</i>		X					
FABACEAE (CAES)	<i>Julbernardia globiflora</i>	X	X	X				
FABACEAE (CAES)	<i>Julbernardia magnistipulata</i>	X		X		X		
FABACEAE (CAES)	<i>Piliostigma thonningii</i>			X		X		
FABACEAE (MIM)	<i>Acacia nigrescens</i>							X
FABACEAE (MIM)	<i>Albizia amara</i>		X					
FABACEAE (MIM)	<i>Albizia gummifera</i>		X	X	X			
FABACEAE (MIM)	<i>Albizia versicolor</i>	X	X	X				
FABACEAE (PAP)	<i>Lonchocarpus bussei</i>							X
FABACEAE (PAP)	<i>Lonchocarpus capassa</i>			X	X			X
FABACEAE (PAP)	<i>Pterocarpus angolensis</i>		X	X	X			X
FABACEAE (PAP)	<i>Pterocarpus rotundifolius</i>		X	X				
FABACEAE (PAP)	<i>Dalbergia melanoxydon</i>	X	X	X	X			
FABACEAE (PAP)	<i>Scorodophloeus fischeri</i>	X						
FLACOURTIACEAE	<i>Flacourtia indica</i>							X
LOGANIACEAE	<i>Strychnos cocculoides</i>	X		X	X			
LOGANIACEAE	<i>Strychnos madagascariensis</i>							X
MORACEAE	<i>Milicia excelsa</i>		X	X	X			X
MYRTACEAE	<i>Syzygium cordatum</i>		X	X			X	
MYRTACEAE	<i>Syzygium cumini</i>						X	
OCHNACEAE	<i>Ochna holstii</i>							X
POLYGALACEAE	<i>Securidaca longipedunculata</i>							X
RUBIACEAE	<i>Vangueria infausta</i>							X
RUTACEAE	<i>Zanthoxylum chalybeum</i>							X
SAPOTACEAE	<i>Bequaertiodendron natelense</i>							X
STERCULIACEAE	<i>Sterculia appendiculata</i>		X	X	X			
VERBANACEAE	<i>Vitex doniana</i>						X	
VERBENACEAE	<i>Vitex zanzibarensis</i>			X				

Hunting

The populations of Chidya and Chiwata hunt within Makonde Scarp I. It transpired from interviews and discussions that hunting is largely indiscriminate with a wide variety of animals taken. These include the Chequered elephant shrews (*Rhynchocyon cirnei*), a species listed as Vulnerable, and the Natal duiker (*Cephalophus natalensis*), a species listed as conservation dependent (IUCN, 2004) (Appendix 12).

Local management

Makonde Scarp I FR is only proposed, therefore at present no management plan is in place, no patrolling of the FR boundaries is conducted and no laws are enforced to protect the area.

DISCUSSION**FLORA**

Makonde Scarp I proposed FR falls under the degraded eastern African coastal *Brachystegia* forest category. Much of this proposed reserve has been converted to farmland, with the little forest remaining consisting of secondary forest that is regenerating following past disturbance, as demonstrated by the small to medium size of most trees. Even though disturbance from timber extraction has changed the physiognomy of the canopy layer into a more open configuration, the presence of a dense shrub layer dominated by Swahilian endemic species and the sparse character of the grass layer still distinguish this vegetation type from the ‘miombo’ *Brachystegia* woodland of the Zambebian regional centre of endemism (Clarke and Robertson, 2000). The presence of saplings of the dominant canopy and sub canopy species in the shrub layer indicates that the forest has approached a climax stage, where no species different from the dominant ones are colonising and replacing them (Schmidt, 1991).

In Makonde Scarp I proposed FR the high degree of encroachment and timber extraction accounts for the low number of species found (73). However, the Shannon diversity index for this forest reserve ($H^1=2.95$) is moderately high, reflecting a community in succession (Magurran, 1988), where a relatively high number of species, and particularly understory species, can colonise the area and reach high rates of population growth following the removal of more competitive canopy trees (Ndangalasi, 1997). If this forest could be allowed to fully regenerate, and canopy and sub canopy species to achieve their potential population size, then the species diversity would be expected to decline. However, human activities (particularly cultivation) have continued to interrupt the regeneration of this forest from degraded to fully developed Eastern Africa coastal *Brachystegia* forest. These activities also threaten some important plant species present here, such as *Vitex zanzibarensis* (Endemic and Vulnerable), *Commiphora zanzibarica*, *Erythrina schliebenii*, *Lamprothamnus zanguebaricus*, *Rytigynia decussata* and *Vitex mossambicensis* (Endemic and Potentially Threatened).

FAUNA

In Makonde Scarp I proposed FR the species composition within most taxa reflects the high level of clearance for agriculture, timber extraction and burning and the consequent dryness of the environment in this reserve (Zullini, 2003; Begon *et al.*, 1996). Research carried out in small patches of *Brachystegia* forest yielded a relatively high number of species (138), some of which are forest dependent. However, large sections of the proposed reserve have already been converted into farmland or cut for timbers and poles, and if resource extraction is not regulated the species richness may gradually decline (Zullini, 2003; Begon *et al.*, 1996).

Small mammals

For the small mammals the overall number of species (3) and individuals (6) captured was low, reflecting the high incidence of deforestation for timber and agriculture in this reserve (see Human Resource-Use and Local Management section) and the open and dry habitat resulting from it (Zullini, 2003; Begon *et al.*, 1996). The Lesser pouched rat (*Beamys hindei* - near threatened) found here is a relic species endemic to a few forest types in Kenya and Tanzania, including the coastal and mountain forests of the EACF hotspot. Until recently it was regarded as one of the rarest rodents in Africa (Groombridge, 1994) but it is now known to be more widespread. In Makonde Scarp I this species was found in small pockets of regenerating *Brachystegia* forest on the edge of cultivated land, and this emphasises its vulnerability to further habitat degradation (Kingdon 1993). *Mastomys natalensis* is known to frequent a variety of habitats and in southern Tanzania is a prolific and recurrent member of the rodent community (Kingdon, 1993), as recorded by this study. One species of White-toothed shrew (*Crocidura* sp.) was recorded. The shrews of the Coastal Forests of Tanzania are poorly known and already there are five unidentified species that have been collected from these forests, each from a separate site (Burgess and Clarke, 2000). It is likely that shrews collected from this survey will yield interesting results once taxonomic verification is accomplished. None of the species recorded are forest dependent or threatened, the lack of forest dependent species reflecting the disturbed and open habitat found here.

Bats

Only one species of bat, the Slit-faced bat (*Nycteris grandis*), was recorded from a single capture. This is a forest dwelling species commonly found in forest and forest relics across tropical Africa (Kingdon, 1974). Therefore, as the forest is degraded here this species is locally vulnerable.

Large mammals

Although the overall number of large mammal species recorded (19) was relatively high, the number of individuals for each species was low, no one species being recorded more than twice. This suggests that the populations of all species are suppressed due to a significant degree of disturbance in this reserve (see Human-Resources Use and Local Management section), a factor that has decreased the extent of suitable habitat and ecological requirements (e.g. prey, shelter) available to support larger populations. The Suni (*Neotragus moschatus* - conservation dependent), the Natal duiker (*Cephalophus natalensis* - conservation dependent), the Blue duiker (*Cephalophus monticola* - CITES II) and the Red-bellied coastal squirrel (*Paraxerus palliatus*) are forest dependent and therefore vulnerable to further encroachment and degradation of the forest reserve. It is possible that *Paraxerus palliatus* recorded here has hybridized with the Smith's bush squirrel (*Paraxerus cepapi*) (Kingdon, 2003). Further research needs to be conducted on the hybrids of *Paraxerus* in this region of Tanzania as very little is known. Most other large mammals recorded only occasionally frequent the forest and therefore will be less affected by encroachment. Nevertheless, these species may need this reserve as a corridor between suitable patches of habitat or for alternative sources of food and shelter. Predators such as the Lion (*Panthera leo* - Vulnerable, CITES II) and the Spotted hyena (*Crocuta crocuta* - conservation dependant) were reported to occur in this forest by inhabitants of adjacent villages and farms. These species are able to utilize different habitats and to adapt well to changes in their environment, and so are likely to be less threatened by further forest degradation. Nevertheless, any reduction in habitat will reduce the visits of these animals as shelter and populations of preyed animals are likely to decrease. Further research needs to be conducted to assess the extent of reliance of large mammals and predators on Makonde Scarp I proposed FR. *Panthera pardus* was reported to occur here and in the adjacent Makonde Scarp II proposed FR and Kambona FR. This species is listed on CITES Appendix I (2005) as a species threatened with extinction and therefore excluded from international trade, and if its presence in these sites will be confirmed then its

protection will be necessary. No large mammal species were found to be strictly endemic to the Coastal Forests and/or Eastern Arc Mountains, but the Small-eared bushbaby (*Otolemur garnetti* - CITES II) has a restricted distribution in the Coastal Forests and a few other habitats in coastal eastern Africa (Burgess *et al.*, 2000). The South African bushbaby (*Galago moholi* - CITES II) is an arboreal species usually found in the semiarid scrub woodlands and savanna grasslands of central southern Africa (Alvarado, 2000). The finding of this species in the Coastal Forest Mosaic of southern Tanzania therefore represents a range extension.

Birds

Even though only two forest dependent species, the African crowned eagle (*Stephanoaetus coronatus* - CITES II) and the African broadbill (*Smithornis capensis*), were detected here, a high number of species (78) were recorded. This probably reflects the proximity of this reserve to the ridges of the Makonde Scarp, where the topographic variation of the escarpment creates a variety of habitats and nesting sites for birds. High species richness is also favoured by the dense understory of the *Brachystegia* forest remaining in this reserve (Mlingwa *et al.*, 2000) (see Flora section). None of the species recorded here are endemic to the Coastal Forests and/or Eastern Arc Mountains and none are listed as threatened by the IUCN Red List (2004). However, Makonde Scarp I proposed FR constitutes part of the Newala District Coastal Forests IBA (TZ053 - category A1) (BirdLife International, 2005) because of the presence of more than a threshold population of the Southern banded snake eagle (*Circaetus fasciolatus*), a species categorized by the IUCN Red List as near threatened. Even though *C. fasciolatus* was not recorded in Makonde Scarp I proposed FR during this study, this species was recorded in adjacent Kambona FR and Makonde Scarp II proposed FR and is therefore likely to occur also in Makonde Scarp I proposed FR. Unfortunately, much of the forest has been converted to farmland, so drastically reducing the habitat for birds.

Reptiles

Local knowledge suggested that snakes and reptiles in general should be abundant in this reserve. The low numbers of species (8) and individuals (8) captured may therefore be a consequence of the rapid nature of this study, which did not permit comprehensive collection of data during the wet season and the study of fossorial species (Broadley and Howell, 2000). However, low numbers may also reflect the largely open and dry environment that has resulted from high levels of encroachment, timber extraction and burning in this reserve (Zullini, 2003; Begon *et al.*, 1996) (see Human Resource-Use and Local Management section). In fact, of all the species recorded only the Rufus egg-eater (*Dasypeltis medici*) is known to favour a forested habitat, and none of the species recorded are forest dependent (Spawls *et al.*, 2002).

Amphibians

The number of amphibian species captured (5) was low and reflects the open and dry nature of large part of the reserve (Zullini, 2003; Begon *et al.*, 1996). Apart from *Arthroleptis* species, all species are non-forest dwellers and non-forest dependent, and were captured in high numbers (42) in cultivated land as well as in small patches of regenerating *Brachystegia* forest. The intrusion into forested areas by species that normally inhabit transient open situations is known to be a recurrent characteristic encouraged by the heterogeneous pattern of the Coastal Forest Mosaic, whereby such species breed in their open habitat but enter the enclosed habitat for refuge, especially during dry periods (Poynton, 2000). *Arthroleptis stenodactylus* and *A. xenodactyloides* favour a forested habitat as they rely on the presence of damp soil and loose leaf mould protected from shrub and canopy cover to lay their eggs (Howell, 1993). Consequently, the Dwarf squeaker (*Arthroleptis xenodactyloides*) is listed as Vulnerable (IUCN, 2004) and both species may become locally threatened by further loss of forest habitat.

Butterflies

For the butterflies there was a moderate number of species (20) and individuals (30) recorded. This reserve contains small patches of regenerating *Brachystegia* forest with a dense understory (see Flora section) where re-colonisation by forest dependent species such as the Forest queen (*Euxanthe wakefieldi*) is taking place. However, most of this reserve has been converted to farmland and consequently most butterfly species recorded are non-forest dwellers.

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

Population growth in the areas adjacent to Makonde Scarp I proposed FR has accelerated and the demand on land for cultivation and wood for building has resulted in severe degradation of the forest reserve. Most of the farmers that were moved out when the area was proposed to be a reserve are now going back to their shambas (cultivated land), in part because of the failure of the government to fully compensate their relocation in new houses and farms (Baldus *et al.*, 2004).

Natural resource use in Makonde Scarp I proposed FR is widespread with various species being exploited for timber, poles, fuel wood, food, medicines and other products. The most urgent problem is the clearing of new land for agriculture. This problem is exacerbated by the practice of shifting cultivation, where people clear new land after exhausting the fertility of the previously cultivated land. Hunting also appears to be largely indiscriminate with a wide variety of animals taken. These include the Chequered elephant shrews (*Rhynchocyon cirnei*), a species listed as Vulnerable, and the Natal duiker (*Cephalophus natalensis*), a species listed as conservation dependent (IUCN, 2004) (Appendix 12).

14. MAKONDE SCARP II PROPOSED FOREST RESERVE



Status	Proposed Forest Reserve
Management Body	Central Government
Location	Newala district. The proposed site starts north east of Lulindi and continues south easterly along the escarpment, ending just before Newala town.
Area	1,554ha
Altitude	550-780m asl
Topography	Lowland plain and gentle lower slope
Temperature	Min: 19°C, Max: 30°C (recorded 28 April - 2 May, dry season)
Rainfall	Average 0.3mm (recorded 28 April - 2 May, dry season)
Soil type	Sandy-loam
Vegetation Type	Eastern African coastal <i>Brachystegia</i> forest, Mixed scrub forest and Thicket
Land Use	The reserve was proposed to preserve the soil on the plateau and scarp and to protect a water source and catchment. Areas are used for agriculture, especially cashew, rice and maize plantations (shifting cultivation is common practice). Brick making occurs, along with timber and pole cutting and hunting.
History and Status	Signs of habitat destruction on the escarpment were noticed and documented in the 1940's (Maganga, 2004). Makonde Scarp II was agreed to be a proposed forest reserve in 1976, the same year as funding for boundary beacons was made available. In 1977 some residents were moved from the escarpment and relocated. In 1980-81 complaints by people who had been moved off their original properties were acknowledged, concluding that TSh 40 million was needed for compensation. Compensation of TSh 1.7 million was made available to Masasi District in 1983 and 1984 but no subsidies

were made available to Newala and Tandahimba districts. Presently the site is not yet fully gazetted and there are no boundary markers. There is no staff, effective capacity or resources to enforce protected area legislation and regulations.

Maps

Topographical map: Lulindi sheet 306/3 and Newala sheet 306/4, East Africa 1:50 000, 1968. From the Institute of Mapping, Dar es Salaam (from Series Y742, Edition 1-TSD).

METHODS

Survey work was conducted over seven days (27 April - 2 May 2005). Five vegetation plots (4800m²), five regeneration plots (48m²), and one zoosite were carried out, incorporating 200 sherman trapping nights, 50 bucket trapping nights, 4.5 man/hours of timed herpetofauna searches, four bat mist net/hours, eight man/hours of timed bird searches, 15 canopy trapping days, six butterfly sweep net/hours, four animal sign transects (totalling 16,000m²), four disturbance transects (totalling 40,000m²), and opportunistic observations (see Appendices 2 to 8 for GPS coordinates and work site descriptions). Ornithological work was conducted on separate days (1-2 July 2005). Bird mist netting was not conducted in this reserve as the camp was located some distance from the escarpment and in order to avoid theft nets could not be left unattended. Habitat notes were taken for the vegetation plots (Appendices 4 and 5) and zoological trap sites (Appendix 6). Structured interviews and open discussions were conducted with four elders from the villages of Chiwambo juu and Nyambunga. For a detailed break down of survey effort see Table 10-a.

RESULTS

In Makonde Scarp II proposed FR 76 plant species were recorded from 22 families. Eight percent of the total number of floral species are endemic to the Swahilian region *sensu lato* and 12% are listed as threatened (IUCN, 2004) or potentially threatened (Gereau and Luke, 2006) (Table 14-a; Appendices 9 and 10).

The forest reserve has 99 faunal species found within 54 families. Of these species 2% are forest dependent, 1% are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains and 2% are listed as threatened by IUCN (2004) and/or CITES (2005) (Table 14-a; Appendices 13-17).

Table 14-a Summary of fauna and flora recorded in Makonde Scarp II proposed FR

Taxa	No. of families	No. of species ^c	No. of forest dependent species ^d	No. of wide-spread species	No. of strictly endemic species: ^e and ^f	No. of threatened species: ^g and ^h	No. of PT species ⁱ
Mammals	15	18	1	17	0	1	-
Birds ^a	30	64	0	64	0	1	-
Reptiles	4	7	0	7	0	0	-
Amphibians	2	2	0	2	1	0	-
Butterflies	3	8	1	7	0	0	-
Total for animals	54	99	2	97	1	2	-
Flora ^b	22	76	0	70	6	3	7
Combined Total	76	175	2	167	7	5	6

a - Includes birds seen on the forest boundary edge

b - All trees, shrubs, herbs, grasses and ferns

c - Includes information collected from all systematic survey work, opportunistic observations, structured interviews and open discussions

d - Species dependent on and associated with primary or closed-canopy forest, not forest edge or secondary forest

e - Faunal species with limited ranges in the Coastal Forests alone or the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a), sometimes being found also in other habitats in a few adjacent locations (e.g. Masasi District in S Tanzania, N Mozambique etc.)

f - Floral species restricted to the Swahilian region *sensu lato* (Clarke and Robertson, 2000)

g - Species listed as Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) in the IUCN Red List (IUCN, 2004)

h - Species listed in CITES Appendix I as threatened with extinction and excluded from international trade (CITES, 2005)

i - Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

*The identification of *Crocidura* sp. may increase this number. We await verification

FLORA

In Makonde Scarp II proposed FR three homogeneous vegetation stands were observed, which were identified as *Brachystegia* forest, Mixed scrub forest and Thicket, interrupted by cultivated and fallow farmland.

- *Species richness and diversity*

A total of 76 species were recorded. Out of these, 42 species were found in 12 vegetation plots and 17 in 12 regeneration plots. The remaining 17 species were recorded from opportunistic collection. More specifically, 32 trees, 36 shrubs and eight grasses were recorded (Appendix 9). A value of 3.01 was calculated for the Shannon diversity index.

- *Species dominance*

In the eastern African coastal *Brachystegia* forest *Brachystegia spiciformis* was the most frequent species in the canopy layer (29% of the plots), accompanied by *Albizia gummifera*, *Pterocarpus rotundifolius*, *Pterocarpus angolensis* and *Albizia versicolor* (14% of the plots respectively) (Table 14-b). No species were found to occur in more than 40% of the plots to be ranked as frequent or dominant (Mueller-Dombois and Ellenberg, 1974).

Table 14-b Species frequency, dominance, rank dominance, no. of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the canopy layer in *Brachystegia* forest in Makonde Scarp II proposed FR

Family	Genus	Species	F	% RF (Dominance)	Rank dominance	No. of indiv. in all plots	% RA	Rank RA
FABACEAE (CAES)	<i>Brachystegia</i>	<i>spiciformis</i>	2	29	1	4	5	1
FABACEAE (MIM)	<i>Albizia</i>	<i>gummifera</i>	1	14	2	3	4	2
FABACEAE (PAP)	<i>Pterocarpus</i>	<i>rotundifolius</i>	1	14	2	3	4	2
FABACEAE (MIM)	<i>Albizia</i>	<i>versicolor</i>	1	14	2	2	3	3
FABACEAE (PAP)	<i>Pterocarpus</i>	<i>angolensis</i>	1	14	2	2	3	3
Total¹	3	3	5			14	19	
Total²	18	23	30			78	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

In the sub canopy layer *Cassia didymobotrya* and *Diplorhynchus condylocarpon* were the most dominant, each one occurring in 29% of the plots, while *Cussonia arborea*, *Schefflera barteri* and *Sclerocarya birrea* occurred in 14% of the plots respectively (Table 14-c). None of the species were found to occur in more than 40% of the plots to be ranked as frequent or dominant (Mueller-Dombois and Ellenberg, 1974).

Table 14-c Species frequency, dominance, rank dominance, no. of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the sub canopy layer in *Brachystegia* forest in Makonde Scarp II proposed FR

Family	Genus	Species	F	% RF (Dominance)	Rank dominance	No. of indiv. in all plots	% RA	Rank RA
FABACEAE (CAES)	<i>Cassia</i>	<i>didymobotrya</i>	2	29	2	8	10	1
APOCYNACEAE	<i>Diplorhynchus</i>	<i>condylocarpon</i>	2	29	2	6	8	2
ARALIACEAE	<i>Cussonia</i>	<i>arborea</i>	1	14	3	2	3	3
ARALIACEAE	<i>Schefflera</i>	<i>barteri</i>	1	14	3	1	1	4
ANACARDIACEAE	<i>Sclerocarya</i>	<i>birrea</i>	1	14	3	1	1	4
Total¹	4	5	5			18	23	
Total²	18	23	30			78	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

Mixed scrub forest was dominated by *Parinari curatellifolia*, occurring in 57% of the plots and ranking as the most dominant species (Table 14-d). Other species found in the canopy layer were *Cassia didymobotrya* and *Diplorhynchus condylocarpon*, both occurring in 29% of the plots, and *Hymenocardia ulmoides* and *Pteleopsis myrtifolia*, each occurring in 14% of the plots.

Table 14-d Species frequency, dominance, rank dominance, no. of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the canopy layer in Mixed scrub forest in Makonde Scarp II proposed FR

Family	Genus	Species	F	% RF (Dominance)	Rank dominance	No. of indiv. in all plots	% RA	Rank RA
CHRYSOBALANACEAE	<i>Parinari</i>	<i>curatellifolia</i>	4	57	1	16	20	1
FABACEAE (CAES)	<i>Cassia</i>	<i>didymobotrya</i>	2	29	2	8	10	2
APOCYNACEAE	<i>Diplorhynchus</i>	<i>condylocarpon</i>	2	29	2	6	8	3
HYMENOCARDIACEAE	<i>Hymenocardia</i>	<i>ulmoides</i>	1	14	3	3	4	4
COMBRETACEAE	<i>Pteleopsis</i>	<i>myrtifolia</i>	1	14	3	2	3	5
Total¹	5	5	5			35	45	
Total²	18	23	30			78	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

In the Thicket *Strychnos madagascariensis* and *Ochna kirkii* were the most frequent species, both occurring in 29% of the plots sampled, while *Flacourtia indica*, *Securidaca longipedunculata* and *Ochna holstii* occurred in 14% of the plots respectively (Table 14-e). None of the species were found to occur in more than 40% of the plots to be ranked as frequent or dominant (Mueller-Dombois and Ellenberg, 1974).

Table 14-e Species frequency, dominance, rank dominance, no. of individuals, % relative abundance and rank relative abundance for the top five most abundant species in Thicket in Makonde Scarp II proposed FR

Family	Genus	Species	F	% RF (Dominance)	Rank dominance	No. of indiv. in all plots	% RA	Rank RA
LOGANIACEAE	<i>Strychnos</i>	<i>madagascariensis</i>	2	29	1	4	5	1
OCHNACEAE	<i>Ochna</i>	<i>kirkii</i>	2	29	1	2	3	2
FLACOURTIACEAE	<i>Flacourtia</i>	<i>indica</i>	1	14	2	4	5	1
POLYGALACEAE	<i>Securidaca</i>	<i>longipedunculata</i>	1	14	2	4	5	1
OCHNACEAE	<i>Ochna</i>	<i>holstii</i>	1	14	2	2	3	2
Total¹	4	4	4			16	21	
Total²	18	23	30			78	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

- *Species relative abundance*

In eastern African coastal *Brachystegia* forest the most abundant species in the canopy layer were *Brachystegia spiciformis*, *Albizia gummifera* and *Pterocarpus rotundifolius*, together contributed only 13% of all the species sampled in this layer (Table 14-b). In the sub canopy layer *Cassia didymobotrya* and *Diplorhynchus condylocarpon* made up 10% and 8% each of all the individuals sampled (Table 14-c).

In Mixed scrub forest *Parinari curatellifolia* was the most abundant species in the canopy layer, making up 20% of the trees recorded, while *Cassia didymobotrya*, *Diplorhynchus condylocarpon* and *Hymenocardia ulmoides* made 10%, 8% and 4% respectively (Table 14-d).

In the Thicket *Strychnos madagascariensis*, *Flacourtia indica* and *Securidaca longipedunculata* contributed 5% each of all individuals in this vegetation type (Table 14-e).

When looking at the overall number of trees recorded in both the canopy and sub canopy layers, the canopy layer (71%) contributed a higher number of individuals than the sub canopy layer (29%) to the overall number of adult trees in this reserve.

- *Species composition and vegetation types*

In Makonde Scarp II proposed FR three homogeneous vegetation stands were observed. On the western side of the escarpment, near to Chiwambo Chini village, **eastern African coastal Brachystegia forest** was found. On the plateau the vegetation was mainly comprised of **Mixed scrub forest**, while down the escarpment to the south, east and north of Chiwambo juu village, the vegetation graded into **Thicket** (Clarke and Robertson, 2000).

In the eastern African coastal *Brachystegia* forest, the canopy layer was characterised by species such as *Brachystegia spiciformis*, *Albizia gummifera*, and *Pterocarpus rotundifolius*, and the sub canopy layer by *Cassia didymobotrya* and *Diplorhynchus condylocarpon*. Other species occurring in the canopy layer included *Albizia versicolor*, *Pterocarpus angolensis*, *Julbernardia globiflora*, *Millettia stuhlmannii*, *Pericopsis angolensis* and *Terminalia brownii*. In the sub canopy layer we observed *Cussonia arborea*, *Schefflera barteri*, *Sclerocarya birrea*, *Lonchocarpus capassa*, *Maerua* sp., *Craibia brevicaudata* and *Lonchocarpus bussei*. The shrub layer was observed to be comprised of saplings of the dominant species from the canopy and sub canopy layers, and shrub species such as *Salacia madagascariensis*, *Strychnos usambarensis*, *Strychnos madagascariensis*, *Ochna holstii*, *Catunaregam spinosa*, *Vangueria infausta*, *Vangueriopsis* sp. and various species from the genus *Combretum*. The herbaceous layer was comprised of grasses, particularly *Sporobolus* sp., *Themeda triandra*, *Digitaria* sp., and *Panicum maximum*. Herbs found in association with these grasses were *Dicoma tomentosa*, *Hypoestes* sp. and *Jasminum* sp. These herbs were recorded as dominant on the edge of cultivated land and open areas where grasses have been removed by fire or cultivation.

Mixed scrub forest was recognised by the presence of *Parinari curatellifolia* in the canopy, an interspersed emergent typical of this forest type, as well as species such as *Hymenocardia ulmoides* and *Pteleopsis myrtifolia*. In the shrub layer the presence of *Strychnos madagascariensis* and *Strychnos cocculoides* confirmed the classification of this forest type as Mixed scrub forest. Herbs here were missing, leaving only grasses such as *Heteropogon contortus*, *Themeda triandra* and *Digitaria* sp. to characterise the herbaceous layer.

Thickets were typically characterised by the absence of canopy and sub canopy layers, and were comprised mainly of shrub species such as *Strychnos madagascariensis*, *Ochna kirkii*, *Flacourtia indica*, *Securidaca longipedunculata* and *Ochna holstii*. Other shrub species recorded included *Vangueria infausta*, *Strychnos spinosa* and *Bequaertiodendron natalense*. No herbs or grasses were recorded underneath the thicket.

- *Endemism and conservation status*

Seven of the species recorded were found to be endemic to Swahilian region *sensu lato*, including *Monodora grandidieri*, *Monanthes fornicata*, *Tetracera boiviniana*, *Gardenia transvenulosa*, *Lamprothamnus zanguibaricus*, *Grewia lepidopetala* and *Vitex zanzibarensis*, (Clarke and Robertson, 2000) (Appendix 10). This amounted to 8% of the total number of species recorded (Figure 6).

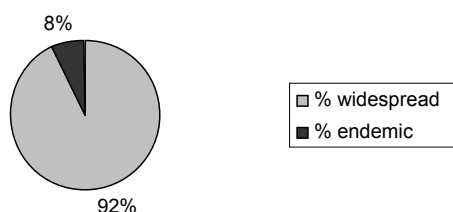


Figure 6 Percentage floral species endemic to the Swahilian region *sensu lato* and those that are widespread in Makonde Scarp II proposed FR

Ten among the species recorded are recognised to be threatened (IUCN, 2004) or potentially threatened (Gereau and Luke, 2006), amounting to 12% of the total number of species recorded (Table 14-f).

Table 14-f Threatened and potentially threatened plant species in Makonde Scarp II proposed FR

Family	Species name	Conservation status	Habit
ANNONACEAE	<i>Monanthes trichocarpa</i>	PT	C/S
ANNONACEAE	<i>Monanthes fornicata</i>	PT	S
DILLENIACEAE	<i>Tetracera boiviniana</i>	PT	S/T
FABACEAE (CAES)	<i>Cassia abbreviata</i>	PT	T
FABACEAE (PAP)	<i>Craibia brevicaudata</i>	PT	T
FABACEAE (PAP)	<i>Millettia impressa</i>	PT	C
MELIACEAE	<i>Khaya anthotheca</i>	VU	T
RUBIACEAE	<i>Gardenia transvenulosa</i>	VU	S/T
RUBIACEAE	<i>Lamprothamnus zanguebaricus</i>	PT	S/T
VERBENACEAE	<i>Vitex zanzibarensis</i>	VU	S

PT = Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

T= Tree, S= Shrub, B= Bamboo, C= Climber, H= Herb

FAUNA

Although the identification of about 90% of the species recorded is certain, the identification of a few specimens remains tentative whilst awaiting taxonomic verification.

Mammals

- *Species richness and composition*

A total of 18 mammals representing 15 families were recorded (Appendix 13).

For the *small mammals* seven species representing five families were recorded from seven captures (not counting three recaptures) that took place during 200 sherman trapping and 50 bucket pitfall trapping nights (Table 10-a). Common species found were the Multimammate rats (*Mastomys natalensis*) and the Spiny mouse (*Acomys spinosissimus*) making up 55% of all captures. Other species included the Mouse (*Mus minutoides*) and a species of the White-toothed shrew (*Crocidura* sp.) (Appendix 18).

No bats were recorded during six bat mist net/hours.

For the *larger mammals*, 11 species representing 10 families were recorded during sign transects totalling 4km, through opportunistic observations and from local knowledge (Appendix 13). Species found included the Greater galago (*Otolemur crassicaudatus*) and the Natal duiker (*Cephalophus natalensis*). Signs from each species were not observed more than twice. The discovery of a foot print of a Leopard (*Panthera pardus*) confirms records of its presence from local knowledge. From interviews with local communities it was also learnt that the Lion (*Panthera leo*), Spotted hyena (*Crocuta crocuta*) and Jackal (*Canis adustus*) occasionally pass through the proposed forest reserve.

- *Forest dependence, endemism and conservation status*

One species, the Natal duiker (*Cephalophus natalensis*), was found to be forest dependent, although many other often frequent and some favour a forested habitat. None of the species recorded are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains, and only one species is listed as threatened (Table 14-g).

Table 14-g Forest dependent, endemic and threatened mammal species in Makonde Scarp II proposed FR

Species	Common name	Forest dependent	Endemic	Threatened
<i>Panthera pardus</i>	Leopard	-	-	CITES I
<i>Cephalophus natalensis</i>	Natal duiker	F	-	-

F= Forest dependent or specialist (Burgess *et al.*, 2000a)

CF= species with limited ranges in the Coastal Forests alone; EACF= species with limited ranges in the in the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

CITES I = Threatened with extinction and excluded from international trade;

Birds

- *Species richness and composition*

Sixty-four species from 30 families were detected during eight man/hours of timed bird searches. Species included the Brown-breasted barbet (*Lybius melanopterus*), the Pale batis (*Batis soror*) and the Livingstone's flycatcher (*Erythrocercus livingstonei*) (Appendix 14).

- *Forest dependence, endemism and conservation status*

The Peregrine falcon (*Falco peregrinus*) is listed on CITES Appendix I (2005) as threatened with extinction and therefore excluded from international trade. No forest dependent or strictly endemic species were found in Makonde Scarp II proposed FR.

Reptiles

- *Species richness and composition*

Seven species of reptiles representing four families were recorded from seven captures that took place during 50 bucket pitfall trapping nights and 4.5 man/hours of herpetological searches. Species included the Burrowing asp (*Mehelya nyassae* juv.), the White-lipped snake (*Crotaphopeltis hotamboeia*), the Nile monitor (*Varanus niloticus*), the Savanna vine snake (*Thelotornis capensis oatesi*)⁹, a species of skink (*Trachylepis* sp.)¹⁰ and the Mozambique agama (*Agama mossambica*) (Appendices 15 and 18).

⁹ The identification of *Thelotornis capensis oatesi* was carried out by Michele Menegon (Appendix 1). We are awaiting taxonomic confirmation.

¹⁰ The Afro-magalian mabuyas have been recognised to constitute a separate genus and have been renamed *Trachylepis* sp. For the partitioning of the genus *Mabuya* see Mausfeld *et al.* (2002); for the taxonomy and nomenclature of *Trachylepis* sp. see Honda *et al.* (2003) and Whiting *et al.* (2003).

- *Forest dependence, endemism and conservation status*

No species were found to be forest dependent, strictly endemic or threatened.

Amphibians

- *Species richness and composition*

Two species of amphibians representing two families were recorded from two captures that took place during 50 bucket pitfall trapping nights and 4.5 man/hours of herpetological searches. Species included *Arthroleptis stenodactylus* and *Mertensophryne micranotis* (Appendices 16 and 18).

- *Forest dependence, endemism and conservation status*

Mertensophryne micranotis is endemic to the Eastern Arc lowland and the Coastal Forest Mosaic of south-eastern Kenya and eastern Tanzania. No species were found to be forest dependent. *Arthroleptis stenodactylus* favours forest habitats but is not forest dependent (Howell, 1993). No threatened species were recorded.

Butterflies

- *Species richness and composition*

Eight species of butterfly representing three families were recorded from 11 captures that took place during 15 canopy trapping days and 4.5 sweep net/hours (Appendix 17). The Large blue charaxes (*Charaxes bohemani*) accounted for 36% of all captures.

- *Forest dependence, endemism and conservation status*

No species were found to be forest dependent, strictly endemic or threatened.

Fauna's strict endemism

None of the faunal species recorded in Makonde Scarp II are endemic to the Coastal Forests and/or Eastern Arc Mountains.

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

Through disturbance transects, levels of pole cutting, fire damage, path densities and other forms of disturbance were recorded. Out of seventy-nine 50m sections, only three (4%) were found to be free from disturbance. Sixty-nine (87%) were subject to pole/timber cutting, 58 (73%) showed signs of fire disturbance and 33 (41%) had been cultivated. Fifteen (19%) were bisected by one or more paths, two (3%) were subject to bark ringing and one (1%) contained a trap (Figure 7). Forest resource use is summarised in Table 14-i.

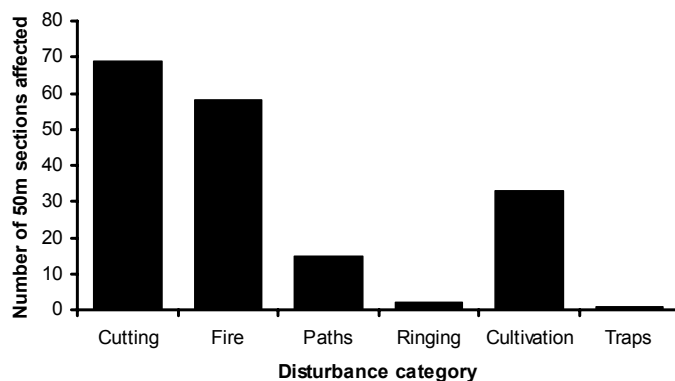


Figure 7 Number of 50m sections (from a total of 76) affected by different forms of human disturbance along transects in Makonde Scarp II proposed FR

Agricultural encroachment

The wooded grassland on top of the scarp was found to have been reduced to a very narrow strip at the edge of the scarp. The presence of a brick factory was recorded. Some areas on the side of the escarpment still support woodland with some large individual trees, but most of it has been cleared and converted to farmland or has regenerated into Thicket. Rice, maize and groundnuts were observed growing on the slopes of the escarpment. The foot of the scarp hosted very few undisturbed areas, most having been converted for agriculture.

Poles and timbers

According to the inhabitants of the area, timber in Makonde Scarp II proposed FR is derived from 15 tree species (Table 14-i). Disturbance transects and information from the residents showed the extensive exploitation of four preferred species (*Azelia quanzensis*, *Milicia excelsa*, *Pterocarpus angolensis* and *P. rotundifolius*). Disturbance transects revealed that 10 species in total are exploited to obtain poles for building materials. No currently active or old pit sawing sites were recorded.

- *Relative abundance and average no. of live, dead and cut individuals per ha*

From disturbance transects the level of pole and timber cutting within the proposed area was determined to be 27% and 19% respectively, with no evidence of large cut timbers. No fresh cut poles or timbers were recorded (Table 14-h).

Table 14-h Summary of pole, timber and large timber cutting in Makonde Scarp II proposed FR

	Total transect length in m	Total no. of indiv. sampled	Total no. (and % RA) of live indiv.	Average live indiv. per ha	Total no. (and % RA) of dead indiv.	Average dead indiv. per ha	Total no. (and % RA) of cut indiv.	Average cut indiv. per ha
Poles	3,950	2669	919 (34)	258	52 (2)	13	727 (27)	184
Timbers	3,950	310	225 (73)	57	27 (9)	7	58 (19)	15
Large timbers	3,950	0	0 (0)	0	0 (0)	0	0 (0)	0

Fuel wood

Residents indicated a total of 18 species (Table 14-i) that are utilised as fuel wood.

Tools and utensils

Various species were found to be used in Makonde Scarp II to make items such as cooking utensils, tool handles and ropes (Table 14-i). Two 50m sections were found to contain one ringed tree each, the trees being dead. Species targeted to make beehives included *Brachystegia longifolia*, *Brachystegia spiciformis*, *Piliostigma thonningii* and *Vitex doniana*.

Edible non-timber forest products

Residents identified five species used for food in Makonde Scarp II. The roots of *Dioscorea hirtiflora* were found to be an important source of carbohydrate exploited for sale on local markets (Table 14-i). Honey is produced and sold locally.

Medicinal plants

Twenty-two species were found to be used for medicine (Table 14-i, Appendix 11).

Table 14-i Plant species utilised in Makonde Scarp II proposed FR as identified by field observations, structured interviews and open discussions. Local names, where known, are presented in Appendix 9

Family	Species	Poles	Timber	Fuel wood	Tools	Ropes	Hives	Food	Medicine
ANACARDIACEAE	<i>Sclerocarya birrea</i>								X
ANNONACEAE	<i>Annona senegalensis</i>	X				X		X	X
BIGNONIACEAE	<i>Markhamia acuminata</i>	X							
BIGNONIACEAE	<i>Markhamia obtusifolia</i>	X		X	X				
BOMBACACEAE	<i>Ceiba pentandra</i>		X	X					
FABACEAE (CAES)	<i>Azelia quanzensis</i>		X	X	X				X
FABACEAE (CAES)	<i>Bauhinia petersiana</i>			X		X			X
FABACEAE (CAES)	<i>Bauhinia tomentosa</i>					X			X
FABACEAE (CAES)	<i>Brachystegia longifolia</i>						X		
FABACEAE (CAES)	<i>Brachystegia spiciformis</i>	X	X	X		X	X		
FABACEAE (CAES)	<i>Cassia abbreviata</i>								X
FABACEAE (CAES)	<i>Hymenaea verrucosa</i>		X						
FABACEAE (CAES)	<i>Julbernardia globiflora</i>	X	X	X					
FABACEAE (CAES)	<i>Julbernardia magnistipulata</i>	X		X		X			
FABACEAE (CAES)	<i>Piliostigma thonningii</i>			X		X	X		
FABACEAE (MIM)	<i>Acacia brevispica</i>								X
FABACEAE (MIM)	<i>Acacia nigrescens</i>								X
FABACEAE (MIM)	<i>Albizia gummifera</i>		X	X	X				
FABACEAE (MIM)	<i>Albizia versicolor</i>	X	X	X					
FABACEAE (PAP)	<i>Dalbergia melanoxylon</i>		X						
FABACEAE (PAP)	<i>Lonchocarpus bussei</i>								X
FABACEAE (PAP)	<i>Lonchocarpus capassa</i>			X	X				
FABACEAE (PAP)	<i>Millettia stuhlmannii</i>		X						
FABACEAE (PAP)	<i>Pterocarpus angolensis</i>		X	X	X				X
FABACEAE (PAP)	<i>Pterocarpus rotundifolius</i>		X	X					
FABACEAE (PAP)	<i>Scorodophloeus fischeri</i>	X							
CHRYSOBALANACEAE	<i>Parinari curatellifolia</i>		X					X	
COMBRETACEAE	<i>Pteleopsis myrtifolia</i>		X	X					
DILLENIACEAE	<i>Tetracera boiviniana</i>								X
DIOSCOREACEAE	<i>Dioscorea hirtiflora</i>							X	
EBENACEAE	<i>Diospyros kirkii</i>								X
FLACOURTIACEAE	<i>Flacourtia indica</i>								X
LOGANIACEAE	<i>Strychnos cocculoides</i>	X		X	X				X

Family	Species	Poles	Timber	Fuel wood	Tools	Ropes	Hives	Food	Medicine
LOGANIACEAE	<i>Strychnos madagascariensis</i>	X							X
MELIACEAE	<i>Khaya anthotheca</i>		X		X				
MORACEAE	<i>Milicia excelsa</i>		X	X	X				
MYRTACEAE	<i>Syzygium cordatum</i>		X	X				X	
OCHNACEAE	<i>Ochna holstii</i>								X
POLYGALACEAE	<i>Securidaca longipedunculata</i>								X
RUBIACEAE	<i>Vangueria infausta</i>								X
RUTACEAE	<i>Zanthoxylum chalybeum</i>								X
SAPOTACEAE	<i>Bequaertiodendron natalense</i>								X
STERCULIACEAE	<i>Sterculia appendiculata</i>		X	X	X				
VERBENACEAE	<i>Vitex doniana</i>	X			X		X	X	
VERBENACEAE	<i>Vitex zanzibarensis</i>			X					

Hunting

Upon being questioned about hunting practices in the area residents responded that hunting does not take place. However, this statement was contradicted by the observation of traps along disturbance transects. In one small area used for cultivation no fewer than eight different traps for small antelopes were observed.

Management

Makonde Scarp II FR is only proposed, therefore no management plan is in place, no patrolling of the FR boundaries is conducted and no laws are enforced to protect the area.

DISCUSSION

FLORA

Makonde Scarp II proposed FR has been transformed by major human disturbance, particularly clearance for agriculture and timber harvesting, into three main vegetation types largely interspersed by cultivated and fallow farmland.

Small patches of eastern African *Brachystegia* forest were found to still be present on the western side of the escarpment, near to Chiwambo Chini village. The low frequency ($\leq 60\%$) and abundance of the *Brachystegia* sp. recorded in this forest reserve, and the absence of *Brachystegia* as a single dominant genus characteristic of this vegetation type may be attributed to the high level of timber extraction observed in this forest reserve (see Human Resources-Use and Local Management section), but further study would be needed to ascertain this. Even though disturbance from timber extraction has changed the physiognomy of the canopy layer into a more open configuration, the presence of a dense shrub layer dominated by Swahilian endemic species and the sparse character of the grass layer still distinguish this vegetation type from the ‘miombo’ *Brachystegia* woodland of the Zambezi regional centre of endemism (Clarke and Robertson, 2000).

Deforestation on the plateau has degraded the climax forest into Thicket and Mixed scrub forest. Both these vegetation types are seral stages that resulted from the historical practice of shifting cultivation on the Makonde Plateau, whereby farmland is left fallow for at least seven years, allowing grassland first, then Thicket and finally Mixed scrub forest to regenerate. If

the clearing cycle was not perpetrated this vegetation type could complete its succession to climax forest (Gillman, 1954).

Makonde Scarp II has one of the lowest plant species richness recorded (76 species), which may be caused by the high proportion of cultivated land comprising this reserves and the intense degree of timber extraction taking place. The Shannon diversity index for this forest reserve ($H^1=3.01$) is relatively high, reflecting a community in succession (Magurran, 1988), where a relatively high number of species, and particularly understory species, can colonise the area and reach high rates of population growth following the removal of more competitive canopy trees (Ndangalasi, 1997). If this forest could be allowed to fully regenerate, and canopy and sub canopy species to achieve their potential population size, then the species diversity would be expected to decline. Important species, such as *Khaya anthotheca* (Vulnerable), *Gardenia transvenulosa* and *Vitex zanzibarensis* (Endemic and Vulnerable), would also be preserved. The African mahogany (*Khaya anthotheca*), yields a very valuable termite resistant timber that is marketed for joinery and cabinet work (Schulman *et. al*, 1998), and is listed as Vulnerable by IUCN (2004). If the extraction of timber from Makonde Scarp II proposed FR is not regulated this and other species may become locally rare.

FAUNA

Overall a low number of faunal species (99) were recorded, reflecting the fact that large sections of the reserve have been converted into farmland and are disturbed by timber extraction, fires and hunting, factors that have decreased the extent of suitable habitat and ecological requirements (e.g. prey, shelter) available to animal species (Zullini, 2003; Begon *et al.*, 1996).

Small mammals

For the small mammals the overall number of species (4) and individuals (7) captured was low, reflecting the high incidence of deforestation in this reserve (see Human Resource-Use and Local Management section) and the open and dry habitat resulting from it (Zullini, 2003; Begon *et al.*, 1996). The dominance of the Multimammate rat (*Mastomys natalensis*) and the Spiny mouse (*Acomys spinosissimus*), together making up more than half of the total capture, and the recording of the Pygmy mouse (*Mus minutoides*) also reflect the type of habitat present, i.e. open canopy forest, scrub and thicket. One species of the White-toothed shrew (*Crocidura* sp.) was found. Shrews found in the Coastal Forests of Tanzania are poorly known and already there are five unidentified species that have been collected from the Coastal Forests of Tanzania, each from a separate forest (Burgess and Clarke, 2000). It is possible that the shrews collected from this survey will yield interesting results once taxonomic verification is accomplished.

Large mammals

For the larger mammals a moderate number of species (11) were recorded and no one species was recorded more than twice. The low number of individuals recorded for all species was probably caused by a significant degree of disturbance in this reserve (see Human Resource-Use and Local Management section), a factor that has decreased the extent of suitable habitat and ecological requirements (e.g. prey, shelter) necessary to support larger populations. In this reserve the forest dependent Natal duiker (*Cephalophus natalensis* - conservation dependent) was found, together with several species such as the Greater galago (*Otolemur crassicaudatus* - CITES II) which, although not forest dependent, often favour a forest environment. Due to their habitat requirements these species are likely to be locally threatened from further encroachment and degradation of the reserve. *Otolemur crassicaudatus* was found to frequent cultivated land, where it feeds on fruit, indicating a possible adaptation to the change in habitat. Predators such as the Lion (*Panthera leo* – Vulnerable, CITES II) and the Spotted hyena (*Crocuta crocuta* - conservation dependent) are able to utilise different habitats and to

adapt well to changes in their environment, and so are likely to be less threatened by further forest degradation. Nevertheless, any reduction in habitat will reduce the visits of these animals as shelter and populations of predated animals are likely to decrease. Further research needs to be conducted to assess the extent of reliance of large mammals and predators on Makonde Scarp II proposed FR. Signs from the Leopard (*Panthera pardus*) were recorded, and the species was reported by local inhabitants to inhabit sheltered areas near the cliff face of the scarp and to be a permanent resident of this reserve. *P. pardus* is listed on CITES Appendix I (2005) as a species threatened with extinction and therefore excluded from international trade, and if its presence in this site will be confirmed then its protection will be necessary.

Birds

Despite the removal of the forest cover in large portions of the reserve a moderate number of species (64) was recorded. This is a consequence of the proximity of this reserve to the ridges of the Makonde Scarp, where the topographic variation of the escarpment creates a variety of habitats and nesting sites for birds. However, the extensive removal of forest cover may be responsible for the low record of forest dependent species. Makonde Scarp II proposed FR constitutes part of the Newala District Coastal Forests IBA (TZ053 - category A1) (BirdLife International, 2005) because of the presence of more than a threshold population of the Southern banded snake eagle (*Circaetus fasciolatus*), a species categorized by the IUCN Red List (2004) as near threatened. *C. fasciolatus* was recorded in Makonde Scarp II proposed FR during this study together with the Peregrine falcon (*Falco peregrinus*), a species listed on CITES Appendix I (2005), confirming the classification of this reserve as part of the TZ053 IBA.

Reptiles

The low number of species (7) and individuals (7) captured may be a consequence of the rapid nature of this study, which did not permit comprehensive collection of data during the wet season and the study of fossorial species (Broadley and Howell, 2000). Conducting further research in the wet season may reveal more comprehensive results. However, low numbers may also reflect the largely open and dry environment that has resulted from high levels of encroachment, timber extraction and burning in this reserve (Zullini, 2003; Begon *et al.*, 1996) (see Human Resource-Use and Local Management section). A sub-species of the Savanna vine snake, characterised by high ventral counts and a black and pink Y-shape on the head, was recognised to be *Thelotornis capensis oatesi*¹¹. This species has been previously recorded to occur across the Tanzanian border at Mbala, Zambia (Spawls *et al.*, 2002). If the identification is confirmed then this record represents the first one for Tanzania and a range extension for this species. A species of skink sighted in this reserve was recognised to resemble either the Rainbow Skink (*Trachylepis margaritifer*) or the Five-lined skink (*Trachylepis quinquetaeniata*). *T. margaritifer* is known to occur in central and south-eastern Tanzania (Spawls *et al.*, 2002). *T. quinquetaeniata* has not been recorded south of the border with Kenya, apart from a record in Kwa Mtoro (north of Dodoma) (Spawls *et al.*, 2002), and its record in the Mtwara Region would therefore represent a range extension. Further research is necessary to ascertain this.

Amphibians

The number of species (2) and individuals (4) captured was low, reflecting the open and dry nature of most of the reserve (Zullini, 2003; Begon *et al.*, 1996). Conducting further research in the wet season may however reveal more comprehensive results. The ‘true’ toad *Mertensophryne micranotis* is a strictly endemic species restricted to the Eastern Arc lowland

¹¹ The identification of *Thelotornis capensis oatesi* was carried out by Michele Menegon (Appendix 1). We are awaiting taxonomic confirmation.

and the Coastal Forest Mosaic of south-eastern Kenya and eastern Tanzania, occurring mainly in closed-canopy forest, but also in thicket and miombo woodland within the mosaic (Conservation International, 2005; IUCN *et al.*, 2004). This bufonidae species was found in an area of regenerating *Brachystegia* forest, demonstrating that it can also survive in modified secondary habitats, as long as there is good cover necessary to provide moisture rich crevices where eggs are laid and larvae develop (Howell *et al.*, 2000). *Arthroleptis stenodactylus* was recorded in one of the small patches of undisturbed *Brachystegia* forest remaining. This species favours a forested habitat as it relies on the presence of damp soil and loose leaf mould protected from shrub and canopy cover to lay its eggs (Howell, 1993), so it may become locally threatened by further loss of forest habitat.

Butterflies

For the butterflies there was a low number of species (8) and individuals captured (11), none of which are forest dependent. This may be a consequence of the disturbed, open and dry nature of the vegetation covering most of this reserve (Kielland and Cordeiro, 2000) (see Flora section).

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

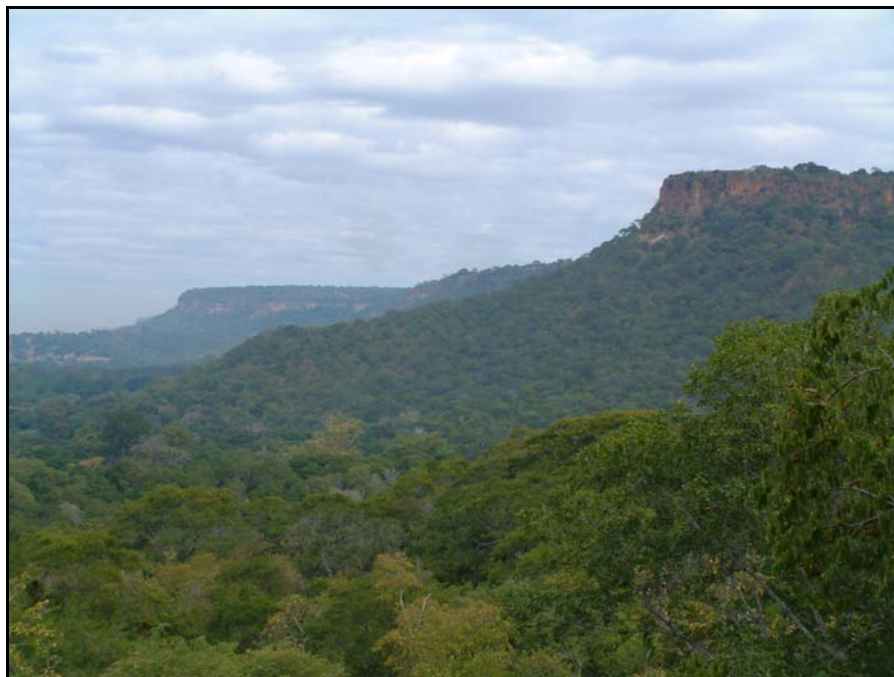
The encroachment of agriculture within the reserve boundaries was the most severe form of disturbance recorded; it is not possible to walk far in the proposed reserve without crossing cultivated land. Most of the farmers that were moved out when the area was proposed to be a reserve are now going back to their shambas (cultivated land), in part because of the failure of the government to fully compensate their relocation in new houses and farms (Baldus *et al.*, 2004). The top of the escarpment has been largely transformed from *Brachystegia* forest into cashew nut (*Anacardium occidentale*) plantations, while rice and maize are grown on the slopes and the plain at the foot of the escarpment. Large areas of the slopes are also covered by Thicket, indicating that shifting agriculture is common practice and that undisturbed areas are likely to become threatened in the future.

Notable about the disturbance patterns in Makonde Scarp II proposed FR was the high number of cut timbers (almost 20% of all recorded timbers). The extensive exploitation of four preferred species (*Azelia quanzensis*, *Milicia excelsa*, *Pterocarpus angolensis* and *P. rotundifolius*) has resulted in the complete absence of large individuals of these species from the proposed reserve. The level of pole cutting was also high (almost 30%), which may indicate a high level of building activity in the area.

Bee farming was common here. When material for the construction of beehives is obtained in a sustainable way, apiculture has been found to be ecologically preferable to harvesting of wild honey, as the latter often results in the cutting of the tree to access the hive (Wegner, 2003). However, bee farming in Makonde Scarp II proposed FR may also result in tree death, as bark is here used for the construction of beehives and is extracted by ringing and often killing the trees. Since the most desirable piece of bark is a complete circle and as larger pieces of bark result in larger hives, large trees are targeted (suggestions to mitigate this impact are discussed in the Conservation Recommendations section). Brick making (which uses large volumes of wood to produce heat) was also found to be a common practice, while hunting was signalled by the presence of several small traps for birds and small mammals in the reserve area.

Residents were found to be unconcerned about the reduction in the size of the forest and the potential that this has for increasing erosion rates and the risk of landslides.

15. MKUNYA RIVER PROPOSED FOREST RESERVE



Status	Proposed Forest Reserve
Management Body	Central Government
Location	Newala district. The forest starts at the Mkunya River spring below Mkunya Village and runs east parallel to the border alongside the Ruvuma River. It comprises of the base and part of the escarpment of the Makonde Scarp. There are several villages nearby including Chiunjila to the west of the water source and Chikwedu, Mapili, Nanguruwe and Magunchila along the base of the escarpment.
Area	4,797.3ha
Altitude	88-250m asl
Topography	Lowland plain and gentle lower slope
Temperature:	Min: 21°C, Max: 39°C (recorded 7-11 May and 16-20 May, dry season)
Rainfall:	0mm (recorded 7-11 May) and 5.1mm (recorded 16-20 May)
Soil type	Sandy-loam
Vegetation type	Eastern African coastal <i>Brachystegia</i> forest and Riverine forest
Land Use	The reserve was proposed for protection of the water spring and prevention of soil erosion on the escarpment. Encroachment of cultivated land (especially cashew plantations), pole cutting and hunting occur.
History and Status	The area was first planned to be a forest reserve in 1976 but has not yet been gazetted as a full reserve. Local elders from adjacent villages fine people who make illegitimate use of the land, but there is no effective capacity nor sufficient resources to enforce legislation and regulations.

Maps Topographical map: Newala sheet 306/4 and Mnavira sheet 318/2, East Africa 1:50 000, 1968. From the Institute of Mapping, Dar es Salaam (from Series Y742, Edition 1-TSD).

METHODS

Survey work was conducted in two study sites over two periods of seven days each (5-11 and 14-20 May 2005). Twenty-one vegetation plots (8400m²), 21 regeneration plots (84m²), and two zoosites were carried out, incorporating 400 sherman trapping nights, 100 bucket trapping nights, 17.5 man/hours of timed herpetofauna searches, 39 bat mist net/hours, 38.5 man/hours of bird mist netting, 16 man/hours of timed bird searches, 30 canopy trapping days, 10.5 butterfly sweep net/hours, seven animal sign transects (totalling 28,000m²), seven disturbance transects (totalling 70,000m²), and opportunistic observations (see Appendices 2 to 8 for GPS coordinates and work site descriptions). Ornithological work was conducted on separate days (22-27 June 2005). Habitat notes were taken for vegetation plots (Appendices 4 and 5) and zoological trap sites (Appendix 6). Structured interviews and open discussions were conducted with four elders from the villages of Chihange and Chinunjila. For a detailed break down of survey effort see Table 10-a.

RESULTS

In the Mkunya River proposed FR 102 plant species were recorded from 22 families. Eleven percent of the total number of floral species are endemic to the Swahilian region *sensu lato* and 12% are listed as threatened (IUCN, 2004) or potentially threatened (Gereau and Luke, 2006) (Table 15-a; Appendices 9 and 10).

One-hundred and seventy-six faunal species were found within 69 families. Of these species 5% are forest dependent, less than 1% are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains and 1% are listed as threatened by IUCN (2004) and/or CITES (2005) (Table 15-a; Appendices 13-17).

Table 15-a Summary of fauna and flora recorded in Mkunya River proposed FR

Taxa	No. of families	No. of species ^c	No. of forest dependent species ^d	No. of wide-spread species	No. of strictly endemic species: ^e and ^f	No. of threatened species: ^g and ^h	No. of PT species ⁱ
Mammals	18	29	3	26	0*	1	-
Birds ^a	36	103	2	101	0	0	-
Reptiles	6	12	0	12	0	0	-
Amphibians	5	8	0	8	0	1	-
Butterflies	4	24	4	20	1	0	-
Total for animals	69	176	9	167	1	2	-
Flora ^b	22	102	0	93	11	3	9
Combined Total	91	278	9	260	12	5	9

a - Includes birds seen on the forest boundary edge

b - All trees, shrubs, herbs, grasses and ferns

c - Includes information collected from all systematic survey work, opportunistic observations, structured interviews and open discussions

d - Species dependent on and associated with primary or closed-canopy forest, not forest edge or secondary forest

e - Faunal species with limited ranges in the Coastal Forests alone or the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a), sometimes being found also in other habitats in a few adjacent locations (e.g. Masasi District in S Tanzania, N Mozambique etc.)

f - Floral species restricted to the Swahilian region *sensu lato* (Clarke and Robertson, 2000)

g - Species listed as Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) in the IUCN Red List (IUCN, 2004)

h - Species listed in CITES Appendix I as threatened with extinction and excluded from international trade (CITES, 2005)

i - Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

*The identification of *Crocidura* sp. may increase this number. We await verification

FLORA

In Mkunya River proposed FR two homogeneous vegetation stands were observed and identified as *Brachystegia* forest and Riverine forest intercepted by cultivated and fallow farmland.

- *Species richness and diversity*

A total of 102 species were recorded. Out of these, 44 species were found in 17 vegetation plots and 19 species were recorded in 17 regeneration plots. The remaining 39 species were recorded from opportunistic collection and observation. More specifically, 42 trees, 46 shrubs, eight herbs, and six grasses were recorded (Appendix 9). A value of 2.80 was calculated for the Shannon diversity index.

- *Species dominance*

Within the *Brachystegia* forest two genera (*Brachystegia* and *Scorodophloeus*) from the Caesalpinioideae family dominated the canopy level. *Brachystegia spiciformis* occurred in 59% of the plots and ranked as the most dominant species (Table 15-b).

Table 15-b Species frequency, dominance, rank dominance, no. of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the canopy layer in *Brachystegia* forest in Mkunya River proposed FR

Family	Genus	Species	F	% RF (Dominance)	Rank dominance	No. indiv. in all plots	%RA	Rank RA
FABACEAE (CAES)	<i>Brachystegia</i>	<i>spiciformis</i>	10	59	1	31	16	1
FABACEAE (CAES)	<i>Scolodophoeus</i>	<i>fischeri</i>	5	29	2	8	4	2
FABACEAE (CAES)	<i>Brachystegia</i>	<i>longifolia</i>	3	17	3	4	2	4
BOMBACACEAE	<i>Bombax</i>	<i>rhodognaphalon</i>	1	6	4	1	1	5
FABACEAE (CAES)	<i>Brachystegia</i>	<i>microphylla</i>	1	6	4	7	4	3
Total¹	2	3	5			51	27	
Total²	18	27	39			191	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

In the sub canopy layer, *Diplorhynchus condylocarpon* was the most dominant species occurring in 77% of the plots (Table 15-c).

Table 15-c Species frequency, dominance, rank dominance, no. of individuals, relative abundance, % relative abundance and rank relative abundance for the top five most abundant species of the sub canopy layer in *Brachystegia* forest in Mkunya River proposed FR

Family	Genus	Species	F	% RF (Dominance)	Rank dominance	No. of indiv. in all plots	%RA	Rank RA
APOCYNACEAE	<i>Diplorhynchus</i>	<i>condylocarpon</i>	13	77	1	55	29	1
COMBRETACEAE	<i>Combretum</i>	<i>paniculatum</i>	5	30	2	8	4	2
COMBRETACEAE	<i>Combretum</i>	<i>hereroense</i>	3	18	3	7	4	3
ANACARDIACEAE	<i>Sclerocarya</i>	<i>birrea</i>	3	18	3	4	2	4
FABACEAE (PAP)	<i>Lonchocarpus</i>	<i>bussei</i>	1	6	4	2	1	5
Total¹	4	4	5			76	40	
Total²	18	27	39			191	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

Within the Riverine forest relatively few tree species were recorded. These were *Barringtonia racemosa*, *Bridelia micrantha* and *Hyphaene compressa*, each occurring in only 6% of the plots sampled (Table 15-d).

Table 15-d Species frequency, dominance, rank dominance, no. of individuals, relative abundance, % relative abundance and rank relative abundance for the top five most abundant species of the canopy layer in Riverine forest in Mkunya River proposed FR

Family	Genus	Species	F	% RF (Domina nce)	Rank dominance	No. of indiv. in all plots	%RA	Rank RA
LECYTHIDACEAE	<i>Barringtonia</i>	<i>racemosa</i>	1	6	1	2	50	1
EUPHORBIACEAE	<i>Bridelia</i>	<i>micrantha</i>	1	6	1	1	25	2
PALMAE	<i>Hyphaene</i>	<i>compressa</i>	1	6	1	1	25	2
Total¹	3	3				4	100	
Total²	18	27				191	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

- *Species relative abundance*

In the canopy layer 22% of the trees recorded were individuals from the genus *Brachystegia* (*B. spiciformis*, *B. microphylla* and *B. longifolia*). *Scorodophloeus fischeri* constituted about 4% (Table 15-b). In the sub canopy layer *Diplorhynchus condylocarpon* (29%), *Combretum paniculatum* (4%) and *Combretum hereroense* (4%) were the most abundant species (Table 15-c).

In the Riverine forest *Barringtonia racemosa* (50%), *Hyphaene compressa* (25%) and *Bridelia micrantha* (25%) were the most abundant species found in the canopy layer.

When looking at the overall number of trees recorded in both the canopy and sub canopy layers of both forest types, the sub canopy layer contributed a slightly higher number of individuals (57%) than the canopy layer (43%) to the overall number of adult trees in the reserve.

- *Species composition and vegetation types*

In Mkunya River proposed FR two homogeneous vegetation stands were observed, whose species composition and relative abundance confirmed to be **eastern African coastal *Brachystegia* forest** and **eastern African coastal Riverine forest** (Clarke and Robertson, 2000).

The species composition of the *Brachystegia* forest was characterised by *Brachystegia spiciformis* as the dominant and most abundant species in the canopy layer, contributing 16% of all individuals, accompanied by *Scorodophloeus fischeri*, *Brachystegia longifolia*, *Bombax rhodognaphalon* and *Brachystegia microphylla*. In the sub canopy layer *Diplorhynchus condylocarpon* was the dominant and most abundant species, contributing 29% of all individuals, accompanied by *Combretum paniculatum*, *Combretum hereroense*, *Sclerocarya birrea* and *Lonchocarpus bussei*. Other species occurring in the canopy layer included *Millettia stuhlmannii*, *Tamarindus indica*, *Brachystegia utilis*, *Sterculia appendiculata*, *Pericopsis angolensis* and *Pterocarpus angolensis*, and in the sub canopy layer we also found *Azelia quanzensis*, *Swartzia madagascariensis* and *Albizia versicolor*. The shrub layer was observed to be comprised of saplings of the dominant species from the canopy and sub canopy layers, and shrub species such as *Salacia madagascariensis*, *Strychnos usambarensis*, *Strychnos madagascariensis*, *Ochna holstii*, *Catunaregam spinosa*, *Vangueria infausta* and various species from the genus *Combretum*. The herbaceous layer was observed to be comprised of grasses, particularly *Sporobolus* sp., *Themeda triandra*, *Digitaris* sp., and *Panicum maximum*. Herbs found in association with these grasses were *Dicoma tomentosa*, *Hypoestes* sp., *Jasminum* sp., *Vernonia* sp. and species from the genus *Bidens*. These herbs

were recorded as dominant on the edge of cultivated land and open areas where grasses have been removed by fire or cultivation.

The species composition of the Riverine forest included *Barringtonia racemosa*, *Hyphaene compressa* and *Bridelia micrantha* as the most abundant species in the canopy layer. Other species recorded were *Sorindeia madagascariensis* in the canopy layer, *Vepris lanceolata* and *Nuxia congesta* in the shrub layer, and the liana *Paullinia pinnata* in the ground layer.

- *Endemism and conservation status*

Eleven of the species recorded were found to be endemic to the Swahilian region *sensu lato*, including *Commiphora zanzibarica*, *Cleistanthus schlechteri*, *Cynometra gillmanii*, *Scorodophloeus fischeri*, *Erythrina schliebenii*, *Xylothea tettensis*, *Lamprothamnus zanguibaricus*, *Rytigynia decussata*, *Mimusops schliebenii*, *Sterculia appendiculata* and *Grewia forbesii* (Clarke and Robertson, 2000) (Appendix 10) accounting for 11% of all species recorded (Figure 8).

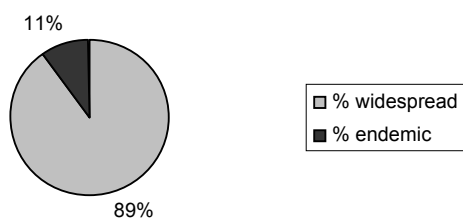


Figure 8 Percentage floral species endemic to the Swahilian region *sensu lato* and those that are widespread in Mkunya River proposed FR

Twelve among the species recorded are threatened (IUCN, 2004) or potentially threatened (Gereau and Luke, 2006), amounting to 12% of the total number of species recorded (Table 15-e).

Table 15-e Threatened and potentially threatened plant species in Mkunya River proposed FR

Family	Species name	Conservation status	Habit
BURSERACEAE	<i>Commiphora zanzibarica</i>	PT	T
EUPHORBIACEAE	<i>Drypetes natalensis</i>	PT	T
FABACEAE (CAES)	<i>Cynometra gillmanii</i>	CR	T
FABACEAE (CAES)	<i>Scorodophloeus fischeri</i>	PT	T
FABACEAE (PAP)	<i>Erythrina schliebenii</i>	PT	T
FABACEAE (PAP)	<i>Millettia impressa</i>	PT	T
FLACOURTIACEAE	<i>Xylothea tettensis</i>	PT	S
MORACEAE	<i>Mesogyne insignis</i>	VU	S/T
RUBIACEAE	<i>Gardenia transvenulosa</i>	VU	S/T
RUBIACEAE	<i>Lamprothamnus zanguibaricus</i>	PT	S/T
RUBIACEAE	<i>Rytigynia decussate</i>	PT	S
VERBENACEAE	<i>Vitex zanzibarensis</i>	VU	S

PT = Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

T= Tree, S= Shrub, B= Bamboo, C= Climber, H= Herb

FAUNA

Although the identification of about 90% of the species recorded is certain, the identification of a few specimens remains tentative whilst awaiting taxonomic verification.

Mammals

- *Species richness and composition*

A total of 29 mammals representing 18 families were recorded (Appendix 13).

For the *small mammals* 10 species representing five families were recorded in total from 12 captures (not counting one recapture) that took place during 400 sherman trapping nights and 100 bucket pitfall trapping nights. Common species found were the Multimammate rat (*Mastomys natalensis*) and the Spiny mouse (*Acomys spinosissimus*), which made up 58% of all captures. Other species included the Lesser pouched rat (*Beamys hindei*), the Narrow-footed woodland mouse (*Grammomys dolichurus*) and two species of the White-toothed shrew (*Crocidura* sp.) (Appendix 18). All species were recorded within Riverine forest with the exception of *Acomys spinosissimus* and *Mastomys natalensis*, which were recorded in Legume-dominated dry forest.

Two species of *bat*, the Evening bat (*Scotoecus hirundo*) and Wahlberg's fruit bat (*Epomophorus wahlbergi*), were recorded from nine captures that took place during 39 bat mist net/hours carried out in a patch of Riverine forest along the Mkunya River. Eight of these captures were individuals of *Scotoecus hirundo*.

For the *larger mammals*, 17 species representing 11 families were recorded during sign transects totalling 7km, through opportunistic observations and from local knowledge. Species recorded included the Greater galago (*Otolemur crassicaudatus*), the Natal duiker (*Cephalophus natalensis*), the Klipspringer (*Oreotragus oreotragus*), the Chequered elephant shrew (*Rhynchocyon cirnei*), and the Red-bellied coastal squirrel (*Paraxerus palliatus*). Signs of digging from the Bush pig (*Potamochoerus larvatus*) were commonly recorded. None of the other species were observed more than twice during the survey. The Moloney's monkey (*Cercopithecus mitis* sub sp.) was observed in two valleys where Legume-dominated forest is dense and relatively undisturbed, with up to five individuals being sighted on two separate occasions in one valley. The discovery of footprints of the Spotted hyena (*Crocuta crocuta*) confirms local knowledge of the presence of this species. From structured interviews it was also learnt that the Leopard (*Panthera pardus*), Lion (*Panthera leo*) and Jackal (*Canis adustus*) occasionally pass through the proposed forest reserve.

- *Forest dependence, endemism and conservation status*

Three species were found to be forest dependent, although many species often frequent and some favour a forested habitat. None of the species recorded are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains, yet one species has a restricted distribution in eastern Africa. Two species are listed as threatened (Table 15-f).

Table 15-f Forest dependent, endemic and threatened mammal species in Mkunya River proposed FR

Species	Common name	Forest dependent	Endemic	Threatened
<i>Cercopithecus mitis</i> (sub sp.)	Moloney's monkey	F	-	-
<i>Rhynchocyon cirnei</i>	Chequered elephant shrew	-	-	VU
<i>Paraxerus palliatus</i>	Red bellied coastal squirrel	F	-	-
<i>Beamys hindei</i>	Lesser pouched rat	-	EACF, a few other forest types in Kenya and Tanzania	VU
<i>Cephalophus natalensis</i>	Natal duiker	F	-	-

F= Forest dependent or specialist (Burgess *et al.*, 2000a)

CF= species with limited ranges in the Coastal Forests alone; EACF= species with limited ranges in the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

Birds

- *Species richness and composition*

A combination of mist netting (38.5 hours) and timed bird searches (16 hours) detected 103 species from 36 families, making this reserve the most bird species rich one surveyed during this study. Mist netting yielded 16 species from a total of 41 captures. Species included the African broadbill (*Smithornis capensis*), the Pale batis (*Batis soror*), the Grey-crested helmet shrike (*Prionops poliophus*), the Red-headed bluebill (*Spermophaga ruficapilla*)¹², the Livingstone's flycatcher (*Erythrocerus livingstonei*), the African barred owlet (*Glaucidium capense*) and the Yellow weaver (*Ploceus subaureus*) (Appendix 14). Mist netting in Riverine forest yielded a high number of understory species (14), while mist netting in the *Brachystegia* forest of the slopes yielded only 2 species.

- *Forest dependence, endemism and conservation status*

Two forest dependent species, the African broadbill (*Smithornis capensis*) and the Blue-mantled crested flycatcher (*Trochocercus cyanomelas*), were found. No strictly endemic or threatened species were found.

Reptiles

- *Species richness and composition*

Twelve species of reptiles representing six families were recorded from 12 captures that took place during 100 bucket pitfall trapping nights and 17.5 man/hours of herpetological searches. Species included the Nile monitor (*Varanus niloticus*), the Snouted night adder (*Causus defilippii*), the Speckled green snake (*Philothamnus semivariatus*), the Striped skink (*Trachylepis varia*)¹³ and the Mozambique Agama (*Agama mossambica*) (Appendices 15 and 18).

¹² The field identification of *Prionops poliophus* and *Spermophaga ruficapilla* was undertaken by Jacob Kiure (Appendix 1).

¹³ The Afro-magalian mabuyas have been recognised to constitute a separate genus and have been renamed *Trachylepis* sp. For the partitioning of the genus *Mabuya* see Mausfeld *et al.* (2002); for the taxonomy and nomenclature of *Trachylepis* sp. see Honda *et al.* (2003) and Whiting *et al.* (2003).

- *Forest dependence, endemism and conservation status*

No species were found to be forest dependent, although several species often frequent and some favour a forested habitat. No strictly endemic or threatened species were recorded.

Amphibians

- *Species richness and composition*

Eight species of amphibians representing five families were recorded from 28 captures that took place during 100 bucket pitfall trapping nights and 17.5 man/hours of herpetological searches. Species included *Arthroleptis stenodactylus*, *A. xenodactyloides*, *Hemiscus marmoratus*, *Afraxalus fornasinii*, *Leptopelis flavomaculatus*, *Xenopus muelleri*, *Ptychadena anchietae* and *Phrynobatrachus* sp. (Appendices 16 and 18).

- *Forest dependence, endemism and conservation status*

No species were found to be forest dependent or strictly endemic. *Arthroleptis xenodactyloides* is listed as Vulnerable (IUCN, 2004).

Butterflies

- *Species richness and composition*

Twenty-four species of butterfly representing four families were recorded from 86 captures that took place during 30 canopy trap trapping days and 10.5 sweep net/hours (Appendix 17). The Blue spotted charaxes (*Charaxes citherion kennethi*) accounted for 17% and the Silver striped charaxes (*Charaxes lasti lasti*) for 10% of all captures.

- *Forest dependence, endemism and conservation status*

Three species from the family Nymphalidae are forest dependent: the Silver striped charaxes (*Charaxes lasti lasti*), the Flame bordered charaxes (*C. protoclea azota*) and the Gold banded forester (*Euphaedra neophron littoralis*). One species, *Charaxes lasti lasti*, is restricted to the closed-canopy lowland forest of the Eastern Arc Mountains and Coastal Forests of Kenya and Tanzania. No butterfly species were found to be threatened.

Fauna's strict endemism

None of the faunal species recorded in Mkunya River proposed FR is endemic to the Coastal Forests and/or Eastern Arc Mountains.

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

Through disturbance transects, levels of pole cutting, fire damage, path densities and other forms of disturbance were recorded. Out of one-hundred and forty 50m sections, seven (5%) were disturbance free. One-hundred and thirty-one (94%) were subject to pole/timber cutting, 57 (41%) showed signs of fire disturbance, three (2%) had been cultivated and 11 (8%) had one or more paths cutting through. No traps were located (Figure 9). Information on resource use is summarised in Table 15-h.

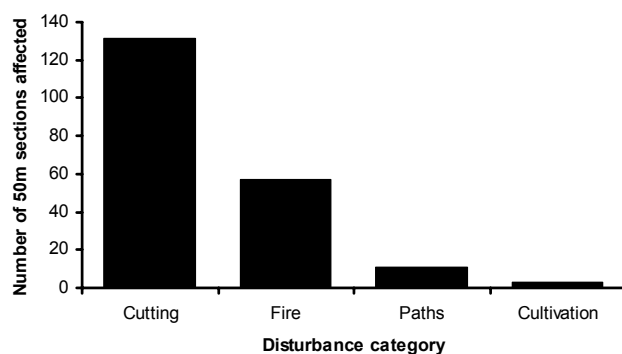


Figure 9 Number of 50m sections (from a total of 133) affected by different forms of human disturbance along transects in Mkunya River proposed FR

Agricultural encroachment

All valleys that run into the escarpment have been planted with cashew trees (*Anacardium occidentale*) and some are inhabited, while the slopes are free of cultivation.

Poles and timbers

Open discussions with residents and disturbance transects determined that 15 species are harvested for timber (Table 15-h). Thirteen species were observed to be cut to supply poles. Five pit sawing sites were observed in the proposed reserve, three of which had been recently active.

- *Relative abundance and average no. of live, dead and cut individuals per ha*

The survey indicated that 20% of all poles and 2% of all timbers were cut. No new cut poles, timbers or large timbers were found and no large timbers were found to have been cut (Table 15-g).

Table 15-g Summary of pole, timber and large timber cutting in Mkunya River proposed FR

	Total transect length in m	Total no. of indiv. sampled	Total no. (and % RA) of live indiv.	Average live indiv. per ha	Total no. (and % RA) of dead indiv.	Average dead indiv. per ha	Total no. (and % RA) of cut indiv.	Average cut indiv. per ha
Poles	7,000	4774	3640(76)	520	164 (3)	23	970 (20)	139
Timbers	7,000	1027	919 (90)	131	83 (8)	12	25 (2)	4
Large timbers	7,000	20	20 (100)	3	0 (0)	0	0 (0)	0

Fuel wood

Residents listed 18 species used for fuel wood (Table 15-h). Cashew nut (*Anacardium occidentale*) trees have been planted to provide fuel wood and fuel wood collection was said to mainly occur in small wooded patches outside the FR.

Tools and utensils

Sixteen species were identified by the inhabitants as important sources of materials to make such products as cooking utensils, tool handles and ropes (Table 15-h).

Edible non-timber forest products

Eleven species were said to be used for food (Table 15-h). The roots of *Dioscorea hirtiflora* were found to be an important source of carbohydrate exploited for sale on local markets.

Medicinal plants

During the survey 23 species were said by residents to provide medicine (Table 15-h Appendix 11).

Table 15-h Plant species utilised in Mkunya River proposed FR as identified by field observations, structured interviews and open discussions. Local names, where known, are presented in Appendix 9

Family	Species	Poles	Timber	Fuel wood	Tools	Ropes	Food	Medicine
ANACARDIACEAE	<i>Sclerocarya birrea</i>				X		X	X
ANNONACEAE	<i>Annona senegalensis</i>	X				X	X	X
APOCYNACEAE	<i>Landolphia buchananii</i>						X	
ARALIACEAE	<i>Cussonia arborea</i>							X
BIGNONIACEAE	<i>Markhamia acuminata</i>	X						
BIGNONIACEAE	<i>Markhamia obtusifolia</i>	X		X	X			
BOMBACACEAE	<i>Bombax rhodognaphalon</i>		X					
BOMBACACEAE	<i>Ceiba pentandra</i>		X	X				
COMBRETACEAE	<i>Pteleopsis myrtifolia</i>		X	X				
DILLENIACEAE	<i>Tetracera boiviniana</i>							X
DIOSCOREACEAE	<i>Dioscorea hirtiflora</i>						X	
EBENACEAE	<i>Diospyros kirkii</i>	X						X
FABACEAE (CAES)	<i>Azelia quanzensis</i>		X	X	X			X
FABACEAE (CAES)	<i>Bauhinia petersiana</i>			X		X		X
FABACEAE (CAES)	<i>Bauhinia tomentosa</i>					X		X
FABACEAE (CAES)	<i>Brachystegia spiciformis</i>	X	X	X		X		
FABACEAE (CAES)	<i>Cassia abbreviata</i>							X
FABACEAE (CAES)	<i>Cynometra gillmanii</i>		X		X			
FABACEAE (CAES)	<i>Hymenaea verrucosa</i>		X					
FABACEAE (CAES)	<i>Julbernardia globiflora</i>	X	X	X				
FABACEAE (CAES)	<i>Julbernardia magnistipulata</i>	X		X		X		
FABACEAE (CAES)	<i>Piliostigma thonningii</i>			X		X		
FABACEAE (CAES)	<i>Swartzia madagascariensis</i>		X					
FABACEAE (MIM)	<i>Acacia brevispica</i>							X
FABACEAE (MIM)	<i>Albizia gummifera</i>		X	X	X			
FABACEAE (MIM)	<i>Albizia versicolor</i>	X	X	X				

Family	Species	Poles	Timber	Fuel wood	Tools	Ropes	Food	Medicine
FABACEAE (PAP)	<i>Lonchocarpus bussei</i>							X
FABACEAE (PAP)	<i>Lonchocarpus capassa</i>			X	X			X
FABACEAE (PAP)	<i>Millettia stuhlmannii</i>		X					
FABACEAE (PAP)	<i>Pterocarpus angolensis</i>		X	X	X			
FABACEAE (PAP)	<i>Pterocarpus rotundifolius</i>		X	X				
FABACEAE (PAP)	<i>Scorodophloeus fischeri</i>	X						
FLACOURTIACEAE	<i>Flacourtia indica</i>							X
LOGANIACEAE	<i>Strychnos cocculoides</i>	X		X	X		X	X
LOGANIACEAE	<i>Strychnos madagascariensis</i>	X					X	X
LOGANIACEAE	<i>Strychnos usambarensis</i>	X					X	
MORACEAE	<i>Milicia excelsa</i>		X	X	X			
MORACEAE	<i>Mesogyne insignis</i>	X		X	X			
MYRTACEAE	<i>Syzygium cordatum</i>		X	X			X	
MYRTACEAE	<i>Syzygium cumini</i>						X	
RUBIACEAE	<i>Crossopteryx febrifuga</i>							X
RUBIACEAE	<i>Vangueria infausta</i>							X
RUTACEAE	<i>Zanthoxylum chalybeum</i>							X
SAPOTACEAE	<i>Bequaertiodendron natalense</i>							X
STERCULIACEAE	<i>Sterculia appendiculata</i>		X	X	X			
VERBENACEAE	<i>Vitex doniana</i>	X			X		X	
VERBENACEAE	<i>Vitex zanzibarensis</i>			X				

Hunting

The populations of Chihanga, Mpilipili and Chikwedu villages stated that they do not practice hunting.

Management

Mkunya River proposed FR is only proposed, therefore no official management plan is in place and no policing of the reserve boundaries is conducted. Village committees were found to spend time educating the local inhabitants about the importance of the water source for the supply of fresh water to the nearby town of Newala and to surrounding villages. Anyone found to be encroaching on the reserve boundary or harvesting poles or timbers was said to be fined by the village committee.

DISCUSSION

FLORA

Much of Mkunya River proposed FR has been converted to farmland. As a consequence, the reserve is comprised of a narrow strip of closed-canopy forest on the steep sides of the scarp on the northern edge of the reserve, interrupted by cashew (*Anacardium occidentale*) plantations in the valleys. The little forest remaining is mainly comprised of *Brachystegia* forest at varying levels of degradation and regeneration. The understory of this vegetation is sparse, probably as a consequence of the steepness of the scarp slope.

In some parts of the reserve the canopy trees have been removed, giving chance to sub canopy species such as *Diplorhynchus condylocarpon* to dominate. The presence of saplings of the dominant canopy and sub canopy species among shrub species in the shrub layer indicates that the forest is approaching a climax stage, where no species different from the dominant ones are colonising and replacing them (Schmidt, 1991).

A small pocket of Riverine forest occurs along the Mkunya River. Here most of the big canopy trees have been removed by people who were previously residing within the forest, as shown by the presence of mango trees (*Mangifera indica*) and remains of buildings a few meters from the river. As a result, species characteristic of Riverine forest are missing and what can be seen is a regenerating form of this vegetation type.

The species richness recorded in this forest reserve was relatively high (102 species) and can be attributed to high variations in topography (see Appendices 4 and 5) that allow species with differing micro-habitat requirements to colonise (George Sangu's personal comms, 2005). The Shannon diversity index ($H^1=2.80$) was also high, reflecting a community in succession (Magurran, 1988), where a relatively high number of species, and particularly understory species, can colonise the area and reach high rates of population growth following the removal of more competitive canopy trees (Ndangalasi, 1997). If this forest could be allowed to fully regenerate, and canopy and sub canopy species to achieve their potential population size, then the species diversity would be expected to decline. However, the succession process of the forest toward a climax stage is being regularly interrupted by cultivation (see Human-Resources Use and Local Management section).

The high number of endemic and threatened plant species recorded, such as *Cynometra gillmanii* (Endemic and Critically Endangered) *Mesogyne insignis* (Vulnerable) and *Vitex zanzibarensis* (Endemic and Vulnerable), shows that this reserve is of significant conservation value. These species are among the ones used by local inhabitants for construction and for making various tool handles. If human disturbance is not controlled the remaining patches of *Brachystegia* coastal forest and the threatened species they host risk to disappear.

FAUNA

In Mkunya River proposed FR the species composition within most taxa reflects extensive clearing for agriculture and the consequent dryness of the environment (Zullini, 2003; Begon *et al.*, 1996). Yet, research carried out in small patches of *Brachystegia* forest on the slopes of the escarpment and in small pockets of Riverine forest yielded a relatively high number of species (176), including various forest dependent and endemic species.

Small mammals

The high sampling intensity applied to this reserve (400 trapping nights) revealed a species poor rodent community (6 captured species), reflecting the high incidence of deforestation for timber and agriculture in this reserve (see Human Resource-Use and Local Management section) and the open and dry habitat resulting from it (Zullini, 2003; Begon *et al.*, 1996).

The majority of these species (five) were found in a patch of Riverine forest, where a larger number of ecological niches are available. The most commonly captured species was the Multimammate rat (*Mastomys natalensis*), which is a recurrent member of the rodent community in southern Tanzania (Kingdon, 1974). The Spiny mouse (*Acomys spinosissimus*) is known to favour dry areas (Kingdon, 2003) and was recorded in open *Brachystegia* forest. The Narrow-footed woodland mouse (*Grammomys dolichurus*) is known to primarily inhabit tall grasses and secondary growth (Kingdon, 1974), and its presence here reflects the fact that a large section of the reserve has been modified by agriculture and timber extraction. The Lesser pouched rat (*Beamys hindei* - near threatened) is a relic species endemic to a few forest types in Kenya and Tanzania, including the coastal and mountain forests of the EACF hotspot. Until very recently it was regarded as one of the rarest rodents in Africa (Groombridge, 1994) but it is now known to be more widespread (Burgess and Clarke, 2000). Two species of White-toothed shrew (*Crocidura* sp.) were also recorded. The shrews of the Coastal Forests of Tanzania are poorly known and already there are five unidentified species that have been collected from the Coastal Forests of Tanzania, each from a separate forest (Burgess and Clarke, 2000). It is likely that shrews collected from this survey will yield interesting results once taxonomic verification is accomplished.

Bats

Most captures were individuals of the Evening bat (*Scotoecus hirundo*), which may suggest that the trap site was in close proximity to a roosting site for this species. The Wahlberg's fruit bat (*Epomophorus wahlbergi*) was instead found only in a very small patch of Riverine forest, which is its preferred habitat, and therefore it may be locally threatened. Both species are known to be forest dwellers (Cockle *et al.*, 1998).

Large mammals

Although the overall number of large mammal species recorded (17) was relatively high, the overall number of individuals was low and no one species was recorded more than twice. This suggests that the populations of all species are suppressed due to a significant degree of disturbance in this reserve (see Human-Resources Use and Local Management section), a factor that has decreased the extent of suitable habitat and ecological requirements (e.g. prey, shelter) necessary to support larger populations. The reserve is very long and thin and in most places it is not wider than one kilometre, making any animal here vulnerable. The Moloney's monkey (*Cercopithecus mitis* sub sp. - CITES II), the Red-bellied coastal squirrel (*Paraxerus palliatus*) and the Natal duiker (*Cephalophus natalensis* - conservation dependent) are forest dependent species (Kingdon, 2003). In this reserve patches of forest are small and affected by varying levels of degradation, and therefore these specialists are locally threatened. Other species such as the Greater galago (*Otolemur crassicaudatus* - CITES II) although not forest dependent often favour a forest environment, and are also likely to be locally threatened. The elephant shrew (*Rhynchocyon* sp.) observed in this reserve is characterised by dark grey and rufous fur with very indistinct chequers, and is likely to represent a sub-species of the Chequered elephant shrew (*Rhynchocyon cirnei macrurus*) rather than a range extension for the similar looking Black and rufous elephant shrew (*R. petersi*) (Rathbun, 2005; Corbet, 1970).¹⁴ The finding of *R. cirnei*, a species listed as Vulnerable (IUCN, 2004), confirms the Coastal Forests to be a globally important area for this genus, closely followed by the Eastern Arc Mountains (Burgess *et al.*, 2000a). *Rhynchocyon* species are forest-dwellers that rely on dense vegetation cover to produce the thick leaf litter they require for foraging and nest construction (Rathbun, 2005). *R. cirnei* may therefore become locally threatened should further habitat destruction ensue. Predators such as the Lion (*Panthera leo* - Vulnerable, CITES II) and the Spotted hyena (*Crocuta crocuta* - conservation dependent) were reported to

¹⁴ At present *R. petersi* has been recorded to occur only in the Eastern Arc Mountains and in the Coastal Forests as far as the Rufiji River. South of the Rufiji River and further down into Mozambique, *R. cirnei* has been recorded instead (Rathbun and Butinski, 2005; Corbet, 1970).

occur in this forest by inhabitants of adjacent villages and farms. These species are able to utilise various habitats and to adapt well to changes in their environment, and so are likely to be less threatened by further forest degradation. Nevertheless, any reduction in habitat will reduce the visits of these animals as shelter and populations of preyed animals are likely to decrease. Further research needs to be conducted to assess the extent of reliance of large mammals and predators on Mkunya River proposed FR. The Leopard (*Panthera pardus*) was reported to occur here. This species is listed on CITES Appendix I (2005) as a species threatened with extinction and therefore excluded from international trade. If its presence in this site will be confirmed then its protection will be necessary.

Birds

Much of Mkunya River proposed FR has been deforested by timber extraction and encroachment of agricultural land (see Human Resource-Use and Local Management section). However, this reserve was the most bird species rich in this study, with 103 species being recorded. This high species richness is probably linked to the large size of this reserve (4,797 ha), which may compensate for the degree of habitat fragmentation occurring here, and its proximity to the ridges of the Makonde Scarp, where the topographic variation of the escarpment creates a variety of habitats and nesting sites for birds. The long period of time spent surveying this reserve may have also contributed to the figure recorded. Mist netting in Riverine forest yielded a high number of understory species in comparison to the *Brachystegia* forest of the slopes (see Results section). This may be due to the presence of denser understory in Riverine forest (Mlingwa *et al.*, 2000) (see Flora section). The only forest dependent species recorded, the African broadbill (*Smithornis capensis*) and the Bluemantled crested flycatcher (*Trochocercus cyanomelas*), were also found in the dense understory of Riverine forest. Other bird species were found to occur in both forest types. The Grey-crested helmet shrike (*Prionops poliophus* - near threatened) has been previously recorded to inhabit open woodland and wooded grassland, including *Acacia/Tarchonanthus* vegetation (1,200-2,200m), in a restricted area encompassing south-western Kenya and northern Tanzania (BirdLife International, 2005). The Red-headed bluebill (*Spermophaga ruficapilla*) has been formerly reported to be a fairly common resident of primary forest and secondary growth in western Kenya and a scarcer one in north-eastern Tanzania. Records of these birds in Mkunya River proposed FR therefore indicate a range extension for these species. Mkunya River proposed FR constitutes part of the Newala District Coastal Forests IBA (TZ053 - category A1) (BirdLife International, 2005) because of the previously recorded presence of more than a threshold population of the Southern banded snake eagle (*Circaetus fasciolatus*), a species categorized by the IUCN Red List (2004) as near threatened. Even though *C. fasciolatus* was not recorded here during this study, the importance of Mkunya River proposed FR for birds is highlighted by its high bird species richness.

Reptiles

Species were mainly found in a small pocket of Riverine forest along the Mkunya River. The species richness recorded here (11 captured species) was the highest for this study and is probably linked to the presence of a water body as well as the high sampling intensity applied to this reserve (see Table 10-a). However, none of the species recorded are forest dependent or endemic. A species of skink sighted in this reserve was recognised to resemble either the Rainbow Skink (*Trachylepis margaritifera*) or the Five-lined skink (*Trachylepis quinquetaeniata*). *T. margaritifera* is known to occur in central and south-eastern Tanzania (Spawls *et al.*, 2002). *T. quinquetaeniata* has not been recorded south of the border with Kenya, apart from a record in Kwa Mtoro (north of Dodoma) (Spawls *et al.*, 2002), and its record in the Mtwara Region would therefore represent a range extension. Further research is needed to ascertain this.

Amphibians

For the amphibians, species were mainly captured within a small patch of Riverine forest along the Mkunya River. The high capture rate (eight species) was due to an intensive search around the spring, where dense vegetation and moist humus soil create an ideal breeding ground (Howell, 1993). Some of these species are water dependent and therefore likely to be affected by further reduction of the forest habitat along the river. The Yellow-spotted tree frog (*Leptopelis flavomaculatus*) and the Squeakers (*Arthroleptis stenodactylus* and *A. xenodactyloides*) were found in small remnant patches of *Brachystegia* forest and are forest dwelling species (Channing, 2001). These squeakers favour a forested habitat as they rely on the presence of damp soil and loose leaf mould protected from shrub and canopy cover to lay their eggs (Howell, 1993). Consequently, the Dwarf squeaker (*Arthroleptis xenodactyloides*) is listed as Vulnerable (IUCN, 2004) and both species may become locally threatened by further loss of forest habitat.

Butterflies

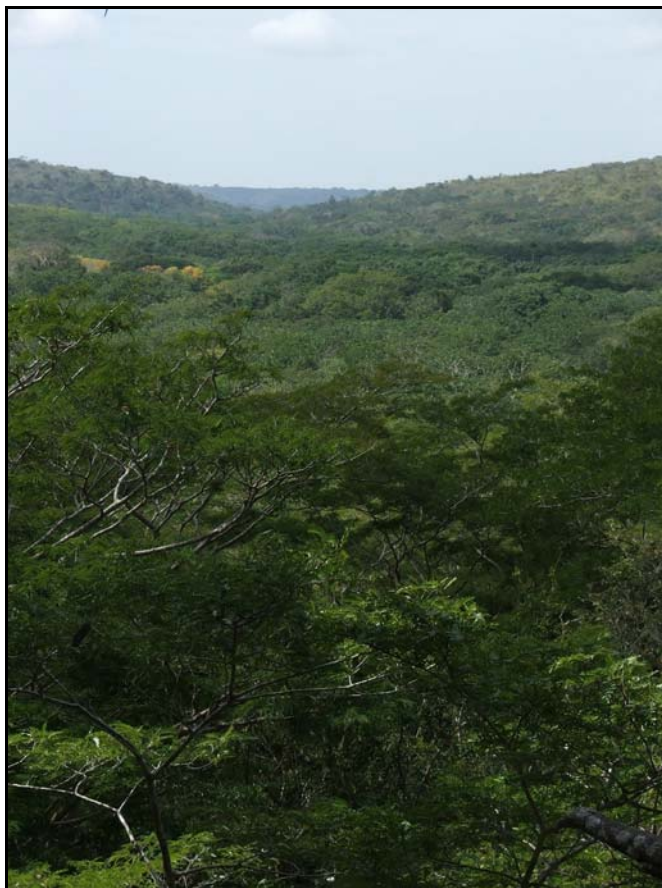
An important butterfly community composed of 24 different species was found in a small pocket of Riverine forest along the Mkunya River, which contained a large proportion of the species recorded in this reserve and three forest dependent species from the Nymphalidae family: the Silver striped charaxes (*Charaxes lasti lasti*), the Flame bordered charaxes (*C. protoclea azota*) and the Gold banded forester (*Euphaedra neophron littoralis*). *Charaxes lasti lasti* is particularly important as it is endemic to the closed-canopy lowland forest of the Eastern Arc and Coastal Forests of Kenya and Tanzania (Congdon and Bampton, 2005). This indicates the importance of the Riverine forest for butterflies and the vulnerability of forest dependent species if habitat degradation is not halted. Butterfly species recorded in the remaining patches of *Brachystegia* forest on the steep sides of the scarp are non-forest dwellers, reflecting the sparse understory found in this vegetation type (see Flora section).

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

Although disturbance transects on the slopes of the escarpment indicated a low level of disturbance, in fact the valleys cutting through the escarpment have been largely transformed into cashew nut (*Anacardium occidentale*) plantations. The steep aspect of the scarp slopes, and hence its unsuitability for agriculture, may be the reason behind the persistence of the forest on them.

Village committees were found to spend time educating the local inhabitants about the importance of the water source for the supply of fresh water to the nearby town of Newala and the surrounding villages, so promoting the conservation of the reserve. However, high levels of pole cutting and the presence of active and old pit sawing sites on the slope of the escarpment suggest that this is ineffective.

16. MTINIKO PROPOSED FOREST RESERVE



Status	Proposed Forest Reserve
Management body	Central Government
Location	Mtwara Rural district. The proposed reserve lies directly southwest of Mtimiko village and just before Newata village, alongside the main road from Mtwara to Newala, and is known to local people as ‘Shamba ya Bibi’. It is bordered along its northern edge by the valley of the Mutumnudi River.
Area	1,736ha
Altitude	170-210m asl
Topography	Lowland plain
Temperature	Min: 17°C, Max: 34°C (recorded 11-15 June, dry season)
Rainfall	Average 0mm (recorded 11-15 June, dry season)
Soil type	Sandy-loam
Vegetation type	Eastern African coastal Mixed dry forest
Land Use	The reserve was proposed to protect timber resources and biodiversity. Fuel wood and pole harvesting occur on a subsistence level. Timber is extracted on a commercial basis. Parts of the reserve boundaries have been used for agriculture and hunting takes place.
History and Status	The area was first proposed to be a forest reserve in 1976 but has not yet been fully gazetted. There is no effective capacity, resources or field staff to enforce protected areas legislation and regulations.

Maps Topographical map: Nanyamba sheet 307/2, East Africa 1:50 000, 1968. From the Institute of Mapping, Dar es Salaam (from Series Y742, Edition 1-TSD).

METHODS

Survey work was conducted over seven days (9-15 June 2005). Twelve vegetation plots (4800m²), 12 regeneration plots (48m²), and one zoosites were carried out, incorporating 200 sherman trapping nights, 50 bucket trapping nights, six man/hours of timed herpetofauna searches, 31.5 bat mist net/hours, 37.5 man/hours of bird mist-netting, 14 man/hours of timed bird searches, 15 canopy trapping days, six butterfly sweep net/hours, four animal sign transects (totalling 16,000m²), four disturbance transects (totalling 40,000m²), and opportunistic observations (see Appendices 2 to 8 for GPS coordinates and work site descriptions). Habitat notes were taken for vegetation plots (Appendices 4 and 5) and zoological trap sites (Appendix 6). Structured interviews and open discussion were conducted with seven elders from the villages of Mtiniko and Mivata. For a detailed break down of survey effort see Table 10-a.

RESULTS

In Mtiniko proposed FR 111 plant species were recorded from 27 families. Nine percent of the total number of floral species are endemic to the Swahilian region *sensu lato* and 9% are listed as threatened (IUCN) or potentially threatened (Gereau and Luke, 2006) (Table 16-a; Appendices 9 and 10).

Eighty-eight faunal species representing 44 families were recorded. Of these species 16% are forest dependent, 2% are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains and 3% are listed as threatened by IUCN (2004) and/or CITES (2005) (Table 16-a; Appendices 13-17).

Table 16-a Summary of fauna and flora recorded in Mtiniko proposed FR

Taxa	No. of families	No. of species ^c	No. of forest dependent species ^d	No. of wide-spread species	No. of strictly endemic species: ^e and ^f	No. of threatened species: ^g and ^h	No. of PT species ⁱ
Mammals	9	12	2	10	0	1	-
Birds ^a	28	56	6	50	1	2	-
Reptiles	2	2	0	2	0	0	-
Amphibians	1	1	0	1	0	0	-
Butterflies	4	17	6	11	1	0	-
Total for animals	44	88	14	74	2	3	-
Flora ^b	27	111	0	101	10	1	9
Combined Total	71	194	14	175	12	4	9

a - Includes birds seen on the forest boundary edge

b - All trees, shrubs, herbs, grasses and ferns

c - Includes information collected from all systematic survey work, opportunistic observations, structured interviews and open discussions

d - Species dependent on and associated with primary or closed-canopy forest, not forest edge or secondary forest

e - Faunal species with limited ranges in the Coastal Forests alone or the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a), sometimes being found also in other habitats in a few adjacent locations (e.g. Masasi District in S Tanzania, N Mozambique etc.)

f - Floral species restricted to the Swahilian region *sensu lato* (Clarke and Robertson, 2000)

g - Species listed as Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) in the IUCN Red List (IUCN, 2004)

h - Species listed in CITES Appendix I as threatened with extinction and excluded from international trade (CITES, 2005)

i - Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

*The identification of *Crocidura* sp. may increase this number. We await verification

FLORA

In Mtiniko proposed FR one single homogeneous vegetation stand was observed, which was recognised to be coastal Mixed dry forest at various levels of degradation.

- *Species richness and diversity*

A total of 111 species were recorded; of these 54 species were found in 12 vegetation plots and 18 species were recorded in 12 regeneration plots. Thirty-nine other species were recorded from opportunistic collection/observation made within the reserve. More specifically 47 trees, 48 shrubs, five herbs, five lianas and six grasses were recorded (Appendix 9). A value of 2.78 was calculated for the Shannon diversity index.

- *Species dominance*

Within the canopy layer *Hymenocardia ulmoides* was dominant, occurring in 83% of the plots and therefore ranking as the most dominant species. Other species frequent in the canopy layer included *Pteleopsis myrtifolia* (50%) and *Hymenaea verrucosa* (42%) (Table 16-b).

Table 16-b Species frequency, dominance, rank dominance, no. of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the canopy layer in Mixed dry forest in Mtiniko proposed FR

Family	Genus	Species	F	% RF (Dominance)	Rank dominance	No. indiv. in all plots	%RA	Rank RA
HYMENOCARDIACEAE	<i>Hymenocardia</i>	<i>ulmoides</i>	10	83	1	24	10	1
COMBRETACEAE	<i>Pteleopsis</i>	<i>myrtifolia</i>	6	50	2	13	5	2
FABACEAE (CAES)	<i>Hymenaea</i>	<i>verrucosa</i>	5	42	3	11	5	3
FABACEAE (CAES)	<i>Brachystegia</i>	<i>spiciformis</i>	1	8	4	3	1	4
FABACEAE (CAES)	<i>Brachystegia</i>	<i>microphylla</i>	1	8	4	1	1	5
Total¹	3	4	5			52	22	
Total²	23	35	41			241	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

The sub canopy layer was dominated by *Grewia mollis*, which occurred in 100% of the plots, and *Markhamia obtusifolia* and *Cola greenwayi*, both occurring in 60% of the plots. *Tetracera boiviniana* was a frequent species, occurring in 50% of the plots (Table 16-c).

Table 16-c Species frequency, dominance, rank dominance, no. of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the sub canopy layer in Mixed dry forest in Mtiniko proposed FR

Family	Genus	Species	F	% RF (Dominance)	Rank dominance	No. indiv. in all plots	%R.A	Rank abundance
TILIACEAE	<i>Grewia</i>	<i>mollis</i>	12	100	1	63	26	1
BIGNONIACEAE	<i>Markhamia</i>	<i>obtusifolia</i>	7	60	2	12	5	4
STERCULIACEAE	<i>Cola</i>	<i>greenwayi</i>	7	60	2	16	7	3
DILLENIACEAE	<i>Tetracera</i>	<i>boiviniana</i>	6	50	3	33	14	2
FABACEAE (CAES)	<i>Azelia</i>	<i>quanzensis</i>	4	33	4	4	2	5
Total¹	5	5	5			128	54	
Total²	2	35	41			241	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

- *Species relative abundance*

In the canopy layer about 20% of the trees recorded were individuals from *Hymenocardia ulmoides*, *Pteleopsis myrtifolia* and *Hymenaea verrucosa*. In the sub canopy layer *Grewia mollis*, *Tetracera boiviniana*, *Cola greenwayi* and *Markhamia obtusifolia* were the most abundant species, together making up 52%.

When looking at the overall number of trees recorded in both the canopy and sub canopy layers, the sub canopy layer contributed a higher number of individuals (71%) than the canopy layer (29%) to the overall number of adult trees in this reserve.

- *Species composition and vegetation types*

Mtiniko proposed FR is comprised of one single homogeneous vegetation stand, whose species composition and relative abundance confirmed to be **eastern African coastal Mixed dry forest** (Clarke and Robertson, 2000; Lowe and Clarke, 2000).

The species composition of the canopy layer was characterised by *Hymenocardia ulmoides* as the dominant and most abundant species, contributing 10% of all species recorded in this layer, followed by *Pteleopsis myrtifolia* and *Hymenaea verrucosa* as frequent species. Other species occurring in the canopy layer included *Brachystegia spiciformis*, *Albizia gummifera*, and *Bombax rhodognaphalon*.

In the sub canopy layer *Grewia mollis*, *Markhamia obtusifolia* and *Cola greenwayi* were the most dominant species, while *Grewia mollis*, *Tetracera boiviniana* and *Cola greenwayi* were the most abundant, constituting up to 47% of all individuals. Other species found in this layer included *Azelia quanzensis*, *Diospyros kirkii*, *Lonchocarpus bussei*, *Sclerocarya birrea* and *Commiphora africana*.

The shrub layer was dense with shrub and liana species forming an impenetrable tangle. Shrubs species from various genera were observed, the most common being *Cleistanthus schlechteri*, *Drypetes usambarica*, *Cola clavata*, *Octolobus spectabilis*, *Mesogyne insignis*, *Suregada zanzibarensis*, *Rinorea* sp., *Antidesma venosum*, *Antidesma membranaceum*, *Drypetes gerrardii*, *Memecylon* sp., *Rytigynia* sp., *Salacia madagascariensis*, *Ochna holstii*, *Strychnos madagascariensis*, *Strychnos usambarensis*, *Flacourtia indica*, and *Croton pseudopulchellus*. Lianas were well represented with species such as *Dalbergia armata*, *Grewia* sp., *Acacia brevispica*, *Dioscorea hirtiflora* and an unidentified species of *Dioscorea*, *Albizia amara* and *Harrisonia abyssinica*.

Herbs were few to absent with only *Asparagus africanus*, *Dicoma tomentosa* and occasionally *Hypoestes* sp. being recorded. In more open areas grasses such as *Sporobolus* sp., *Panicum maximum*, *Digitaria* sp., *Themeda triandra* and *Heteropogon contortus* were present.

- *Endemism and conservation status*

Ten of the species found are endemic to the Swahilian region *sensu lato*, including *Monodora grandidieri*, *Bombax rhodognaphalon*, *Tetracera boiviniana*, *Cleistanthus schlechteri*, *Erythrina schliebenii*, *Rytigynia decussata*, *Cola clavata*, *Grewia lepidopetala*, *Rinorea elliptica* and *Vitex mossambicensis* (Clarke and Robertson, 2000) (Appendix 10). This amounts to 9% of the total number of species recorded (Figure 10).

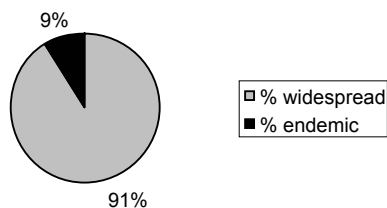


Figure 10 Percentage floral species endemic to the Swahilian region *sensu lato* and those that are widespread in Mtiniko proposed FR

Ten among the species recorded are threatened (IUCN, 2004) or potentially threatened (Gereau and Luke, 2006), amounting to 9% of the total number of species recorded (Table 16-d).

Table 16-d Threatened and potentially threatened plant species in Mtiniko proposed FR

Family	Species name	Conservation status	Habit
BOMBACACEAE	<i>Bombax rhodognaphalon</i>	PT	T
DILLENACEAE	<i>Tetracera boiviniana</i>	PT	S/T
EUPHORBIACEAE	<i>Drypetes natalensis</i>	PT	S/T
FABACEAE (PAP)	<i>Erythrina schliebenii</i>	PT	T
FABACEAE (PAP)	<i>Millettia impressa</i>	PT	C
FABACEAE (PAP)	<i>Craibia brevicaudata</i>	PT	T
MORACEAE	<i>Mesogyne insignis</i>	VU	S/T
RUBIACEAE	<i>Rytigynia decussata</i>	PT	S
STERCULIACEAE	<i>Cola clavata</i>	PT	S/T
VIOLACEAE	<i>Rinorea angustifolia</i>	PT	S/T

PT = Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

T= Tree, S= Shrub, B= Bamboo, C= Climber, H= Herb

FAUNA

Although the identification of about 90% of the species recorded is certain, the identification of a few specimens remains tentative whilst awaiting taxonomic verification.

Mammals

- *Species richness and composition*

A total of 12 mammals representing nine families were recorded (Appendix 13).

For the *small mammals* five species representing three families were recorded from five captures that took place during 200 sherman trapping nights and 50 bucket pitfall trapping nights. The Lesser pouched rat (*Beamys hindei*) was the sole species captured (Appendix 18).

No *bats* were recorded during 31.5 bat mist net/hours.

For the *larger mammals*, seven species representing six families were recorded during sign transects totalling 4km, through one sherman trap capture (*Paraxerus palliatus*) and opportunistic observations, and from local knowledge. Species included the Chequered elephant shrew (*Rhynchocyon cirnei*), the Red-bellied coastal squirrel (*Paraxerus palliatus*), the Moloney's monkey (*Cercopithecus mitis* sub sp.) and the South African galago (*Galago moholi*)¹⁵. Apart from *Rhynchocyon cirnei*, which was recorded at least twice every day for the duration of the survey, all other mammals were recorded only on one or two occasions. From structured interviews with local communities it was also learnt that Lion (*Panthera leo*) frequently passes through the forest. Lion vocalisations were also heard by the game guard one evening during the survey.

¹⁵ The field identification of *Galago moholi* was undertaken by Frontier-Tanzania research team.

- *Forest dependence, endemism and conservation status*

Two species were found to be forest dependent. None of the species recorded are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains, yet one species has a restricted distribution in eastern Africa. One species is listed as threatened (Table 16-e, Appendix 13).

Table 16-e Forest dependent, endemic and threatened mammal species in Mtiniko proposed FR

Species	Common name	Forest dependent	Endemic	Threatened
<i>Cercopithecus mitis</i> (sub sp.)	Moloney's monkey	F	-	-
<i>Rhynchocyon cirnei</i>	Chequered elephant shrew	-	-	VU
<i>Paraxerus palliatus</i>	Red bellied coastal squirrel	F	-	-
<i>Beamys hindei</i>	Lesser pouched rat	-	EACF, a few other forest types in Kenya and Tanzania	-

F= Forest dependent or specialist (Burgess *et al.*, 2000a)

CF= species with limited ranges in the Coastal Forests alone; EACF= species with limited ranges in the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

Birds

- *Species richness and composition*

This study detected 56 species from 28 different families. Mist netting (37.5 hours) yielded 15 species from a total of 34 captures and the remaining 41 species were recorded from timed searches (14 hours). Among the species recorded were the African broadbill (*Smithornis capensis*), the Livingstone's flycatcher (*Erythrocerus livingstonei*), the Reichenow's batis (*Batis reichenowi*), the Yellow streaked greenbul (*Phyllastrephus flavostriatus*), the Fischer's greenbul (*P. fischeri*) and the East coast akalat (*Sheppardia gunningi*) (Appendix 14). A relatively large population of *S. gunningi* was found (five individuals).

- *Forest dependence, endemism and conservation status*

In this reserve five forest dependent species were found, including the Reichenow's batis (*Batis reichenowi*), the East coast akalat (*Sheppardia gunningi*), the Yellow streaked greenbul (*Phyllastrephus flavostriatus*), the Fischer's greenbul (*P. fischeri*), the Blue-mantled crested flycatcher (*Trochocercus cyanomelas*) and the African broadbill (*Smithornis capensis*). Among the bird species recorded only *Batis reichenowi* is strictly endemic to the Coastal Forests, while *Sheppardia gunningi* has a restricted distribution in the Coastal Forests and a few other forest types in Tanzania, Kenya, Malawi, and Coastal Mozambique. *S. gunningi* also appears as Vulnerable on the IUCN Red List (2004). The Peregrine falcon (*Falco peregrinus*) is listed on CITES Appendix I (2005) as threatened with extinction and therefore excluded from international trade.

Reptiles

- *Species richness and composition*

Two species of reptiles representing two families were recorded from 2 captures that took place during 50 bucket pitfall trapping nights and six man/hours of herpetological searches. Species were identified as the Mozambique agama (*Agama mossambica*) and the Speckle-lipped skink (*Trachylepis maculilabris*)¹⁶ (Appendices 15 and 18).

¹⁶ The Afro-magaliasian mabuyas have been recognised to constitute a separate genus and have been renamed *Trachylepis* sp. For the partitioning of the genus *Mabuya* see Mausfeld *et al.* (2002); for the taxonomy and nomenclature of *Trachyletis* sp. see Honda *et al.* (2003) and Whiting *et al.* (2003).

- *Forest dependence, endemism and conservation status*

No species were found to be forest dependent, strictly endemic or threatened.

Amphibians

- *Species richness and composition*

One species of amphibian, the Grey tree frog (*Chiromantis xerampelina*), was recorded from a single capture that took place during 50 bucket pitfall trapping nights and six man/hours of herpetological searches (Appendices 16 and 18).

- *Forest dependence, endemism and conservation status*

No species were found to be forest dependent, strictly endemic or threatened.

Butterflies

- *Species richness and composition*

Seventeen species of butterflies representing four families were recorded from 183 captures that took place during 15 canopy trapping days and six sweep net/hours. The Golden piper (*Eurytela dryope angulata*) accounted for a substantial percentage of the captures (62%) (Appendix 17).

- *Forest dependence, endemism and conservation status*

Three species from the family Nymphalidae are forest dependent: the Silver striped charaxes (*Charaxes lasti lasti*), the Gold banded forester (*Euphaedra neophron littoralis*) and a Glider species (*Harma theobene blassi*). One species, *Charaxes lasti lasti*, is endemic to the closed-canopy lowland forest of the Eastern Arc and Coastal Forests of Kenya and Tanzania. No butterfly species were found to be threatened.

Fauna's strict endemism

Of the total number of species recorded in Mtiniko Proposed FR 99% are widespread and 1% are endemic to the Coastal Forests and/or Eastern Arc Mountains (Figure 11).

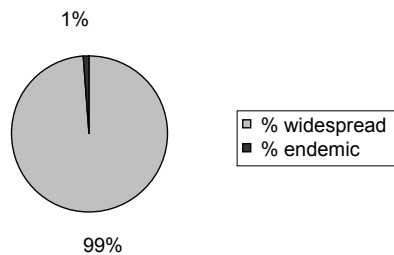


Figure 11 Percentage of strictly endemic and widespread faunal species in Mtiniko proposed FR

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

Disturbance transects were used to record the level of disturbance from encroachment, pole cutting, bark ringing, fire damage and paths. Of the eighty 50m sections that comprised the disturbance transects, 32 (40%) were found to be unaffected by disturbance. Thirty-one (39%) sections contained evidence of pole cutting, 12 (15%) contained one or more bisecting paths, six (8%) had been affected by fire, and snare 'duiker' traps were found in four (5%) sections. No evidence of bark ringing or cultivation was found (Figure 12). Information on resource use is summarised in Table 16-g.

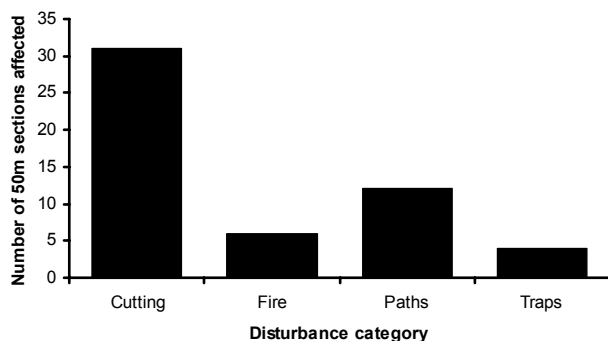


Figure 12 Number of 50m sections (from a total of 48) affected by different forms of human disturbance along transects in Mtiniko proposed FR

Agricultural encroachment

On the eastern, western and northern sides of the reserve the boundary was not demarcated. The residents stated that the size of the proposed reserve has increased since the boundary was demarcated. Our field observations did not support this view. Farms appeared to have been extended inside the proposed reserve.

Poles and timbers

Residents stated that timber obtained from *Albizia gummifera*, *Bombax rhodognaphalon*, and *Hymenaea verrucosa* is used for house building. Two species, *Azelia quanzensis* and *Bombax rhodognaphalon* were also said to be harvested for commercial use. Disturbance transects showed that poles are obtained from a range of different species (Table 16-g). Four separate pit sawing sites, at least one of which had been recently active (Appendix 8), were observed. In addition, three youths were encountered sawing timber for payment.

- *Relative abundance and average no. of live, dead and cut individuals per ha*

The survey found that 2% of all poles and 1% of all timbers are cut. Eleven (12%) cut poles were fresh, and one (25%) fresh cut timber was observed. No cut large timbers were detected (Table 16-f).

Table 16-f Summary of pole, timber and large timber cutting in Mtiniko proposed FR

	Total transect length in m	Total no. of indiv. sampled	Total no. (and % RA) of live indiv.	Average live indiv. per ha	Total no. (and % RA) of dead indiv.	Average dead indiv. per ha	Total no. (and % RA) of cut indiv.	Average cut indiv. per ha
Poles	4,000	5015	4362 (87)	1091	561 (11)	187	92 (2)	23
Timbers	4,000	534	490 (92)	122	40 (8)	10	4 (1)	1
Large timbers	4,000	6	5 (83)	1	1 (17)	0.25	0 (0)	0

Fuel wood

Residents stated that fuel wood comes from dead trees. Species are listed in Table 16-g.

Tools and utensils

Observations and discussions revealed that tree cutting takes place to make cooking utensils and tool handles. Bark from several tree species was said to be used to make ropes, although no actual evidence of bark ringing was observed (Figure 12) (Table 16-g).

Edible non-timber forest products

Through discussions six species were found to be commonly used as food sources by the local community (Table 16-g). Digging for the roots of *Dioscorea hirtiflora* was extensive in Mtiniko as observed along disturbance transects.

Medicinal plants

Ten plant species were said to be of medicinal value (Table 16-g, Appendix 11).

Table 16-g Plant species utilised in Mtiniko proposed FR as identified by field observations, structured interviews and open discussion. Local names, where known, are presented in Appendix 9

Family	Species	Poles	Timber	Fuel wood	Tools	Ropes	Food	Medicine
ANACARDIACEAE	<i>Sclerocarya birrea</i>						X	
ANNONACEAE	<i>Annona senegalensis</i>	X		X		X	X	
APOCYNACEAE	<i>Landolphia buehneri</i>						X	
BIGNONIACEAE	<i>Markhamia obtusifolia</i>	X		X	X			
BOMBACACEAE	<i>Bombax rhodognaphalon</i>		X					
COMBRETACEAE	<i>Pteleopsis myrtifolia</i>			X				
DILLENIACEAE	<i>Tetracera boiviniana</i>							X
DIOSCOREACEAE	<i>Dioscorea hirtiflora</i>						X	
EBENACEAE	<i>Diospyros kirkii</i>							X
FABACEAE (CAES)	<i>Azelia quanzensis</i>		X	X	X			X
FABACEAE (CAES)	<i>Brachystegia spiciformis</i>	X		X		X		
FABACEAE (CAES)	<i>Cassia abbreviata</i>							X
FABACEAE (CAES)	<i>Hymenaea verrucosa</i>		X					
FABACEAE (MIM)	<i>Albizia gummifera</i>		X	X	X			
FABACEAE (PAP)	<i>Dalbergia melanoxydon</i>		X					
FABACEAE (PAP)	<i>Lonchocarpus capassa</i>			X	X			X
FABACEAE (PAP)	<i>Millettia dura</i>		X					
FLACOURTIACEAE	<i>Flacourtia indica</i>						X	
HYMENOCARDIACEAE	<i>Hymenocardia ulmoides</i>	X		X	X			X
LOGANIACEAE	<i>Strychnos cocculoides</i>	X						X
LOGANIACEAE	<i>Strychnos madagascariensis</i>	X						

Family	Species	Poles	Timber	Fuel wood	Tools	Ropes	Food	Medicine
LOGANIACEAE	<i>Strychnos usambarensis</i>	X						
MORACEAE	<i>Milicia excelsa</i>		X		X			
MORACEAE	<i>Mesogyne insignis</i>	X		X	X			
POLYGALACEAE	<i>Securidaca longipedunculata</i>							X
RUTACEAE	<i>Zanthoxylum</i> sp.			X				X
SAPOTACEAE	<i>Bequaertiodendron natalense</i>							X
STERCULIACEAE	<i>Cola greenwayi</i>	X		X	X			
VERBENACEAE	<i>Vitex doniana</i>						X	

Hunting

Residents stated that no hunting takes place in the proposed reserve, yet traps for small mammal were detected in four (5%) of all transect sections (Figure 12).

Management

The present environmental committee does not have the capacity to be effective. Funds are not available for patrols and law enforcement. Forest officers from the District of Natural Resources were said to visit very infrequently.

DISCUSSION

FLORA

Mtiniko proposed FR is mainly covered by Mixed dry forest and experiences a relatively low degree of encroachment. The Mixed dry forest is characterised by a dense understory with the highest number of shrub and lianas species and individuals of all forest surveyed. Valuable species such as *Bombax rhodognaphalon* (Potentially Threatened), *Antiaris toxicaria* and *Milicia excelsa* (near threatened) commonly present in the canopy layer have been cut for timber and were represented by less than 25% individuals. Removal of canopy species has given way to sub canopy species to dominate in terms of relative abundance, the sub canopy layer contributing a higher number of individuals (71%) than the canopy layer (29%) to the overall number of adult trees in this reserve.

Mtiniko proposed FR was found to have one of the highest plant species richness (111 species). This reflects the relatively low degree of encroachment observed here and the natural character of Mixed dry forest (Clarke and Robertson, 2000). The Shannon diversity index for this forest reserve ($H^1=2.78$) was moderately high reflecting a community in succession (Magurran, 1988), where a relatively high number of species, and particularly understory species, can colonise the area and access enough resources for growth following the removal of more competitive canopy trees (Ndangalasi, 1997). If this forest could be allowed to fully regenerate, and canopy and sub canopy species to achieve their potential population size, then the species diversity would be expected to decline. However, human activities (particularly timber cutting) have continued to interrupt the regeneration of this forest from degraded to fully developed Mixed dry forest (Welch, 1960). These activities also threaten some important plant species present here, such as *Mesogyne insignis* (Vulnerable). The hard and heavy wood of this tree is often selected and used by local inhabitants for building poles and tool handles (see Human Resource-Use and Local Management section). If the extraction of timber from Mtiniko proposed FR is not regulated this and other species may become locally rare.

FAUNA

Mtiniko proposed FR supports an important animal community characteristic of a relatively stable forest habitat, with twelve species between birds, mammals and butterflies being forest dependent. This reserve also has relatively high numbers of endemic and threatened species. Despite this the overall number of species recorded was low (88) when related to the size of the reserve and the sampling intensity. This suggests that the level of disturbance occurring in this reserve may be higher than recorded, as reported by local people during interviews and discussions.

Small mammals

Of the small mammals the Lesser pouched rat (*Beamys hindei* - near threatened) appeared to be dominant, being the only species recorded. This is a relic species endemic to a few forest types in Kenya and Tanzania, including the coastal and montane forests of the EACF hotspot. Until very recently it was regarded as one of the rarest rodents in Africa (Groombridge, 1994) but it is now known to be more widespread. Findings from Mtiniko proposed FR seem to support this evidence, since this reserve holds a relatively large population of this species (see Results section and Appendix 18). Although not found during our survey it is likely that other species known to live along with *Beamys* in most habitats, such as the Multimammate rat (*Mastomys natalensis*) (Kingdon, 1974), are also present.

Large mammals

The low number of species (7) and individuals recorded in this reserve may be a consequence of a higher degree of disturbance than actually recorded (see Human-Resources Use and Local Management), a factor that may have decreased the extent of suitable habitat and ecological requirements (e.g. prey, shelter) necessary to support larger populations. The elephant shrew species (*Rhynchocyon* sp.) observed in this reserve is characterised by dark grey and rufous fur with very indistinct chequers, and is likely to represent a sub-species of the Chequered elephant shrew (*Rhynchocyon cirnei macrurus*) rather than a range extension for the similar looking Black and rufous elephant shrew (*R. petersi*) (Rathbun, 2005; Corbet, 1970).¹⁷ The finding of *R. cirnei*, a species listed as Vulnerable (IUCN, 2004), confirms the Coastal Forests to be a globally important area for this genus, closely followed by the Eastern Arc Mountains (Burgess *et al.*, 2000a). *Rhynchocyon* species are forest-dwellers that rely on dense vegetation cover to produce the thick leaf litter they require for foraging and nest construction (Rathbun, 2005). *R. cirnei* may therefore become locally threatened should further habitat destruction ensue. According to Kingdon (1974), the forest dependent Red-bellied coastal squirrel (*Paraxerus palliatus*) observed here is likely to be the result of hybridization with the Smith's bush squirrel (*Paraxerus cepapi*). More research would be needed to ascertain the levels of hybridization of these species. The Lesser bushbaby (*Galago moholi* - CITES II) is an arboreal species usually found in the semiarid scrub woodlands and savanna grasslands of central southern Africa (Alvarado, 2000). The finding of this species in the Coastal Forest Mosaic of southern Tanzania therefore represents a range extension.

Birds

Mtiniko proposed FR is unique among the reserves studied because of the presence of avifauna of ecological and conservation importance. This is the only reserve where forest dependent species were recorded in large numbers, including the Reichenow's batis (*Batis reichenowi* - Coastal Forests Endemic), the Yellow streaked greenbul (*Phyllastrephus flavostriatus*), the Fischer's greenbul (*Phyllastrephus fischeri*), the African broadbill (*Smithornis capensis*), the Blue-mantled crested flycatcher (*Trochocercus cyanomelas*) and the East coast akalat (*Sheppardia gunningi* - Vulnerable). The dense understory of Mixed dry

¹⁷ At present *R. petersi* has been recorded to occur only in the Eastern Arc Mountains and in the Coastal Forests as far as the Rufiji River. South of the Rufiji River and further down into Mozambique, *R. cirnei* has been recorded instead (Rathbun and Butinski, 2005; Corbet, 1970).

forest, characterised by numerous lianas and shrubs, and the absence of severe disturbance from fire explain the presence of these forest dependent species and of a large number of understory species in general (15) (Sinclair and Ryan, 2003). *Sheppardia gunningi* has a restricted distribution in the Coastal Forests and a few other forest types in Tanzania, Kenya, Malawi, and Coastal Mozambique. This species also appears as Vulnerable on the IUCN Red List (2004), and the relatively high number of individuals captured indicates that Mtiniko proposed FR is an important area for this threatened species. *Batis reichenowi* also highlights the importance of Mtiniko proposed FR for birds, being the only Coastal Forests endemic bird species recorded in this study. *B. reichenowi* has been recognised as a separate species from the Forest batis (*Batis mixta*) by Mlingwa *et al.* (2000) and Baker and Baker (2002). However, IUCN (2004) and BirdLife International (2005) classify both species as *B. mixta*, and under this classification this bird is considered to be more widespread than if it was a separate species, and therefore of less interest. Mtiniko proposed FR constitutes the Mtwara District Coastal Forests IBA (TZ052 - category A1) (BirdLife International, 2005) because of the previously recorded presence of more than a threshold population of the Southern banded snake eagle (*Circaetus fasciolatus*), a species categorized as near threatened by the IUCN Red List (2004). *Circaetus fasciolatus* was recorded in Mtiniko proposed FR during this study, along with another IUCN threatened species (*S. gunningi* - Vulnerable) and a species listed by in CITES Appendix I (*Falco peregrinus*), confirming the classification of this reserve. If *Batis reichenowi* was to be confirmed as a separate species from *B. mixta*, then this IBA would become part of a Secondary or Full Endemic Bird Area (EBA) (Baker and Baker, 2002).

Reptiles

Despite the relatively extensive and dense Mixed dry forest found in Mtiniko proposed FR (see Flora section), the reptile species richness was very low (2 captured species). This figure may be a consequence of the rapid nature of this study, which did not permit comprehensive collection of data during the wet season and the study of fossorial species (Broadley and Howell, 2000). Further studies during the wet season would be likely to yield a higher number of species. The species captured were the Mozambique agama (*Agama mossambica*) and the Speckle-lipped skink (*Trachylepis maculilabris*), which are known to be widespread in south-eastern Tanzania and adapted to various types of habitat (Spawls *et al.*, 2002).

Amphibians

For the amphibians only one individual of the Grey tree frog (*Chiromantis xerampelina*) was collected, which is typical of wooded grassland (Channing 2001). Again, the low number of species recorded may reflect the hot and dry climate at the time of this study, and a survey during the wet season would probably yield more results.

Butterflies

For the butterflies the number of species recorded (17) was moderate when compared to the high number of individuals captured (183). This is a consequence of the fact that two thirds of the total number of individuals captured was represented by the Golden piper (*Eurytela dryope angulata*). This species is particularly attracted to banana bait used by this study (Larsen, 1996) so the number of captures may misrepresent its dominance within the butterfly community. The Mixed dry forest found in this reserve is characterised by a dense understory (see section on Flora), so constituting a good habitat for forest dependent species (Kielland and Cordeiro, 2000). Three forest dependent species were consequently observed: the Silver striped charaxes (*Charaxes lasti lasti*), the Gold banded forester (*Euphaedra neophron littoralis*) and a Glider species (*Harma theobene blassi*). *Charaxes lasti lasti* is particularly important as it is endemic to the closed-canopy lowland forest of the Eastern Arc and Coastal Forests of Kenya and Tanzania (Congdon and Bampton, 2005).

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

Results suggest that disturbance in Mtiniko proposed FR is negligible, with one of the lowest levels of encroachment found among the reserves surveyed and only 2% of poles and 1% of timbers being cut. However, residents stated that boundary demarcation has not taken place in the past 20 years and therefore it is difficult to determine the real extent of encroachment into the reserve. Moreover, several recently active and old pit sawing sites were witnessed (Appendix 8) and 12% of the cut poles were freshly cut, suggesting that illegal off-take of timber may be ongoing and higher than the study indicates. Local people were also found to be paid to cut timber inside the proposed reserve, suggesting that timber extraction is an organised business. Further studies would be required to ascertain the level of timber cutting and the market destination of the timber. The most common species used for timber in the study area (*Swartzia madagascariensis*, *Azelia quanzensis*, *Dalbergia melanoxylon*, *Milicia excelsa*) are either uncommon in this reserve or too small in size to yield timber. Thus different species, such as the potentially threatened *Bombax rhodognaphalon*, are currently exploited.

From meetings with village representatives it transpired that the local attitude towards the protection of the forest is largely negative. This stems from the fact that no information has been forthcoming about why the government is protecting this forest — no water source is present here and the inhabitants feel that its size should be halved to increase the amount of farmland available to them. The high levels of pit sawing and a lack of value attached to the forest indicates that action to protect this reserve is more urgently needed than the low level of disturbance detected by this study suggests.

17. MTULI HINJU PROPOSED FOREST RESERVE



Status	Proposed Forest Reserve
Management Body	Central Government
Location	Mtwara Rural District. Between the villages of Mtuli Mjengua and Hinju, on the main road between Newala and Mtwara.
Area	296ha
Altitude	215-260m asl
Topography	Lowland plain
Temperature	Min: 17°C, Max: 31°C (recorded 17-19 June, dry season)
Rainfall	Average 0mm (recorded 17-19 June, dry season)
Soil type	Sandy-loam
Vegetation type	Eastern African coastal Legume-dominated dry forest
Land Use	The area was proposed as a reserve to preserve a water source and to protect timber resources. Encroachment of cultivated land, pole extraction and hunting take place.
History and Status	The area was first planned to be a forest reserve in 1976 and is still yet to be fully gazetted. There is no effective capacity, in terms of staff or resources available, to enforce protected area legislation and regulations
Maps	Topographical map: Ndanda South sheet 306/1, East Africa 1:50 000, 1968. From the Institute of Mapping, Dar es Salaam (from Series Y742, Edition 1-TSD).

METHODS

Survey work was conducted over five days (17-19 June 2005). Five vegetation plots (2000m²), five regeneration plots (20m²), and one zoosite were carried out, incorporating 120

sherman trapping nights, 30 bucket trapping nights, four man/hours of timed herpetofauna searches, 15 bat mist net/hours, 24.5 man/hours of bird mist netting, seven man/hours of timed bird searches, nine canopy trapping days, two butterfly sweep net/hours, two animal sign transects of 1km and 900m respectively (totalling 7600m²), two disturbance transects of 1km and 900m respectively (totalling 19,000m²), and opportunistic observations (see Appendices 2 to 8 for GPS coordinates and work site descriptions). Habitat notes were taken for vegetation plots (Appendices 4 and 5) and zoological trap sites (Appendix 6). Structured interviews and open discussions were conducted with three elders from the village of Hinju. For a detailed break down of survey effort see Table 10-a.

RESULTS

In Mtuli Hinju proposed FR 122 plant species were recorded from 12 families. Six percent of the total number of floral species are endemic to the Swahilian region *sensu lato* and 8% are listed as threatened (IUCN, 2004) or potentially threatened (Gereau and Luke, 2006) (Table 17-a; Appendices 9 and 10).

Eighty-five faunal species were found representing 49 families. Of these species 6% are forest dependent, 1% are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains and 1% are listed as threatened by IUCN (2004) and/or CITES (2005) (Table 17-a; Appendices 13-17).

Table 17-a Summary of fauna and flora recorded in Mtuli Hinju Proposed FR

Taxa	No. of families	No. of species ^c	No. of forest dependent species ^d	No. of wide-spread species	No. of strictly endemic species: ^e and ^f	No. of threatened species: ^g and ^h	No. of PT species ⁱ
Mammals	8	11	1	10	0	1	-
Birds ^a	32	56	2	54	0	0	-
Reptiles	1	1	0	1	0	0	-
Amphibians	3	6	0	6	0	0	-
Butterflies	5	11	2	11	1	0	-
Total for animals	49	85	5	82	1	1	-
Flora ^b	12	122	0	115	7	1	9
Combined Total	61	207	5	197	8	2	9

a - Includes birds seen on the forest boundary edge

b - All trees, shrubs, herbs, grasses and ferns

c - Includes information collected from all systematic survey work, opportunistic observations, structured interviews and open discussions

d - Species dependent on and associated with primary or closed-canopy forest, not forest edge or secondary forest

e - Faunal species with limited ranges in the Coastal Forests alone or the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a), sometimes being found also in other habitats in a few adjacent locations (e.g. Masasi District in S Tanzania, N Mozambique etc.)

f - Floral species restricted to the Swahilian region *sensu lato* (Clarke and Robertson, 2000)

g - Species listed as Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) in the IUCN Red List (IUCN, 2004)

h - Species listed in CITES Appendix I as threatened with extinction and excluded from international trade (CITES, 2005)

i - Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

*The identification of *Crocidura* sp. may increase this number. We await verification

FLORA

In Mtuli Hinju proposed FR one single homogeneous vegetation stand was observed, which was identified as Legume-dominated dry forest interspersed by cultivated and fallow farmland.

- *Species richness and diversity*

A total of 122 species were recorded. Of these, 47 species were found in five vegetation plots and 18 species were recorded in five regeneration plots. The other 57 species were recorded from opportunistic collection made within the reserve. More specifically, 53 trees, 45 shrubs, ten herbs, seven lianas and seven grasses and sedges were recorded (Appendix 9). A value of 2.21 was calculated for the Shannon diversity index.

- *Species dominance*

Pterocarpus angolensis and *Albizia gummifera* were dominant in the canopy layer, occurring in 100% and 75% of the plots respectively and ranking as the most dominant species. *Pseudolachnostylis maprouneifolia* was frequent, occurring in 50% of the plots (Table 17-b).

Table 17-b Species frequency, dominance, rank dominance, no. of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the canopy layer in Legume-dominated dry forest in Mtuli Hinju proposed FR

Family	Genus	Species	F	% RF (Dominance)	Rank dominance	No. indiv. in all plots	%RA	Rank RA
FABACEAE (PAP)	<i>Pterocarpus</i>	<i>angolensis</i>	4	100	1	12	27	1
FABACEAE (MIM)	<i>Albizia</i>	<i>versicolor</i>	3	75	2	5	11	2
EUPHORBIACEAE	<i>Pseudolachnostylis</i>	<i>maprouneifolia</i>	2	50	3	4	9	3
COMBRETACEAE	<i>Pteleopsis</i>	<i>myrtifolia</i>	1	25	4	1	2	4
FABACEAE (PAP)	<i>Pericopsis</i>	<i>angolensis</i>	1	25	4	1	2	4
Total¹	4	5				23	51	
Total²	8	13				44	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

The sub canopy layer was dominated by *Combretum molle* occurring in 75% of the plots. Other frequent species were *Cassia petersiana* and *Crossopteryx febrifuga*, both occurring in 50% of the plots (Table 17-c).

Table 17-c Species frequency, dominance, rank dominance, no. of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the sub canopy layer in Legume-dominated dry forest in Mtuli Hinju proposed FR

Family	Genus	Species	F	% RF (Dominance)	Rank dominance	No. indiv. in all plots	%RA	Rank RA
COMBRETACEAE	<i>Combretum</i>	<i>molle</i>	3	75	1	7	16	1
FABACEAE (CAES)	<i>Cassia</i>	<i>petersiana</i>	2	50	2	5	11	2
RUBIACEAE	<i>Crossopteryx</i>	<i>febrifuga</i>	2	50	2	2	5	3
FABACEAE (CAES)	<i>Swartzia</i>	<i>madagascariensis</i>	1	25	3	1	2	4
FABACEAE (PAP)	<i>Lonchocarpus</i>	<i>bussei</i>	1	25	3	1	2	4
Total¹	4	5				16	36	
Total²	8	13				44	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

- *Species relative abundance*

In the canopy layer about 27% of the trees recorded were individuals from *Pterocarpus angolensis*, while *Albizia versicolor* contributed up to 11% and *Pseudolachnostylis maprouneifolia* about 9% (Table 17-b). In the sub canopy layer, *Combretum molle*, *Cassia petersiana* and *Crossopteryx febrifuga* were the top three species, together making up 32% (Table 17-c).

When looking at the overall number of trees recorded in both the canopy and sub canopy layers, the canopy layer (59%) contributes a slightly higher number of individuals than the sub canopy layer (41%) to the overall number of adult trees in this reserve.

- *Species composition and vegetation types*

Mtuli Hinju proposed FR is comprised of one single homogeneous vegetation stand; the species composition and relative abundance indicated this to be **eastern African coastal legume-dominated dry forest** (Clarke and Robertson, 2000).

The species composition was dominated in the canopy layer by species from the Legume family, such as *Pterocarpus angolensis* (subfamily Papilionideae) and *Albizia versicolor*, (subfamily Mimosoideae). Other species occurring in the canopy layer included *Pseudolachnostylis maprouneifolia*, which ranked as frequent, *Pteleopsis myrtifolia*, *Pericopsis angolensis*, *Bombax rhodognaphalon*, *Hymenaea verrucosa* and *Hymenocardia ulmoides*. The sub canopy layer was characterised by the presence of legume species such as *Cassia petersiana*, which ranked as frequent, and other species such as *Swartzia madagascariensis*, *Lonchocarpus bussei*, *Sclerocarya birrea*, *Azelia quanzensis* and *Combretum molle*, a species often associated with legume species.

In the shrub layer the most frequently encountered species were *Mesogyne insignis*, *Suregada zanzibarensis*, *Rinorea elliptica*, *Antidesma venosum*, *Antidesma membranaceum*, *Memecylon* sp. and *Grewia lepidopetala*. In more open areas species from the genus *Combretum*, and species such as *Salacia madagascariensis*, *Ochna kirkii*, *Strychnos spinosa*, *S. madagascariensis*, *S. mosambicensis*, *Cleistanthus schlechteri*, *Markhamia obtusifolia*, *Tetracera boiviniana*, *Flacourtia indica* and *Croton pseudopulchellus* were observed. Lianas from various species were recorded, and the most common climbers encountered included *Dalbergia armata*, *Grewia* sp., *Acacia brevispica*, *Capparis tomentosa*, *Dioscorea hirtiflora* and a species of *Dioscorea* for which we are awaiting identification.

The herbaceous layer was formed by grasses such as *Sporobolus* sp. and *Themeda triandra*, together with herbs such as *Dicoma tomentosa*, *Jussiaea repens*, *Hypoestes* sp., *Asparagus africanus*, *Asparagus* sp., *Hibiscus* sp., *Vernonia* sp., *Commelina* sp. and *Jasminum* sp.

- *Endemism and conservation status*

Seven of the species recorded were found to be endemic to the Swahilian region *sensu lato*, including *Tetracera boiviniana*, *Cleistanthus schlechteri*, *Erythrina schliebenii*, *Xylothea tettensis*, *Rytigynia decussata*, *Cola clavata* and *Grewia lepidopetala* (Clarke and Robertson, 2000) (Appendix 10) and this accounts for 6% of all species recorded (Figure 13).

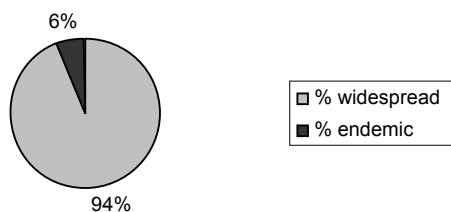


Figure 13 Percentage floral species endemic to the Swahilian region *sensu lato* and those that are widespread in Mtuli Hinju proposed FR

Ten among the species recorded are threatened (IUCN, 2004) or potentially threatened (Gereau and Luke, 2006), amounting to 8% of the total number of species recorded (Table 17-d).

Table 17-d Threatened and potentially threatened plant species in Mtuli Hinju proposed FR

Family	Species name	Conservation status	Habit
CELASTRACEAE	<i>Maytenus mossambicensis</i>	PT	S/T
FABACEAE (CAES)	<i>Cassia abbreviata</i>	PT	T
FABACEAE (MIM)	<i>Acacia nilotica</i>	PT	T
FABACEAE (PAP)	<i>Craibia brevicaudata</i>	PT	T
FABACEAE (PAP)	<i>Erythrina schliebenii</i>	PT	T
FLACOURTIACEAE	<i>Xylothea tettensis</i>	PT	S
MORACEAE	<i>Mesogyne insignis</i>	VU	S/T
RUBIACEAE	<i>Lasianthus kilimandscharicus</i>	PT	S/T
RUBIACEAE	<i>Rytigynia decussata</i>	PT	S
STERCULIACEAE	<i>Cola clavata</i>	PT	S/T

PT = Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

T= Tree, S= Shrub, B= Bamboo, C= Climber, H= Herb

FAUNA

Although the identification of about 90% of the species recorded is certain, the identification of a few specimens remains tentative whilst awaiting taxonomic verification.

Mammals

- *Species richness and composition*

A total of 11 mammals representing eight families were recorded (Appendix 13).

For the *small mammals* five species representing three families were recorded from nine captures (excluding four recaptures) that took place during 120 sherman trapping nights and 30 bucket pitfall trapping nights (Appendix 18). Species included the Spiny mouse (*Acomys spinosissimus*) and the Multimammate rat (*Mastomys natalensis*). *Acomys spinosissimus* made up 77% of all captures.

No bats were recorded during 15 bat mist net/hours.

For the *larger mammals*, six species representing six families were recorded during sign transects totalling 1.9km, opportunistic observations and from local knowledge. Species found included the Blue duiker (*Cephalophus monticola*) and the Chequered elephant shrews (*Rhynchocyon cirnei*). The South African galago (*Galago moholi*)¹⁸ was found in patches of close-canopy forest in the valleys. No one species was recorded on more than two separate occasions. From interviews with local communities it was also learnt that the Lion (*Panthera leo*) occasionally passes through the forest.

- *Forest dependence, endemism and conservation status*

One species was found to be forest dependent and one is listed as threatened by the IUCN Red List (2004) (Table 17-e). No species were found to be strictly endemic to the Coastal Forests and/or Eastern Arc Mountains. One species is listed as threatened.

Table 17-e Forest dependent, endemic and threatened mammal species in Mtuli Hinju proposed FR

Species	Common name	Forest dependent	Endemic	Threatened
<i>Rhynchocyon cirnei</i>	Chequered elephant shrew	-	-	VU
<i>Cephalophus monticola</i>	Blue duiker	F	-	-

F= Forest dependent or specialist (Burgess *et al.*, 2000a)

CF= species with limited ranges in the Coastal Forests alone; EACF= species with limited ranges in the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

Birds

- *Species richness and composition*

Fifty-six species from 32 families were recorded from 24.5 hours of mist netting and seven hours of timed bird searches. Mist netting yielded seven species from a total of 15 captures and opportunistic observations yielded 49 species. The White-faced whistling-duck (*Dendrocygna viduata*), the African pygmy-goose (*Nettapus auritus*), the African jacana (*Actophilornis africanus*) and the Black crane (*Amaurornis flavirostris*) were recorded on a large body of water. Other species found were the African broadbill (*Smithornis capensis*) and the Livingstone's flycatcher (*Erythrocerus livingstonei*) (Appendix 14).

¹⁸ The field identification of *Galago moholi* was undertaken by Frontier-Tanzania research team.

- *Forest dependence, endemism and conservation status*

Two forest dependent species, the African broadbill (*Smithornis capensis*) and the Blue-mantled crested flycatcher (*Trochocercus cyanomelas*), were found. None of the species found are strictly endemic or threatened.

Reptiles

- *Species richness and composition*

One species of reptile was recorded from one sighting that took place during 30 bucket pitfall trapping nights and six man/hours of herpetological searches. The sole species recorded was the Nile monitor (*Varanus niloticus*) (Appendices 15 and 18).

- *Forest dependence, endemism and conservation status*

No species were found to be forest dependent, strictly endemic or threatened.

Amphibians

- *Species richness and composition*

Six species of amphibian representing three families were recorded from 10 captures that took place during 30 bucket pitfall trapping nights and six man/hours of herpetological searches. Species recorded included the Spotted reed frog (*Hyperolius punctulatus*), Fornasini's spiny reed frog (*Afrixalus fornasinii*), the Yellow-spotted tree frog (*Leptopelis flavomaculatus*) and the Mozambique ridged frog (*Ptychadena mossambica*) (Appendices 16 and 18).

- *Forest dependence, endemism and conservation status*

No species were found to be forest dependent, strictly endemic or threatened.

Butterflies

- *Species richness and composition*

Eleven species of butterfly representing five families were recorded from 52 captures that took place during nine canopy trapping days and two sweep net/hours (Appendix 17). The Golden piper (*Eurytela dryope angulata*) accounted for 38% and the Common bush brown (*Bicyclus safitza safitza*) for 17% of these captures.

- *Forest dependence, endemism and conservation status*

Two species from the family Nymphalidae, the Silver striped charaxes (*Charaxes lasti lasti*) and the Common sailor (*Neptis alta*), are forest dependent. One species, *C. lasti lasti*, is restricted to the closed-canopy lowland forest of the Eastern Arc and Coastal Forests of Kenya and Tanzania.

Fauna's strict endemism

None of the faunal species recorded in Mtuli Hinju proposed FR is endemic to the Coastal Forests and/or Eastern Arc Mountains.

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

Disturbance transects were used to record the level of disturbance from encroachment, pole cutting, bark ringing, fire damage and paths. Of forty 50m sections that were conducted, 17 (43%) were free of disturbance. This was the highest percentage of undisturbed sections of any reserve. Seventeen (43%) contained evidence of pole cutting, six (15%) showed signs of fire, three (8%) contained one or more paths, two (5%) contained cultivated crops (predominantly maize) and one (3%) contained a trap (Figure 14). Resource use is summarised in Table 17-g.

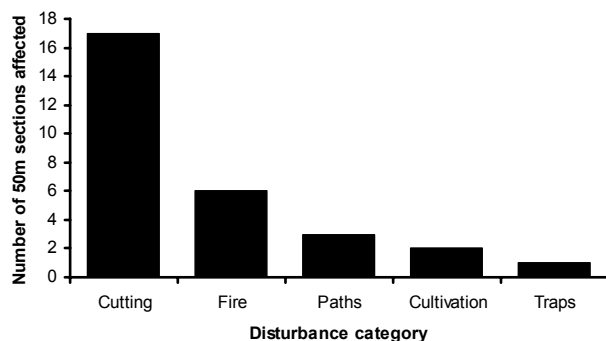


Figure 14 Number of 50m sections (from a total of 23) affected by different forms of human disturbance along transects in Mtuli Hinju proposed FR

Agricultural encroachment

Only two 50m sections were found to contain signs of cultivation (Figure 14).

Poles and timbers

Disturbance transects revealed that three main species (*Azelia quanzensis*, *Milicia excelsa* and *Pterocarpus angolensis*) are harvested for timber. Four other species are also used as identified by both disturbance transects and structured interviews. Transects indicated that poles are commonly obtained from 11 different species (Table 17-g). One example of recently active pit sawing was detected which targeted a large side branch from *Azelia quanzensis*, therefore not causing the death of the tree (Appendix 8). Previously, *Pterocarpus angolensis* was harvested for sale but the village elders say that this practice has been discontinued.

- *Relative abundance and average no. of live, dead and cut individuals per ha*

Approximately 6% of poles and 4% of timbers were found to have been cut, while no cut large timbers were detected. One fresh cut pole was detected (Table 17-f).

Table 17-f Summary of pole, timber and large timber cutting in Mtuli Hinju proposed FR

	Total transect length in m	Total no. of indiv. sampled	Total no. (and % RA) of live indiv.	Average live indiv. per ha	Total no. (and % RA) of dead indiv.	Average dead indiv. per ha	Total no. (and % RA) of cut indiv.	Average cut indiv. per ha
Poles	1,900	1176	1007 (86)	530	98 (8)	5	71 (6)	37
Timbers	1,900	292	238 (81)	125	43 (15)	23	11 (4)	6
Large timbers	1,900	6	6 (100)	3	0 (0)	0	0 (0)	0

Fuel wood

Interviews revealed that fuel wood is usually collected from dead trees and cashew nut (*Anacardium occidentale*) trees. From transects there appeared to be much potential fuel wood in the area (15% of all timbers were found to be dead) (Table 17-g).

Tools and utensils

Through discussion, several species were identified to be used for tool handles and ropes (Table 17-g). We did not observe any evidence of bark ringing throughout the reserve.

Edible non-timber forest products

Interviewees reported nine species as sources of food for the local communities (Table 17-g).

Medicinal plants

Thirteen plant species were identified by the residents as commonly utilised for medicinal purposes (Table 17-g, Appendix 11).

Table 17-g Plant species utilised in Mtuli Hinju proposed FR as identified by field observations, structured interviews and open discussion. Local names, where known, are presented in Appendix 9

Family	Species	Poles	Timber	Fuel wood	Tools	Ropes	Food	Medicine
ANACARDIACEAE	<i>Sclerocarya birrea</i>			X			X	X
ANNONACEAE	<i>Annona senegalensis</i>	X		X		X	X	
APOCYNACEAE	<i>Landolphia buchananii</i>						X	
COMBRETACEAE	<i>Pteleopsis myrtifolia</i>			X				
DILLENIACEAE	<i>Tetracera boiviniana</i>							X
DIOSCOREACEAE	<i>Dioscorea hirtiflora</i>						X	
FABACEAE (CAES)	<i>Afzelia quanzensis</i>	X	X	X	X			X
FABACEAE (CAES)	<i>Brachystegia microphylla</i>	X		X		X		
FABACEAE (CAES)	<i>Cassia petersiana</i>	X						X
FABACEAE (CAES)	<i>Swartzia madagascariensis</i>		X	X	X			
FABACEAE (MIM)	<i>Albizia gummifera</i>	X	X	X		X		
FABACEAE (MIM)	<i>Albizia versicolor</i>	X	X	X	X			
FABACEAE (PAP)	<i>Dalbergia melanoxylon</i>		X	X	X			
FABACEAE (PAP)	<i>Lonchocarpus bussei</i>	X		X	X			X
FABACEAE (PAP)	<i>Pterocarpus angolensis</i>		X	X	X			X
FLACOURTIACEAE	<i>Flacourtia indica</i>			X		X	X	X
HYMENOCARDIACEAE	<i>Hymenocardia ulmoides</i>			X	X	X		X
LOGANIACEAE	<i>Strychnos cocculoides</i>	X		X	X		X	X
LOGANIACEAE	<i>Strychnos madagascariensis</i>	X						
LOGANIACEAE	<i>Strychnos usambarensis</i>	X						
MORACEAE	<i>Ficus sur</i>			X			X	
MORACEAE	<i>Milicia excelsa</i>		X		X			X
MORACEAE	<i>Mesogyne insignis</i>	X		X	X			
RUBIACEAE	<i>Vangueria infausta</i>						X	
RUTACEAE	<i>Zanthoxylum chalybeum</i>							X
SAPOTACEAE	<i>Bequaertiodendron natalense</i>	X			X			X
STERCULIACEAE	<i>Cola greenwayi</i>				X			
VERBENACEAE	<i>Vitex doniana</i>				X		X	X

Hunting

The people interviewed stated that no hunting takes place in the area. Our study located only one trap in the proposed reserve suggesting that hunting pressure is low.

Management

The local inhabitants of the area have an environmental committee that patrol the forest. A Forestry Officer visits the reserve once a month. It was not clear from structured interviews and open discussions why Mtuli Hinju proposed FR is regularly visited by a Forestry Officer while other studied reserves are not.

DISCUSSION

FLORA

Mtuli Hinju proposed FR is mainly comprised of eastern African coastal Legume-dominated dry forest and affected from a relatively low degree of encroachment and timber extraction. The canopy layer is dominated by species from the Legume family such as *Pterocarpus angolensis* (subfamily Papilionideae) and *Albizia versicolor*, (subfamily Mimosoideae). A variation can be observed within this vegetation type according to the topography and edaphic conditions occurring within the reserve. In the valley, where moisture content is relatively high and deeper soils have developed, the forest looks comparatively denser, with a high number of shrubs and large trees from the Fabaceae family. On the slopes of the ridge, where soils are thinner, the forest is less dense and species from the Papilionaceae family appear, particularly *Pterocarpus angolensis*.

Mtuli Hinju proposed FR was found to have the highest floral species richness (122 species) encountered in this study, with important species such as *Mesogyne insignis* (Vulnerable), *Tetracera boiviniana*, *Erythrina schliebenii*, *Xylothea tettensis*, *Rytigynia decussata* and *Cola clavata* (Endemic and Potentially Threatened), which is remarkable when considering the small size of this reserve (296ha). This species rich plant community probably reflects the relatively low levels of encroachment and timber extraction occurring in this reserve. The Shannon diversity index for this forest reserve ($H^1=2.21$) is relatively low in relation to the total number of species recorded. This reflects a stable community where the more competitive and productive species, particularly from the canopy and sub canopy layer, have reached high rates of population growth and have come to dominate (Magurran, 1988; Begon *et al.*, 1996).

Even though human disturbance was low when compared to other reserves studied, some degree of timber extraction and agricultural encroachment was observed. The small size of this reserve (296ha) and the low regeneration capacity of Legume-dominated forest mean that the continuity of this forest is particularly threatened by human disturbance (Ndangalasi, 1997). The seeds of the Fabaceae trees are heavy and not dispersed by wind or animal. Moreover, these seeds do not remain viable in the seed bank for long, do not tolerate desiccation, require a forest microclimate (shade and high-humidity) to germinate and are pyrophobic (Clarke, 2000). Therefore, the complete clearance of this forest type drastically lowers the chances of its regeneration on the same sites, which then can become dominated by more easily dispersed pioneer tree species characteristic of mixed dry forest and mixed scrub forest (Clarke, 2000). It is therefore important to protect this vulnerable and unique plant community.

FAUNA

The major importance of Mtuli Hinju proposed FR lies in its wetland. This is a year-round source of water for many people in the surrounding area and hosts a number of bird, amphibian and reptile species. The overall low number of species (85) recorded was unexpected when considering that disturbance was amongst the lowest here, but may be reflective of the small size of this reserve (296ha) and low sampling intensity applied to it (Table 10-a).

Small mammals

For the small mammals the overall number of species captured was low (2), reflecting the small size of the reserve and the low sampling intensity applied to this reserve. The Spiny mouse (*Acomys spinosissimus*), a species that inhabits open and dry areas (Kingdon, 2006), was found to be dominant in areas of open grassland and at the edges of cultivated land in and

around the reserve. *Mastomys natalensis* is known to frequent a variety of habitats and in Southern Tanzania is a recurrent member of the rodent community (Kingdon, 1974).

Large mammals

The small size of this reserve may limit its ability to support viable large mammal populations, and explains the low number of large mammal species (6) and individuals recorded (no one species was recorded on more than two separate occasions). The finding of the Chequered elephant shrew (*Rhynchocyon cirnei*), a species listed as Vulnerable (IUCN, 2004), confirms the Coastal Forests to be a globally important area for this genus, closely followed by the Eastern Arc Mountains (Burgess *et al.*, 2000a). *Rhynchocyon* species are forest-dwellers that rely on dense vegetation cover to produce the thick leaf litter they require for foraging and nest construction (Rathbun, 2005). *R. cirnei* may therefore become locally threatened should further habitat destruction ensue. The South African bushbaby (*Galago moholi* - CITES II) is an arboreal species usually found in the semiarid scrub woodlands and savanna grasslands of central southern Africa (Alvarado, 2000). In Mtuli Hinju *G. moholi* was found in patches of closed-canopy forest, especially in the valleys, therefore indicating a range extension of this species in the Coastal Forests of southern Tanzania. The Striped bush squirrel (*Paraxerus flavovittis*) and the Mutable sun squirrel (*Heliosciurus mutabilis*) were found in their preferred habitat, i.e. in areas of open grassland and at the edges of cultivated land in and around the reserve. The Lion (*Panthera leo* - Vulnerable, CITES II) occasionally pass through the forest but its presence has allegedly reduced in recent years. This may be due to an increase in human population and disturbance in the area. Populations of the Blue Duiker (*Cephalophus monticola* - CITES II) will be the most adversely affected if further human disturbance ensues, given the dependency of this species on a closed-canopy forest habitat.

Birds

The number of species recorded was relatively low (56), and only two forest dependent species, the African broadbill (*Smithornis capensis*) and the Blue-mantled crested flycatcher (*Trochocercus cyanomelas*), were found. These findings may reflect the small size of this reserve (296ha) as well as the low sampling intensity of the study in this reserve (Table 10-a). However, the importance of Mtuli Hinju proposed FR for birds lies in its large wetland, on which four species were detected that were not found elsewhere during this study: the White-faced whistling-duck (*Dendrocygna viduata*), the African pygmy-goose (*Nettapus auritus*), the African jacana (*Actophilornis africanus*) and the Black crane (*Amaurornis flavirostris*).

Reptiles

Mtuli Hinju proposed FR hosts a water body, is largely covered by forest and is relatively free from disturbance; consequently, it would be expected to host a significant number of species and individuals. Instead, only the Nile monitor (*Varanus niloticus* - CITES II) was recorded, which is a common species known to frequent any suitable water source (Spawls *et al.*, 2002). The very low species richness recorded may be reflective of the low sampling intensity applied to this reserve (Table 10-a), as well as a consequence of the continuous disturbance by people collecting water from the spring.

Amphibians

For the amphibians the number of species (6) and individuals (10) captured was low. All species, with the exception of *Leptopelis flavomaculatus*, occurred around the water source, where dense vegetation and moist humus soil create an ideal breeding ground (Howell, 1993). Apart from the Yellow-spotted tree frog (*Leptopelis flavomaculatus*) and the Spotted reed frog (*Hyperolius punctulatus*), the majority of the species captured are non-forest dwelling (e.g. *Afraxalus fornasinii* and *Ptychadena mossambica*) (Schiotz, 1999; Channing, 2001). The intrusion into forested areas by species that normally inhabit transient open habitats is known

to be a recurrent characteristic encouraged by the heterogeneous pattern of the Coastal Forest Mosaic, whereby such species continue breeding in their open habitat but enter the enclosed habitat for refuge, especially during dry periods (Poynton, 2000). Many species recorded are water dependent, therefore the quality of the water source and the forest cover protecting it are vital to their continued presence.

Butterflies

For the butterflies there was a low number of species (11) recorded from an average number of individuals (52) captured. The low species richness observed cannot be linked to the structure of the plant community found here, since the Legume-dominated dry forest dominant in Mtuli Hinju proposed FR is characterised by a relatively dense understory, especially in the valleys, and affected by a relatively low degree of deforestation (see Flora section). The low species richness observed is therefore probably a consequence of the small size of this reserve and short period of time spent studying it (Kielland and Cordeiro, 2000) (Table 10-a). These factors may also explain why only two forest dependent species were recorded the Silver striped charaxes (*Charaxes lasti lasti*) and the Common sailor (*Neptis alta*). Over 50% of the total numbers of individuals were represented by the Golden piper (*Eurytela dryope angulata*). This species is particularly attracted to banana bait used by this study (Larsen, 1996) so the number caught may actually misrepresent its dominance within the butterfly community found here. *Charaxes lasti lasti* is particularly worth of notice as it is endemic to the closed-canopy lowland forest of the Eastern Arc and Coastal Forests of Kenya and Tanzania (Congdon and Bampton, 2005).

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

Overall, human disturbance was relatively low in Mtuli Hinju with respect to encroachment, timber extraction and hunting, and this reserve was one of the few where efforts were made by local inhabitants to manage it in a sustainable way. The inhabitants of the areas viewed the protection of the forest positively as its presence is vital for the persistence of the water supply, relied upon by a large number of villagers. However, some degree of timber extraction and agricultural encroachment was observed in areas in and around the reserve. The small size of this reserve (296ha) and the low regeneration capacity of its Legume-dominated forest mean that this forest and its water source are particularly vulnerable to human disturbance. Therefore, conservation efforts to protect them need to be sustained and supported.

18. MAKONDE SCARP III PROPOSED FOREST RESERVE



Status	Proposed Forest Reserve
Management body	Central Government
Location	Tandahimba district. West of Lidumbe and Mcholi villages.
Area	1,434.7ha
Altitude	340-435m asl
Topography	Lowland plain and gentle lower slope
Temperature	Min: 18°C, Max: 28°C (recorded 25-29 June, dry season)
Rainfall	Average 1.6mm (recorded 25-29 June, dry season)
Soil type	Sandy-loam
Vegetation type	Eastern African <i>Brachystegia</i> coastal forest and Thicket
Land Use	The reserve was proposed to prevent soil erosion on the plateau and scarp and to protect the water source and catchment. Crops are grown in the reserve, fuel wood and poles are extracted on a subsistence level and hunting occurs.
History and Status	Signs of destruction on the escarpment were noticed and documented in the 1940's (Maganga, 2004). Makonde Scarp III was agreed to be a proposed forest reserve in 1976, the same year as funding for boundary beacons was made available. In 1977 some residents were moved from the escarpment and relocated. In 1980 complaints by people who had been moved off their original properties were acknowledged, concluding that Tsh 40 million was needed for compensation. Compensation of Tsh 1.7 million was made available to Masasi District in 1983 and 1984 but no subsidies were made available to Newala and Tandahimba districts. Presently the site is not yet fully gazetted and there are no boundary markers. There is no

staff, effective capacity or resources to enforce protected area legislation and regulations.

Maps

Topographical map: Newala sheet 306/4, East Africa 1:50 000, 1968. From the Institute of Mapping, Dar es Salaam (from Series Y742, Edition 1-TSD).

METHODS

Survey work was conducted over seven days (23-29 June 2005). Nine vegetation plots (3600m²), nine regeneration plots (36m²), and one zoosite were carried out, incorporating 200 sherman trapping nights, 50 bucket trapping nights, 4.5 man/hours of timed herpetofauna searches, 18 man/hours of timed bird searches, 15 canopy trapping days, 4.5 butterfly sweep net/hours, three animal sign transects (totalling 12,000m²), three disturbance transects (totalling 30,000m²), and opportunistic observations (see Appendices 2 to 8 for GPS coordinates and work site descriptions). Ornithological work was conducted on separate days (28-30 June 2005). Bird mist netting was not conducted in this reserve as the camp was located some distance from the escarpment and in order to avoid theft nets could not be left unattended. No bat mist netting was conducted due to the alleged presence of large predators. Habitat notes were taken for vegetation plots (Appendices 4 and 5) and zoological trap sites (Appendix 6). Structured interviews and open discussions were arranged with three elders from Lidumbe village but they failed to attend. For a detailed break down of survey effort see Table 10-a.

RESULTS

In Makonde Scarp III proposed FR 90 plant species were recorded from 17 families. Nine percent of the total number of floral species are endemic to the Swahilian region *sensu lato* and 12% are listed as threatened (IUCN, 2004) or potentially threatened (Gereau and Luke, 2006) (Table 18-a; Appendices 9 and 10).

Ninety-three faunal species belonging to 46 families were recorded. Of these species 10% are forest dependent, 1% are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains and none are listed as threatened by IUCN (2004) and/or CITES (2005) (Table 18-a; Appendices 13-17).

Table 18-a Summary of fauna and flora recorded in Makonde Scarp III Proposed FR

Taxa	No. of families	No. of species ^c	No. of forest dependent species ^d	No. of wide-spread species	No. of strictly endemic species: ^e and ^f	No. of threatened species: ^g and ^h	No. of PT species ⁱ
Mammals	10	13	1	12	0*	0	-
Birds ^a	27	49	2	47	0	0	-
Reptiles	3	5	0	5	0	0	-
Amphibians	2	3	0	3	0	0	-
Butterflies	4	23	6	17	1	0	-
Total for animals	46	93	9	84	1	0	-
Flora ^b	17	90	0	72	8	2	9
Combined Total	63	183	9	156	9	2	9

a - Includes birds seen on the forest boundary edge

b - All trees, shrubs, herbs, grasses and ferns

c - Includes information collected from all systematic survey work, opportunistic observations, structured interviews and open discussions

d - Species dependent on and associated with primary or closed-canopy forest, not forest edge or secondary forest

e - Faunal species with limited ranges in the Coastal Forests alone or the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a), sometimes being found also in other habitats in a few adjacent locations (e.g. Masasi District in S Tanzania, N Mozambique etc.)

f - Floral species restricted to the Swahilian region *sensu lato* (Clarke and Robertson, 2000)

g - Species listed as Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) in the IUCN Red List (IUCN, 2004)

h - Species listed in CITES Appendix I as threatened with extinction and excluded from international trade (CITES, 2005)

i - Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

*The identification of *Crocodyra* sp. may increase this number. We await verification

FLORA

In Makonde scarp III proposed FR two homogeneous vegetation stands were observed, which were recognised as *Brachystegia* forest and Thicket and interspersed by cultivated and fallow farmland.

- *Species richness and diversity*

A total of 90 species were recorded. Out of these, 23 species were found in nine vegetation plots and 28 species were recorded in nine regeneration plots. The other 39 species were recorded from opportunistic collection made within the reserve. More specifically, 35 trees, 36 shrubs, 12 herbs and seven grasses were recorded (Appendix 9). A value of 2.75 was calculated for the Shannon diversity index.

- *Species dominance*

Within the eastern African coastal *Brachystegia* forest *Brachystegia microphylla* was the dominant species at the canopy level, occurring in 57% of the plots. Other frequent species included *Julbernardia globiflora*, *Pseudolachnostylis maprouneifolia* and *Pteleopsis myrtifolia*, all occurring in about 43% of the plots (Table 18-b).

Table 18-b Species frequency, dominance, rank dominance, no. of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the canopy layer in *Brachystegia* forest in Makonde Scarp III proposed FR

Family	Genus	Species	F	% RF (Domina nce)	Rank dominance	No. indiv. in all plots	%RA	Rank RA
FABACEAE (CAES)	<i>Brachystegia</i>	<i>microphylla</i>	4	57	1	15	21	1
FABACEAE (CAES)	<i>Julbernardia</i>	<i>globiflora</i>	3	43	2	5	7	2
EUPHORBIACEAE	<i>Pseudolachnostylis</i>	<i>maprouneifolia</i>	3	43	2	4	6	3
COMBRETACEAE	<i>Pteleopsis</i>	<i>myrtifolia</i>	3	43	2	4	6	3
FABACEAE (CAES)	<i>Hymenaea</i>	<i>verrucosa</i>	2	29	3	4	6	3
Total¹	3	5				32	46	
Total²	5	8				39	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

The sub canopy layer was dominated by *Diplorhynchus condylocarpon*, occurring in 57% of the plots (Table 18-c).

Table 18-c Species frequency, dominance, rank dominance, no. of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the sub canopy layer in *Brachystegia* forest in Makonde Scarp III proposed FR

Family	Genus	Species	F	% RF (Domina nce)	Rank dominance	No. indiv. In all plots	%R.A	Rank RA
APOCYNACEAE	<i>Diplorhynchus</i>	<i>condylocarpon</i>	4	57	1	6	29	1
ANACARDIACEAE	<i>Sorindeia</i>	<i>madagascariensis</i>	2	29	2	4	19	2
RUBIACEAE	<i>Crossopteryx</i>	<i>febrifuga</i>	2	29	2	2	9	3
FABACEAE (CAES)	<i>Azelia</i>	<i>quanzensis</i>	1	14	3	1	5	4
BIGNONIACEAE	<i>Markhamia</i>	<i>obtusifolia</i>	1	14	3	1	5	4
Total¹	5	5				14	67	
Total²	13	19				21	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

Dominance was not analysed for Thicket, as thickets do not comprise canopy and sub-canopy layers.

- *Species relative abundance*

In the canopy layer 21% of the trees recorded were individuals from *Brachystegia microphylla*, 7% were individuals from *Julbernardia globiflora*, while *Pseudolachnostylis maprouneifolia*, *Pteleopsis myrtifolia* and *Hymenaea verrucosa* made 6% each (Table 18-b). In the sub canopy layer *Diplorhynchus condylocarpon* contributed 29% of all individuals, *Sorindeia madagascariensis* 19%, *Crossopteryx febrifuga* 9%, and *Azelia quanzensis* and *Markhamia obtusifolia* about 5% each (Table 18-c).

When looking at the overall number of trees recorded in both the canopy and sub canopy layers, the canopy layer contributed a slightly higher number of individuals (54%) than the sub canopy layer (46%) to the overall number of adult trees in this reserve.

- *Species composition and vegetation types*

Makonde scarp III is comprised of two homogeneous vegetation stands, whose species composition and relative abundance confirmed to be **eastern African coastal *Brachystegia* forest** (Clarke and Robertson, 2000) and **Thicket**.

The species composition of the coastal *Brachystegia* forest was characterised by *Brachystegia microphylla* from the canopy layer and *Diplorhynchus condylocarpon* from the sub canopy layer as dominant species, making 15% and 29% of their respective layers. Other species occurring in the canopy layer included *Julbernardia globiflora*, *Pseudolachnostylis maprouneifolia* and *Pteleopsis myrtifolia*, which ranked as frequent, and *Albizia amara*, *Sterculia appendiculata*, *Milicia excelsa*, *Pterocarpus angolensis* and *Hymenaea verrucosa*. The sub canopy layer also included *Sorindeia madagascariensis*, *Crossopteryx febrifuga*, *Azelia quanzensis*, *Markhamia obtusifolia*, *Vangueria infausta*, *Markhamia acuminata*, *Commiphora africana*, *Sclerocarya birrea* and *Bauhinia petersiana*.

The shrub layer was observed to be comprised of shrub species such as *Combretum hereroense*, *Combretum zeyheri*, *Securidaca longipedunculata*, *Salacia madagascariensis*, *Antiaris toxicaria*, *Monotes africanus*, *Monodora junodii*, *Antidesma venosum*, *Grewia lepidopetala*, *Ochna holstii*, *Strychnos madagascariensis*, *Flacourtia indica* and *Croton pseudopulchellus*.

The herbaceous layer was comprised of grasses, particularly *Sporobolus* sp., *Themeda triandra*, together with herbs such as *Dicoma tomentosa*, *Jussiaea repens*, *Crotalaria* sp., *Maerua* sp., *Tephrosia* sp., *Hypoestes* sp. and *Jasminum* sp.

In Thicket shrubs such as *Securidaca longipedunculata*, *Antiaris toxicaria* and *Monotes africanus* were recorded.

- *Endemism and conservation status*

Eight of the species found were endemic to the Swahilian region *sensu lato*, including *Cussonia zimmermannii*, *Bombax rhodognaphalon*, *Tetracera boiviniana*, *Scorodophloeus fischeri*, *Xylothea tettensis*, *Sterculia appendiculata*, *Grewia lepidopetala* and *Aframomum orientale* (Clarke and Robertson, 2000) (Appendix 10) and this amounted to 9% of the total number of species recorded (Figure 15).

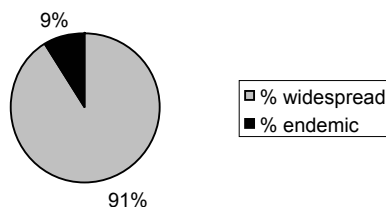


Figure 15 Percentage floral species endemic to the Swahilian region *sensu lato* and those that are widespread in Makonde Scarp III proposed FR

Eleven among the species recorded are threatened (IUCN, 2004) or potentially threatened (Gereau and Luke, 2006), amounting to 12% of the total number of species recorded (Table 18-d).

Table 18-d Threatened and potentially threatened plant species in Makonde Scarp III proposed FR

Family	Species name	Conservation status	Habit
ARALIACEAE	<i>Cussonia zimmermannii</i>	PT	T
BOMBACACEAE	<i>Bombax rhodognaphalon</i>	PT	T
DILLENIACEAE	<i>Tetracera boiviniana</i>	PT	S/T
EUPHORBIACEAE	<i>Drypetes natalensis</i>	PT	S/T
FABACEAE (CAES)	<i>Cassia abbreviata</i>	PT	S
FABACEAE (CAES)	<i>Scorodophloeus fischeri</i>	PT	T
FLACOURTIACEAE	<i>Xylothea tettensis</i>	PT	S
MELIACEAE	<i>Khaya anthotheca</i>	VU	T
MORACEAE	<i>Mesogyne insignis</i>	VU	S/T
RUBIACEAE	<i>Lasianthus kilimandscharicus</i>	PT	S/T
ZINGIBERACEAE	<i>Aframomum orientale</i>	PT	H

PT = Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

T= Tree, S= Shrub, B= Bamboo, C= Climber, H= Herb

FAUNA

Although the identification of about 90% of the species recorded is certain, the identification of a few specimens remains tentative whilst awaiting taxonomic verification.

Mammals

- *Species richness and composition*

A total of 13 mammals representing 10 families were recorded (Appendix 13).

For the *small mammals* five species representing three families were recorded from 24 captures (not counting three recaptures) that took place during 200 sherman trapping nights and 50 bucket pitfall trapping nights. Species commonly found were the Spiny mouse (*Acomys spinosissimus*), making up 67% of the total capture, the Multimammate rat (*Mastomys natalensis*) and the Lesser pouched rat (*Beamys hindei*). *Beamys hindei* was recorded in traps located in relatively undisturbed forest. Two species of the White-toothed shrew (*Crocidura* sp.) were also recorded (Appendix 18).

No *bat* mist netting was conducted in this proposed reserve as the game guard was unwilling to work at night due to the alleged presence of the Spotted hyena (*Crocuta crocuta*) and the Leopard (*Panthera pardus*).

For the *larger mammals*, eight species representing seven families were recorded during sign transects totalling 3km, through opportunistic observations and local knowledge. Species included the Greater galago (*Otolemur crassicaudatus*) and the Moloney's monkey (*Cercopithecus mitis* sub sp.). Vocalisations and signs of the Spotted hyena (*Crocuta crocuta*) were recorded every day during the survey.

- *Forest dependence, endemism and conservation status*

One species was found to be forest dependent, although many others often frequent and some favour a forested habitat. None of the species recorded are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains, yet one species has a restricted distribution in eastern Africa. None of the species found is listed as threatened (Table 18-e).

Table 18-e Forest dependent, endemic and threatened mammal species in Makonde Scarp III proposed FR

Species	Common name	Forest dependent	Endemic	Threatened
<i>Cercopithecus mitis</i> (sub sp.)	Moloney's monkey	F	-	-
<i>Beamys hindei</i>	Lesser pouched rat	-	EACF, a few other forest types in Kenya and Tanzania	-

F= Forest dependent or specialist (Burgess *et al.*, 2000a)

CF= species with limited ranges in the Coastal Forests alone; EACF= species with limited ranges in the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

Birds

- *Species richness and composition*

All 49 species, representing 27 families, were recorded from 18 man/hours of bird searches. Mist netting was not conducted in this reserve as the camp had to be located at a distance from the reserve and in order to avoid theft nets could be left unattended. Among the species found were the African broadbill (*Smithornis capensis*), the Livingstone's flycatcher (*Erythrocerus livingstonei*) and the Pale batis (*Batis soror*) (Appendix 14).

- *Forest dependence, endemism and conservation status*

Two forest dependent species, the African broadbill (*Smithornis capensis*) and the Blue-mantled crested flycatcher (*Trochocercus cyanomelas*) were recorded. No strictly endemic or threatened species were found.

Reptiles

- *Species richness and composition*

Five species of reptiles representing three families were recorded from six captures that took place during 50 bucket pitfall trapping nights and 4.5 man/hours of herpetological searches. Species recorded included the Mozambique vine snake (*Thelotornis mossambicanus*), two species of Sand snake (*Psammophis orientalis* and *P. mossambicus*) and the Mozambique agama (*Agama mossambica*) (Appendices 15 and 18).

- *Forest dependence, endemism and conservation status*

No species were found to be forest dependent, strictly endemic or threatened.

Amphibians

- *Species richness and composition*

Three species of amphibians representing two families were recorded from 20 captures that took place during 50 bucket pitfall trapping nights and 4.5 man/hours of herpetological searches. Species were identified as *Arthroleptis xenodactyloides* (accounting for 80% of the capture), *Arthroleptis stenodactylus* and *Bufo maculatus* (Appendices 16 and 18).

- *Forest dependence, endemism and conservation status*

Even though *Arthroleptis* sp. favour forest habitats, no forest dependent species were observed. None of the species recorded are strictly endemic. *Arthroleptis xenodactyloides* is listed as Vulnerable (IUCN, 2004).

Butterflies

- *Species richness and composition*

Twenty-three species of butterfly representing four families were recorded from 27 captures that took place during 30 canopy trapping days and 4.5 sweep net/hours (Appendix 17). The Silver striped charaxes (*Charaxes lasti lasti*) was the most common species accounting for 15% of all captures.

- *Forest dependence, endemism and conservation status*

Eight species from the family Nymphalidae are forest dependent: the Silver striped charaxes (*Charaxes lasti lasti*), the Flame bordered charaxes (*C. protoclea azota*), *Cymothoe herminia*, the Gold banded forester (*Euphaedra neophron littoralis*), the Forest queen (*Euxanthe wakefieldi*), a Glider species (*Harma theobene blassi*), the Common sailor (*Neptis alta*) and the Banded evening brown (*Gnophodes betsimena diversa*). One species, *Charaxes lasti lasti*, is endemic to the closed-canopy lowland forest of the Eastern Arc and Coastal Forests of Kenya and Tanzania. No butterfly species were found to be threatened.

Fauna's strict endemism

None of the faunal species recorded in Makonde Scarp III proposed FR is endemic to the Coastal Forests and/or Eastern Arc Mountains.

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

Through disturbance transects the levels of pole cutting, fire damage, path densities and other forms of disturbance were recorded. Of the sixty 50m sections carried out none were found to be free of disturbance. Fifty-two (87%) showed evidence of pole cutting, 13 (22%) contained paths, 18 (30%) showed signs of fire damage and 26 (43%) contained cultivated land. No traps were located (Figure 16). In Makonde Scarp III it was not possible to meet with village elders and therefore no conclusive evidence on medicinal or food plants was obtained, nor on what species are used for fuel wood or for making utensils. Our field data allowed us to infer which species are used for timber extraction and rope making (Table 18-g).

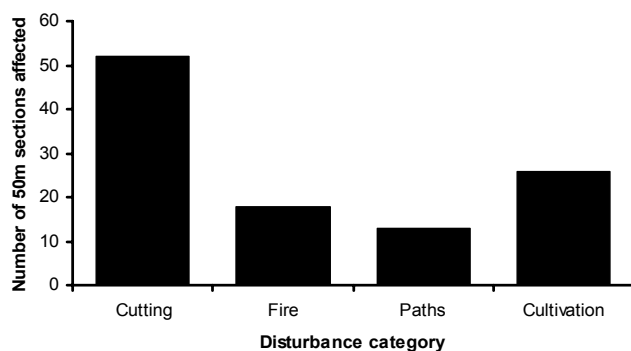


Figure 16 Number of 50m sections (from a total of 60) affected by different forms of human disturbance along transects in Makonde Scarp III proposed FR

Agricultural encroachment

A large number of 50m sections (43%) contained cultivated land (Figure 16). Cattle and goats were seen to be grazing within the reserve on a number of occasions and some inhabitants were observed in the process of felling trees to create arable land.

Poles and timbers

Disturbance transects revealed that 16 species are used for poles and timbers in Makonde Scarp III (Table 18-g). No currently active or old pit sawing sites were recorded.

- *Relative abundance and average no. of live, dead and cut individuals per ha*

The level of pole cutting (37%) is the highest of any reserve surveyed in this study. Approximately 15% of both timbers and large timbers recorded were cut. Furthermore, the study detected the largest number of fresh cut poles of any study site (6% of all cuts). No fresh cut timbers or large timbers were detected (Table 18-f).

Table 18-f Summary of pole, timber and large timber cutting in Makonde Scarp III proposed FR

	Total transect length in m	Total no. of indiv. sampled	Total no. (and % RA) of live indiv.	Average live indiv. per ha	Total no. (and % RA) of dead indiv.	Average dead indiv. per ha	Total no. (and % RA) of cut indiv.	Average cut indiv. per ha
Poles	3,000	1245	679 (55)	226	104 (8)	5	462 (37)	12
Timbers	3,000	396	261 (66)	87	77 (19)	26	58 (15)	3
Large timbers	3,000	7	6 (86)	2	0 (0)	0	1 (14)	0.3

Fuel wood

Due to the lack of a meeting with village representatives, definitive information on which species are used for fuel wood is not available. It is likely that the patterns of use here are similar to those of other sites in this study.

Tools and utensils

Due to the lack of a meeting with village representatives, definitive information on which species are used for making utensils is not available. It is likely that the patterns of use here are similar to those of other sites in this study. Although no ringed trees were detected along the transects some were observed through opportunistic observations, showing that ropes are made from several different tree species (Table 18-g).

Edible non-timber forest products

See Fuel wood.

Medicinal plants

Again, the lack of a meeting with the village elders means that information on the use of species for medicinal purposes is not available. It is likely that the species used here are similar to those in other sites in this study (Appendix 11).

Table 18-g Plant species utilised in Makonde Scarp III proposed FR as identified by field observations only. Local names, where known, are presented in Appendix 9

Family	Species	Poles	Timber	Fuel wood	Tools	Ropes	Food	Medicine
ANNONACEAE	<i>Annona senegalensis</i>	X				X		
FABACEAE (CAES)	<i>Azelia quanzensis</i>	X	X					
FABACEAE (CAES)	<i>Brachystegia microphylla</i>	X				X		
FABACEAE (CAES)	<i>Cassia petersiana</i>	X						
FABACEAE (CAES)	<i>Hymenaea verrucosa</i>		X					
FABACEAE (MIM)	<i>Albizia gummifera</i>	X	X			X		
FABACEAE (MIM)	<i>Albizia versicolor</i>	X	X					
FABACEAE (PAP)	<i>Dalbergia melanoxylon</i>		X					
FABACEAE (PAP)	<i>Lonchocarpus bussei</i>	X						
FABACEAE (PAP)	<i>Pterocarpus angolensis</i>		X					
FLACOURTIACEAE	<i>Flacourtia indica</i>					X		
HYMENOCARDIACEAE	<i>Hymenocardia ulmoides</i>					X		
LOGANIACEAE	<i>Strychnos cocculoides</i>	X						
MELIACEAE	<i>Khaya anthotheca</i>		X		X			
MORACEAE	<i>Mesogyne insignis</i>	X		X	X			
MORACEAE	<i>Milicia excelsa</i>		X					
RUBIACEAE	<i>Vangueria infausta</i>		X					
SAPOTACEAE	<i>Bequaertiodendron natalense</i>	X						

Hunting

No traps were detected in the disturbance transects, but three traps for small birds were observed on an opportunistic basis, although it is unclear as to which species they were being targeted.

Management

Makonde Scarp III proposed FR is only proposed therefore no official management plan is in place and no policing of the reserve boundaries is conducted.

DISCUSSION**FLORA**

In Makonde Scarp III proposed FR a large proportion of the land has been converted into cultivated and fallow farmland or has turned into Thicket. Only small pockets of relatively undisturbed eastern African coastal *Brachystegia* forest are left. These are characterised by a closed-canopy and relatively dense understory; one of these pockets of forest (approx. 50 x 50m) is concentrated around a spring in the interior of the reserve, and the others are nestled in small valleys. Thicket has resulted from the practice of shifting cultivation, where farmland

is left fallow for at least seven years and gets covered by woody Thicket that is then cleared again (Gillman, 1954).

In Makonde Scarp III proposed FR the high proportion of cultivated land comprising the reserve and the high degree of timber extraction account for the relatively low number of species found (90). The Shannon diversity index for this forest reserve is moderate ($H^1=2.75$), reflecting a community in succession (Magurran, 1988) where a relatively high number of species, and particularly understory species, can colonise the area and reach high rates of population growth following the removal of more competitive canopy trees (Ndangalasi, 1997). If this forest could be allowed to fully regenerate, and canopy and sub canopy species to achieve their potential population size, then the species diversity would be expected to decline.

However, human activities, such as the cultivation of maize and the cutting of poles, have continued to interrupt the regeneration of this forest from degraded to fully developed Eastern African coastal *Brachystegia* forest. These activities also threaten some important plant species present here, such as *Khaya anthotheca* and *Mesogyne insignis* (Vulnerable).

FAUNA

Overall low numbers of faunal species (93), including forest dependent and endemic species, were recorded, reflecting the fact that large sections of the reserve have been converted into farmland and are disturbed by timber extraction and fire, factors that have decreased the extent of suitable habitat and ecological requirements (e.g. prey, shelter) available to animal species (Zullini, 2003; Begon *et al.*, 1996) (see Human Resource-Use and Local Management section).

Small mammals

For the small mammals the overall number of species captured was low (5), reflecting the high incidence of deforestation for timber and agriculture in this reserve (see Human Resource-Use and Local Management section) and the open and dry habitat resulting from it (Zullini, 2003; Begon *et al.*, 1996). The dominance of the Spiny mouse (*Acomys spinosissimus*), which made up over two-thirds of the captures, reflects this open and dry habitat. The Lesser pouched rat (*Beamys hindei* - near threatened) captured here is a relic species endemic to a few forest types in Kenya and Tanzania, including the coastal and montane forests of the EACF hotspot. Until very recently it was regarded as one of the rarest rodents in Africa (Groombridge, 1994) but it is now known to be more widespread (Burgess & Clark 2000). In Makonde Scarp III this species was found only in small pockets of *Brachystegia* forest, and this emphasises its vulnerability to further habitat degradation (Kingdon 1993). Two species of the White-toothed shrew (*Crocidura sp.*) were found. The shrews of the Coastal Forests of Tanzania are poorly known and already there are five unidentified species that have been collected from the Coastal Forests of Tanzania, each from a separate forest (Burgess and Clarke, 2000). It is likely that shrews collected from this survey will yield interesting results once taxonomic verification is accomplished.

Large mammals

For the large mammals a low number of species (8) was recorded and no one species was recorded more than twice. The low number of individuals for all species recorded is probably caused by a significant degree of disturbance in this reserve (see Human Resource-Use and Local Management), a factor that has decreased the extent of suitable habitat and ecological requirements (e.g. prey, shelter) necessary to support larger populations. The Moloney's monkey (*Cercopithecus mitis* sub sp. - CITES II) is forest dependent, and given the small size of suitable habitat remaining in this reserve this primate may be locally threatened. The

Greater galago (*Otolemur crassicaudatus* - CITES II) was found to frequent cultivated land; however, this species generally favours denser vegetation, so populations of this species may also be affected by encroachment and degradation. The Spotted hyena (*Crocuta crocuta* - conservation dependent) appeared to frequent the steep rocky parts of the escarpment close to cultivated land. Being an opportunist, this species was observed to have adapted well to changes in its environment, e.g. by preying on goats from nearby villages. Nevertheless, any further reduction in habitat will reduce the presence of this species in this reserve, as populations of predated wild animals decrease and conflict with man increases.

Birds

Makonde Scarp III proposed FR constitutes part of the Newala District Coastal Forests IBA (TZ053 - category A1) (BirdLife International, 2005) because of the previously recorded presence of more than a threshold population of the Southern banded snake eagle (*Circaetus fasciolatus*), a species categorized by the IUCN Red List (2004) as near threatened. *C. fasciolatus* was not recorded in Makonde Scarp III proposed FR during this study, nor were other IUCN threatened species. However, *C. fasciolatus* was recorded in adjacent Makonde Scarp II proposed FR and is therefore likely to occur in Makonde Scarp III proposed FR. This reserve has been extensively transformed by timber extraction and encroachment from agricultural land (see Human Resource-Use and Local Management section), which may be responsible for the lowest number of bird species recorded in all forest reserves (49), while the sparse understory in the small patches of *Brachystegia* forest remaining (see Flora section) is responsible for the low number of forest dependent species found (Mlingwa *et al.*, 2000). Only the African broadbill (*Smithornis capensis*) and the Blue-mantled crested flycatcher (*Trochocercus cyanomelas*) were found to be forest dependant.

Reptiles

The low numbers of species (5) and individuals (6) captured may be a consequence of the rapid nature of this study, which did not permit comprehensive collection of data during the wet season and on fossorial species (Broadley and Howell, 2000). Conducting further research in the wet season may reveal more comprehensive results. However, low numbers may also reflect the largely open and dry environment that has resulted from high levels of encroachment, timber extraction and burning in this reserve (Zullini, 2003; Begon *et al.*, 1996) (See Human Resource-Use and Local Management section). All snakes were recorded along the banks of dry river beds throughout the reserve. A species of skink sighted in this reserve was recognised to resemble either the Rainbow Skink (*Trachylepis margaritifera*) or the Five-lined skink (*Trachylepis quinquetaeniata*). *T. margaritifera* is known to occur in central and south-eastern Tanzania (Spawls *et al.*, 2002). *T. quinquetaeniata* has not been recorded south of the border with Kenya, apart from a record in Kwa Mtoro (north of Dodoma) (Spawls *et al.*, 2002), and its record in the Mtwara Region would therefore represent a range extension. Further research is needed to ascertain this.

Amphibians

For the amphibians a high number of individuals (20) representing three species were captured near to a spring where dense vegetation and moist humus soil create an ideal breeding ground (Howell, 1993). However, areas such as these are small and infrequent, which makes the species inhabiting them vulnerable to forest degradation. The Squeakers (*Arthroleptis stenodactylus* and *A. xenodactyloides*) accounted for over 80% of the captures. These species favour a forested habitat as they rely on the presence of damp soil and loose leaf mould protected from shrub and canopy cover to lay their eggs (Howell, 1993). Consequently, the Dwarf squeaker (*Arthroleptis xenodactyloides*) is listed as Vulnerable (IUCN, 2004) and both species may become locally threatened by further loss of forest habitat.

Butterflies

There was a high number of butterfly species (23) relative to the number of individuals captured (27). Most butterfly species recorded are non-forest dwellers and this reflects the high degree of disturbance that has converted many parts of the forest into farmland and Thicket. However, a number of forest dependent butterflies were recorded in the small patches of *Brachystegia* forest remaining, including the Banded evening brown (*Gnophodes betsimena diversa*), the Silver striped charaxes (*Charaxes lasti lasti*), the Flame bordered charaxes (*C. protoclea azota*), *Cymothoe herminia*, the Gold banded forester (*Euphaedra neophron littoralis*), the Forest queen (*Euxanthe wakefieldi*), a Glider species (*Harma theobene blassi*) and the Common sailor (*Neptis alta*). *Charaxes lasti lasti* is particularly important as it is endemic to the closed-canopy lowland forest of the Eastern Arc and Coastal Forests of Kenya and Tanzania (Congdon and Bampton, 2005). The dependence of these species on fragmented patches of forest makes them particularly vulnerable to the high level of disturbance occurring here.

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

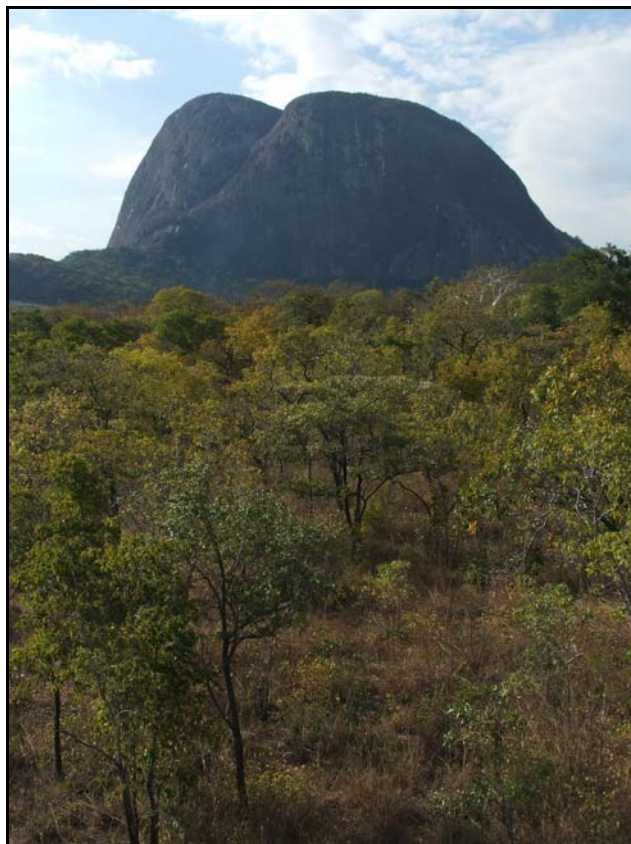
Makonde Scarp III was the most disturbed area surveyed during this study.

The encroachment of agriculture within the reserve boundaries was the most severe form of disturbance recorded; it is not possible to walk far in the proposed reserve without crossing cultivated land. Most of the farmers that were moved out when the area was proposed to be a reserve are now going back to their shambas (cultivated land), in part because of the failure of the government to fully compensate their relocation in new houses and farms (Balduş *et al.*, 2004). The top of the escarpment has been largely transformed from *Brachystegia* forest into cashew nut (*Anacardium occidentale*) plantations, while rice and maize are grown on the slopes and the plain at the foot of the escarpment. Large areas of the slopes are also covered by Thicket, indicating that shifting agriculture is common practice and that undisturbed areas are likely to become threatened in the future.

Notable about the disturbance patterns in Makonde Scarp III proposed FR was the high level of pole and timber cutting (37% and 15% of sections respectively). The extensive exploitation of certain preferred species, such as the African teak (*Pterocarpus angolensis*), the Snake bean tree (*Swartzia madagascariensis*), the Pod mahogany (*Azelia quanzensis*) and *Milicia excelsa* (near threatened) has resulted in the complete absence of large individuals of these species from the proposed reserve.

Residents were found to be unconcerned about the reduction in the size of the forest and the potential that this has for increasing erosion rates and the risk of landslides.

19. NDECHELA FOREST RESERVE



Status	Gazetted Forest Reserve
Management body	Central Government
Location	Masasi district. Directly above the Lukwika-Lumesale Game Reserve, south of Nakopi (where the Natural Resources Office is situated) and east of Nihale. The Lukwimba River borders the west side of the reserve. Ndechela town is situated in a large recess in the reserve, next to Lukwimba River.
Area	6,216ha
Altitude	250-340m asl
Topography	Lowland plain
Temperature	Min: 15.5°C, Max: 39°C (recorded 7-11 and 13-17 July, dry season)
Rainfall	0mm (recorded 7-11 and 13-17 July, dry season)
Soil type	Sandy-loam
Vegetation type	Eastern African coastal Legume-dominated dry forest
Land Use	The reserve was gazetted to protect timber resources and biodiversity. Pit sawing and hunting take place.
History and Status	The forest was given protected status in 1958. Presently there are no effective methods for controlling illegal resources use. An Environmental committee was set up in 1991 but no longer functions; a part-time forest officer was employed from 1993 to 1997 as a replacement to patrol for illegal fires. Future plans include a possible link with the Lukwika-Lumesale Game Reserve.

Maps

Topographical map: Ndanda South sheet 306/1, East Africa 1:50 000, 1968. From the Institute of Mapping, Dar es Salaam (from Series Y742, Edition 1-TSD).

Land use and cover map: Masasi sheet SC-37-10/11, 1996. From the Institute of Resource Planning, UDSM.

METHODS

Survey work was conducted over 14 days (5-11 and 11-17 July 2005) incorporating two study sites of equal duration. Twenty-one vegetation plots (8400m²), 21 regeneration plots (84m²), and two zoosites were carried out, incorporating 400 sherman trapping nights, 100 bucket trapping nights, seven man/hours of timed herpetofauna searches, 86 bat mist net/hours, 13 man/hours of bird mist netting, 16 man/hours of timed bird searches, 30 canopy trapping days, four butterfly sweep net/hours, seven animal sign transects (totalling 28,000m²), seven disturbance transects (totalling 70,000m²), and opportunistic observations (see Appendices 2 to 8 for GPS coordinates and work site descriptions). Habitat notes were taken for vegetation plots (Appendices 4 and 5) and zoological trap sites (Appendix 6). Structured interviews and open discussions were conducted with five elders from the village of Ndechela. For a detailed break down of survey effort see Table 10-a.

RESULTS

In Ndechela FR 78 plant species were recorded from 21 families. Thirteen percent of the total number of floral species are endemic to the Swahilian region *sensu lato* and 12% are listed as threatened (IUCN, 2004) or potentially threatened (Gereau and Luke, 2006) (Table 19-a; Appendices 9 and 10).

One-hundred and seventy-four faunal species were found representing 81 families. Of these species 4% are forest dependent, less than 1% are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains and 2% are listed as threatened by IUCN (2004) and/or CITES (2005) (Table 19-a; Appendices 13-17).

Table 19-a Summary of fauna and flora recorded in Ndechela FR

Taxa	No. of families	No. of species ^c	No. of forest dependent species ^d	No. of wide-spread species	No. of strictly endemic species: ^e and ^f	No. of threatened species: ^g and ^h	No. of PT species ⁱ
Mammals	24	38	2	36	0*	3	-
Birds ^a	41	97	0	97	0	0	-
Reptiles	8	10	0	10	1	0	-
Amphibians	4	8	0	8	0	0	-
Butterflies	4	21	4	17	0	0	-
Total for animals	81	174	6	168	1	3	-
Flora ^b	21	78	0	68	10	1	8
Combined Total	102	252	6	236	11	4	8

a - Includes birds seen on the forest boundary edge

b - All trees, shrubs, herbs, grasses and ferns

c - Includes information collected from all systematic survey work, opportunistic observations, structured interviews and open discussions

d - Species dependent on and associated with primary or closed-canopy forest, not forest edge or secondary forest

e - Faunal species with limited ranges in the Coastal Forests alone or the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a), sometimes being found also in other habitats in a few adjacent locations (e.g. Masasi District in S Tanzania, N Mozambique etc.)

f - Floral species restricted to the Swahilian region *sensu lato* (Clarke and Robertson, 2000)

g - Species listed as Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) in the IUCN Red List (IUCN, 2004)

h - Species listed in CITES Appendix I as threatened with extinction and excluded from international trade (CITES, 2005)

i - Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

*The identification of *Crocidura* sp. may increase this number. We await verification

FLORA

In Ndechela FR one homogeneous vegetation stand was identified as dry Legume-dominated forest.

- *Species richness and diversity*

A total of 78 species were recorded. Out of these, 41 species were found in 21 vegetation plots and 21 species were recorded in 21 regeneration plots. The other 16 species were recorded from opportunistic collection and observation made within the reserve. More specifically, 48 trees, 21 shrubs, five herbs, and four grasses were recorded (Appendix 9). A value of 3.46 was calculated for the Shannon diversity index.

- *Species dominance*

Within the Legume-dominated dry forest *Brachystegia spiciformis* and *Milletia stuhlmannii* are the most frequent in the canopy layer, occurring in 45% and 40% of the plots respectively (Table 19-b).

Table 19-b Species frequency, dominance, rank dominance, no. of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the canopy layer in Legume-dominated dry forest in Ndechela FR

Family	Genus	Species	F	% RF (Dominance)	Rank dominance	No. indiv. in all plots	%RA	Rank RA
FABACEAE (CAES)	<i>Brachystegia</i>	<i>spiciformis</i>	9	45	1	25	31	1
FABACEAE (PAP)	<i>Millettia</i>	<i>stuhmannii</i>	8	40	2	22	27	2
EUPHORBIACEAE	<i>Pseudolachnostylis</i>	<i>maprouneifolia</i>	5	25	3	18	22	3
FABACEAE (CAES)	<i>Brachystegia</i>	<i>longifolia</i>	2	10	4	10	12	4
STERCULIACEAE	<i>Sterculia</i>	<i>appendiculata</i>	1	5	5	2	2	5
Total¹	3	5	5			77	94	
Total²	17	19	23			81	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

In the sub canopy layer no species were found to be either dominant or frequent, all occurring in no more than 30% of the plots (Mueller-Dombois and Ellenberg, 1974) (Table 19-c).

Table 19-c Species frequency, dominance, rank dominance, no. of individuals, % relative abundance and rank relative abundance for the top five most abundant species of the sub canopy layer in Legume-dominated dry forest in Ndechela FR

Family	Genus	Species	F	% RF (Dominance)	Rank dominance	No. indiv. in all plots	%RA	Rank RA
APOCYNACEAE	<i>Diplorhynchus</i>	<i>condylocarpon</i>	7	35	1	21	13	1
FABACEAE (CAES)	<i>Bauhinia</i>	<i>petersiana</i>	6	30	2	10	6	3
FABACEAE (PAP)	<i>Lonchocarpus</i>	<i>bussei</i>	6	30	2	7	4	4
COMBRETACEAE	<i>Terminalia</i>	<i>sambesiaca</i>	5	25	3	10	6	3
BURSERACEAE	<i>Commiphora</i>	sp.	4	20	4	19	12	2
Total¹	5	5	5			67	41	
Total²	13	21	25			157	100	

F= Frequency; %RF= Relative frequency; %RA= Percentage relative abundance

Total¹= Total for top five species; Total²= Total for all canopy layer species in the reserve

• Species relative abundance

In the canopy layer 92% of the trees recorded were individuals from *Brachystegia spiciformis* (31%), *Millettia stuhmannii* (27%), *Pseudolachnostylis maprouneifolia* (22%) and *Brachystegia longifolia* (12%) (Table 19-b). In the sub canopy layer 41% of the trees recorded were individuals from *Diplorhynchus condylocarpon* (13%), *Commiphora* sp. (12%), *Bauhinia petersiana* (6%), *Terminalia sambesiaca* (6%), and *Lonchocarpus bussei* (4%) (Table 19-c).

When looking at the overall number of trees recorded in both the canopy and sub canopy layers, the canopy layer (53%) contributed a slightly higher number of individuals than the sub canopy layer (46%) to the overall number of adult trees in this reserve.

- *Species composition and vegetation types*

Ndechela FR is comprised of one homogeneous vegetation stand, whose species composition and relative abundance confirmed to be **eastern African Legume-dominated coastal dry forest** (Clarke and Robertson, 2000).

The species composition of this forest type is characterised by *Brachystegia spiciformis*, *B. longifolia* and *Millettia stuhlmannii* from the family Fabaceae as the most frequent and abundant species in the canopy layer, together contributing up to about 70% of all trees recorded. Other species occurring in the canopy layer included *Pseudolachnostylis maprouneifolia*, *Bombax rhodognaphalon*, *Brachystegia longifolia*, *Sterculia appendiculata*, *Millettia impressa* and *Acacia xanthophloea*. The sub canopy layer was characterised by the absence of dominant or frequent species. Species recorded in this layer included *Diplorhynchus condylocarpon*, *Bauhinia petersiana*, *Lonchocarpus bussei*, *Terminalia sambesiaca*, *Commiphora* sp., *Azelia quanensis*, *Schrebera trichoclada*, *Markhamia obtusifolia*, *Terminalia brownii*, *Tamarindus indica* and *Cussonia zimmermannii*.

The shrub layer was observed to be comprised of saplings of the dominant species from the canopy and sub canopy layer, and shrub species such as *Combretum hereroense*, *Flacourtia indica*, *Croton pseudopulchellus*, *Salacia madagascariensis*, *Strychnos usambarensis*, *Strychnos madagascariensis*, *Ochna holstii*, *Catunaregam spinosa* and *Vangueria infausta*. The herbaceous layer was composed of grasses, particularly *Olyra* sp. and *Themeda triandra*, together with herbs such as *Dicoma tomentosa*, *Hypoestes* sp., *Crotalaria* sp., *Tephrosia* sp. and *Jasminum* sp.

- *Endemism and conservation status*

Ten of the species found are endemic to the Swahilian region *sensu lato*, including *Cussonia zimmermannii*, *Commiphora zanzibarica*, *Tetracera boiviniana*, *Scorodophloeus fischeri*, *Entada stuhlmannii*, *Gardenia transvenulosa*, *Sterculia appendiculata*, *Grewia lepidopetala* and *Vitex mossambicensis* (Clarke and Robertson, 2000) (Appendix 10), and amounting to 12% of the total number of species recorded (Figure 17).

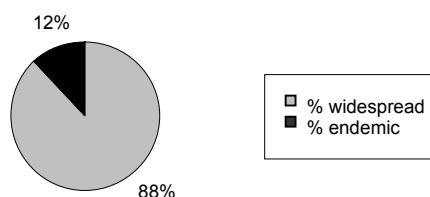


Figure 17 Percentage floral species endemic to the Swahilian region *sensu lato* and those that are widespread in Ndechela FR

Nine among the species recorded are recognised to be threatened (IUCN, 2004) or potentially threatened (Gereau and Luke, 2006), amounting to 12% of the total number of species recorded (Table 19-d).

Table 19-d Threatened and potentially threatened plant species in Ndechela FR

Family	Species name	Conservation status	Habit
ARALIACEAE	<i>Cussonia zimmermannii</i>	PT	T
BURSERACEAE	<i>Commiphora zanzibarica</i>	PT	T
DILLENIACEAE	<i>Tetracera boiviniana</i>	PT	S/T
FABACEAE (CAES)	<i>Cassia abbreviata</i>	PT	T
FABACEAE (CAES)	<i>Scorodophloeus fischeri</i>	PT	T
FABACEAE (MIM)	<i>Entada stuhlmannii</i>	PT	C
FABACEAE (PAP)	<i>Millettia impressa</i>	PT	C
RUBIACEAE	<i>Gardenia transvenulosa</i>	VU	S/T
VERBENACEAE	<i>Vitex mossambicensis</i>	PT	S

PT = Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

Habit T= Tree, S= Shrub, B= Bamboo, C= Climber, H= Herb

FAUNA

Although the identification of about 90% of the species recorded is certain, the identification of a few specimens remains tentative whilst awaiting taxonomic verification.

Mammals

- *Species richness and composition*

A total of 36 mammals representing 24 families were recorded (Appendix 13).

Eight species of *small mammal* representing four families were recorded in total from 16 captures (not counting two recaptures) that took place during 400 sherman trapping nights and 100 bucket pitfall trapping nights (Appendix 18). The most common species was the Multimammate rat (*Mastomys natalensis*) making up 50% of all captures. Other species recorded included the Spiny mouse (*Acomys spinosissimus*), the Narrow-footed woodland mouse (*Grammomys dolichurus*), the Tatera gerbil (*Tatera robusta*), the Black rat (*Rattus rattus alexandrinus*) and one species of White-toothed shrew (*Crocidura* sp.).

Two species of *bat*, the Slit faced bat (*Nycteris hispida*) and the Horse-shoe bat (*Rhinolophus hildebrandti*), were recorded from four captures during 86 bat mist net/hours.

For the *larger mammals*, 28 species representing 18 families were recorded during sign transects totalling 7km, through opportunistic observations and from local knowledge. Few signs of the Leopard (*Panthera pardus*), Lion (*Panthera leo*), Moloney's monkeys (*Cercopithecus mitis* sub sp.), Elephant (*Loxodonta africana*), Buffalo (*Syncerus caffer*), Zebra (*Equus quagga*) and Warthog (*Phacochoerus africanus*) were found. These signs were often more than one month old. Other species recorded included the Blue duiker (*Cephalophus monticola*), the Chequered elephant shrew (*Rhynchocyon cirnei*) and the Greater galago (*Otolemur crassicaudatus*). Local knowledge also suggested the presence of the Klipspringer (*Oreotragus oreotragus*), the Sable antelope (*Hippotragus niger*) and the Hippopotamus (*Hippopotamus amphibius*). The occurrence of many large species within the FR is seasonal.

- *Forest dependence, endemism and conservation status*

Two of the species recorded are forest dependent, although many often frequent and some favour a forested habitat. Four species are listed as threatened in the IUCN Red List (2004) and/or CITES Appendix I (2005) (Table 19-e). No species were recorded to be strictly endemic to the Coastal Forests and/or Eastern Arc Mountains.

Table 19-e Forest dependent, endemic and threatened mammal species in Ndechela FR

Species	Common name	Forest dependent	Endemic	Threatened
<i>Cercopithecus mitis</i> (sub sp.)	Moloney's monkey	F	-	-
<i>Rhynchocyon cirnei</i>	Chequered elephant shrew	-	-	VU
<i>Panthera leo</i>	Lion	-	-	VU
<i>Panthera pardus</i>	Leopard	-	-	CITES I
<i>Loxodonta africana</i>	African Elephant	-	-	VU
<i>Cephalophus monticola</i>	Blue duiker	F	-	-

F= Forest dependent or specialist (Burgess *et al.*, 2000a)

CF= species with limited ranges in the Coastal Forests alone; EACF= species with limited ranges in the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

CITES I = Threatened with extinction and excluded from international trade;

Birds

- *Species richness and composition*

Ninety-seven species from 41 families were observed. Thirteen hours of mist netting and 16 hours of timed bird searches were carried out. Mist netting yielded three species (*Dicrurus adsimilis*, *Tchagra australis* and *Terpsiphone viridis*) from a total of three captures, and timed bird searches the remaining 94. Species found included the Grey-crested helmet shrike (*Prionops poliophus*)¹⁹, the Livingstone's flycatcher (*Erythrocerus livingstonei*) and the Pale batis (*Batis soror*) (Appendix 14). Many species were observed along a seasonal river bed.

- *Forest dependence, endemism and conservation status*

No forest dependent, strictly endemic or threatened bird species were recorded in Ndechela FR.

Reptiles

- *Species richness and composition*

Ten species of reptiles representing eight families were recorded from nine captures that took place during 100 bucket pitfall trapping nights and 17.5 man/hours of herpetological searches. Species included the Spotted flat lizard (*Platysaurus maculatus*), which was found in abundance on rock outcrops, and a species of skink (*Trachylepis* sp.)²⁰ that has not been identified yet and that was also frequent on rock outcrops. The Striped skink (*Trachylepis striata*), the Snouted night adder (*Causus defilippii*) and the Mozambique agama (*Agama mossambica*) were each only sighted on one occasion. Shells of a Leopard tortoise (*Geochelone pardalis*) and the Helmeted terrapin (*Pelomedusa subrufa*) were recorded (Appendices 15 and 18).

- *Forest dependence, endemism and conservation status*

One of the species recorded, the Spotted flat-lizard (*Platysaurus maculatus*), is strictly endemic to northern Mozambique and the Masasi district in south-eastern Tanzania. No species were found to be forest dependent or threatened.

¹⁹ The field identification of *Prionops poliophus* was undertaken by Jacob Kiure (Appendix 1).

²⁰ The Afro-magalian mabuyas have been recognised to constitute a separate genus and have been renamed *Trachylepis* sp. For the partitioning of the genus *Mabuya* see Mausfeld *et al.* (2002); for the taxonomy and nomenclature of *Trachylepis* sp. see Honda *et al.* (2003) and Whiting *et al.* (2003).

Amphibians

- *Species richness and composition*

Eight species of amphibians representing four families were recorded from 10 captures that took place during 100 bucket pitfall trapping nights and 17.5 man/hours of herpetological searches. Species recorded included a squeaker (*Arthroleptis stenodactylus*), *Kassina* sp., the Grey tree frog (*Chiromantis xerampelina*), two species of *Ptychadena* and two species of *Phrynobatrachus* (Appendices 16 and 18).

- *Forest dependence, endemism and conservation status*

None of the species found are forest dependent, even though *Arthroleptis stenodactylus* is known to favour a forested habitat (Howell, 1993). No strictly endemic or threatened species were recorded.

Butterflies

- *Species richness and composition*

Twenty-one species of butterfly representing four families were recorded from 48 captures that took place during 30 canopy trapping days and four sweep net/hours (Appendix 17). The Jordan's Sailor (*Neptis jordani*) accounted for 23% and the Common joker (*Byblia anvatara acheloia*) for 19% of all captures.

- *Forest dependence, endemism and conservation status*

One species from the family Nymphalidae, the Gold banded forester (*Euphaedra neophron littoralis*), is forest dependent. No species were found to be strictly endemic or threatened.

Fauna's strict endemism

Of the total number of faunal species recorded in Ndechela FR 99% are widespread and 1% are endemic to the Coastal Forests and/or Eastern Arc Mountains (Figure 18).

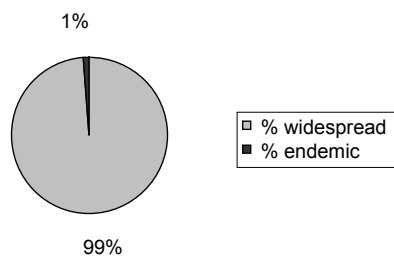


Figure 18 Percentage of strictly endemic and widespread faunal species in Ndechela FR

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

Disturbance transects were used to record the level of disturbance from pole cutting, fire damage, paths and other forms of disturbance within the reserve. Of one-hundred and forty 50m transects, 36 (26%) were free of disturbance. Fire was the most common form of disturbance in Ndechela, with 101 (72%) sections showing fire damage. Pole cutting was detected in 21 (18%) sections, 13 (9%) sections had one or more paths bisecting them and one (1%) section contained a drift fence to trap large ungulates (Figure 19). Information on resource use is summarised in Table 19-g below.

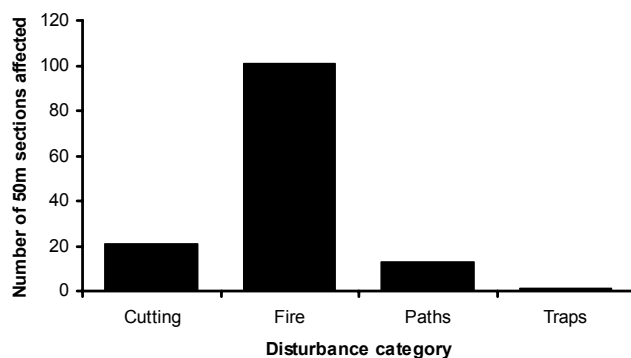


Figure 19 Number of 50m sections (from a total of 104) affected by different forms of human disturbance along transects in Ndechela FR

Agricultural encroachment

Disturbance transects did not reveal any encroachment in Ndechela. Some local farmers grow tomatoes in the dry riverbed that marks the boundary of the reserve, but they may be unable to extend this water-demanding crop into the drier soil of the reserve.

Poles and timbers

Disturbance transects showed that six main species (*Azelia quanzensis*, *Milicia excelsa*, *Millettia dura*, *M. impressa*, *M. stuhlmannii* and *Pterocarpus angolensis*) are harvested to provide timber and a wide variety of species are harvested to obtain poles (Table 19-g). Pit sawing was found to be common, with three recently active sites detected.

- *Relative abundance and average no. of live, dead and cut individuals per ha*

One percent of both poles and timbers were cut, but no cut large timbers were detected. Two fresh cut poles and one fresh cut timber were observed (Table 19-f).

Table 19-f Summary of pole, timber and large timber cutting in Ndechela FR

	Total transect length in m	Total no. of indiv. sampled	Total no. (and % RA) of live indiv.	Average live indiv. per ha	Total no. (and % RA) of dead indiv.	Average dead indiv. per ha	Total no. (and % RA) of cut indiv.	Average cut indiv. per ha
Poles	7,000	3009	2599 (86)	371	394 (13)	56	16 (1)	2
Timbers	7,000	1129	1024 (91)	146	95 (8)	14	10 (1)	1
Large timbers	7,000	33	31 (94)	5	2 (6)	0.3	0 (0)	0

Fuel wood

Most fuel wood was said by the local residents to be extracted from wooded vegetation outside the FR.

Tools and utensils

Besides ropes and tool handles beehives are commonly constructed, with *Brachystegia longifolia* and *Brachystegia spiciformis* being the species most commonly targeted for this production, as it resulted from structured interviews (Table 19-g).

Edible non-timber forest products

A wide range of species was found to provide food to the local inhabitants (Table 19-g). Honey is produced and sold locally.

Medicinal plants

Sixteen different species were said to be used for medicinal purposes within the reserve (Table 19-g, Appendix 11).

Table 19-g List of plant species utilised in Ndechela FR as identified by field observations, structured interviews and open discussions. Local names, where known, are presented in Appendix 9

Family	Species	Poles	Timber	Fuel wood	Tools	Ropes	Hives	Food	Medicine
<i>Aloeaceae</i>	<i>Aloe macrosiphon</i>								X
ALOEACEAE	<i>Aloe secundiflora</i>								X
ANACARDIACEAE	<i>Sclerocarya birrea</i>			X				X	X
ANNONACEAE	<i>Annona senegalensis</i>	X		X		X		X	
APOCYNACEAE	<i>Landolphia buchananii</i>							X	
BIGNONIACEAE	<i>Markhamia obtusifolia</i>	X		X	X				
COMBRETACEAE	<i>Pteleopsis myrtifolia</i>			X					
DILLENIACEAE	<i>Tetracera boiviniana</i>								X
DIOSCOREACEAE	<i>Dioscorea hirtiflora</i>							X	
FABACEAE (CAES)	<i>Azelia quanzensis</i>	X	X	X	X				X
FABACEAE (CAES)	<i>Brachystegia longifolia</i>	X				X	X		
FABACEAE (CAES)	<i>Brachystegia spiciformis</i>	X		X		X	X		X
FABACEAE (CAES)	<i>Cassia singueana</i>	X							X
FABACEAE (MIM)	<i>Acacia nigrescens</i>								X
FABACEAE (MIM)	<i>Acacia xanthophloea</i>								X
FABACEAE (PAP)	<i>Millettia impressa</i>		X		X				
FABACEAE (PAP)	<i>Millettia stuhlmannii</i>		X		X				
FABACEAE (CAES)	<i>Swartzia madagascariensis</i>	X	X	X	X				
FLACOURTIACEAE	<i>Flacourtia indica</i>							X	
HYMENOCARDIACEAE	<i>Hymenocardia ulmoides</i>			X	X	X			X
LOGANIACEAE	<i>Strychnos madagascariensis</i>							X	
LOGANIACEAE	<i>Strychnos usambarensis</i>							X	

Hunting

Many (>10) traps for small birds were found in the riverbed. A drift fence designed to trap large ungulates was also observed, but the trap was not in use at the time of this study. Two dead baboons (*Papio cynocephalus*) were observed in the riverbed that had been killed because they had raided crops. Among the species hunted the Sable antelope (*Hippotragus niger*) is listed as conservation dependant in the IUCN Red List (2004).

Management

Minimal management takes place in Ndechela FR. The last management action was boundary clearance in 1997, but the boundary is no longer evident. A ‘fire committee’ was set up in 1997 to control fires but is no longer effective. Regular patrols of the reserve are conducted by game officers from Lukwika-Lumesule game reserve.

DISCUSSION**FLORA**

Ndechela FR is comprised of Legume-dominated coastal dry forest largely affected by frequent fires. No species appeared to be dominant in the canopy and sub canopy layers; instead an assemblage of various species from the family Fabaceae comprised this vegetation type, including *Brachystegia spiciformis*, *B. longifolia* and *Millettia stuhlmannii* in the canopy layer, and *Bauhinia petersiana* and *Lonchocarpus bussei* in the sub canopy layer. Legume-dominated dry forest is usually characterised by the dominance of one or few species, therefore the lack of any dominant species in Ndechela FR is quite unusual; further research would be required to determine the factors responsible for the observed species composition. The shrub layer was mainly comprised of saplings of the canopy species, indicating a climax community, while herbs and lianas were scarce.

The species richness recorded in this reserve is relatively low (78 species) and may be attributed to the high level of fire disturbance recorded, which can prevent the regeneration of fire tolerant species (Burgess and Clarke, 2000). Nevertheless, the Shannon diversity index for this forest reserve ($H' = 3.46$) is the highest recorded during this study. This is associated with the high number of individual mature trees (314 in total) recorded in the reserve, which is linked to a relatively low level of timber and pole extraction, and the lack of one or few dominant species, whereby the total number of individual trees is evenly distributed between a number of species (Magurran, 1988).

Ndechela FR represents the least disturbed forest surveyed in this study in terms of timber and pole extraction, as demonstrated by the relatively high number of large and old trees recorded here. However, throughout the survey extensive and frequent burning was recorded to have removed an otherwise conspicuous understory, constituting a threat to the continuity of this particularly vulnerable forest type. The seeds of the Fabaceae trees are heavy and not dispersed by wind or animal. Moreover, these seeds do not remain viable in the seed bank for long, do not tolerate desiccation, require a forest microclimate (shade and high-humidity) to germinate and are pyrophobic (Clarke, 2000). Therefore, the complete clearance of this forest type drastically lowers the chances of its regeneration on the same sites, which then can become dominated by more easily dispersed pioneer tree species characteristic of mixed dry forest and mixed scrub forest (Clarke, 2000). The vulnerability of this forest is highlighted also by the presence of various endemic and threatened plants, such as *Gardenia transvenulosa* (Endemic and Vulnerable), *Cussonia zimmermannii*, *Commiphora zanzibarica*, *Tetracera boiviniana*, *Scorodophloeus fischeri*, *Entada stuhlmannii* and *Vitex mossambicensis* (Endemic and Potentially Threatened), and it is therefore important to protect its threatened and unique plant community.

Ndechela FR is also singular for the presence of granite kopjes dramatically protruding from the plain and reaching up to 800m, which contribute to the scenic beauty of this site, and for having a relatively small human population living around its boundaries. As a result, much forest that lies outside the borders of the reserve is not appreciably different from that inside the reserve. This represents an excellent opportunity to extend the boundaries of the reserve to create and protect more habitats for plants and animals.

FAUNA

In Ndechela FR a high number of species were recorded (172), including various endemic and threatened species. However, the species composition within most taxa is characteristic of an open and dry understory habitat that has been created by the removal of this layer by frequent burning.

Small mammals

A species poor rodent community (8 captured species) reflects the high incidence of fire damage (see Human Resource-Use and Local Management section) and the sparse and dry understory resulting from it (Zullini, 2003; Begon *et al.*, 1996). The most common species recorded, the Multimammate rat (*Mastomys natalensis*) and the Spiny mouse (*Acomys spinosissimus*), are in fact known to prefer dry areas (Kingdon, 2003). The Narrow-footed woodland mouse (*Grammomys dolichurus*) and the Tatera gerbil (*Tatera robusta*) are known to inhabit tall grasses and secondary growth (Kingdon, 1974), and were recorded in areas where grasses dominated as a result of frequent fire disturbance. The Black rat (*Rattus rattus alexandrinus*) was found scavenging amongst food supplies at the base camp. This species is thought to have originated in the Middle-east and to have been introduced into Tanzania through the shipping of goods, and now appears to have returned to a predominantly feral state (Kingdon, 2003). More research is needed to assess the level of invasion by *Rattus rattus alexandrinus* and its implications on the ecology of this region.

Bats

The Slit-faced bat (*Nycteris hispida*) and the Horse-shoe bat (*Rhinolophus hildebrandti*) were caught in open woodland areas at the edge of the forest. Both species are non-forest dwellers (Kingdon, 1974) commonly found in the Coastal Forests of eastern Africa (Cockle *et al.*, 1998).

Large mammals

Of the larger mammals a high number of species (26) were recorded, but no one species was recorded more than twice. This suggests that large mammal populations are suppressed by extensive fires and hunting occurring in this reserve (see Human-Resources Use and Local Management), factors that have decreased the extent of suitable habitat and ecological requirements (e.g. prey, shelter) necessary to support larger populations. Species recorded included the Buffalo (*Syncerus caffer* - conservation dependent), the Zebra (*Equus quagga*) and the Warthog (*Phacochoerus africanus*). Forest dependent species found here were the Blue duiker (*Cephalophus monticola* - CITES II) and the Moloney's monkey (*Cercopithecus mitis* sub sp. - CITES II), together with species such as the Greater galago (*Otolemur crassicaudatus* - CITES II) which, although not forest dependent, often favours a forest environment. The Yellow baboon (*Papio cynocephalus*) is regarded as a pest here and is being killed by villagers. The elephant shrew species (*Rhynchocyon* sp.) observed in this reserve is characterised by dark grey and rufous fur with very indistinct chequers, and is likely to represent a sub-species of the Chequered elephant shrew (*Rhynchocyon cirnei macrurus*) rather than a range extension for the similar looking Black and rufous elephant shrew (*R.*

petersi) (Rathbun, 2005; Corbet, 1970)²¹. The finding of *R. cirnei*, a species listed as Vulnerable (IUCN, 2004), confirms the Coastal Forests to be a globally important area for this genus, closely followed by the Eastern Arc Mountains (Burgess *et al.*, 2000a). *Rhynchocyon* species are forest-dwellers that rely on dense vegetation cover to produce the thick leaf litter they require for foraging and nest construction (Rathbun, 2005). *R. cirnei* may therefore become locally threatened should further habitat destruction ensue. Ndechela FR is contiguous with Lukwika-Lumesale Game Reserve and was consequently found to contain the highest number of large mammal species of conservation status (10), among which the Leopard (*Panthera pardus* - CITES I), the Lion (*Panthera leo* - Vulnerable, CITES II) and the Elephant (*Loxodonta africana* - Vulnerable, CITES I). The presence of many species of conservation status makes Ndechela FR an important conservation site, and the Masasi District Natural Resources Office mentioned future plans to link this reserve with the Lukwika-Lumesale Game Reserve.

Birds

In Ndechela FR a high number of species were recorded (97). This figure may be linked to the large size of the reserve (6,216ha) and the long period of time spent surveying it (Table 10-a), which compensated for the evident absence of a dense shrub layer following extensive fire disturbance. Nevertheless, the removal of undergrowth vegetation is responsible for the absence of forest dependent species and the low number of captures in the mist nets. Many species were observed along a seasonal river bed where fruiting trees from the genus *Ficus* provide a substantial food source. The Grey-crested helmet shrike (*Prionops poliophus* - near threatened) has been previously recorded to inhabit open woodland and wooded grassland, including *Acacia/Tarchonanthus* vegetation (1,200-2,200m), in a restricted area encompassing south-western Kenya and northern Tanzania (BirdLife International, 2005). Records of this bird in Ndechela FR therefore indicate a range extension for this species.

Reptiles

For the reptiles the number of species (9) and individuals (9) captured was moderate. Yet, the rocky nature of Ndechela creates microhabitats for more reptiles than it was possible to capture, and individuals were frequently observed basking in the sun on rock outcrops. Conversely, the extensive and frequent fires occurring in this reserve are probably responsible for the lack of forest dependent species. The Spotted flat-lizard (*Platysaurus maculatus*) found here is strictly endemic to northern Mozambique and the Masasi district in south-eastern Tanzania. This species has a specific habitat requirement: it only inhabits rock outcrops of granite, gneiss and sandstone that weather to produce thin fissures where it seeks refuge (Spawls *et al.*, 2002). In Ndechela FR this lizard was found in abundance due to the large quantity of rocky microhabitats present. The Helmeted terrapin (*Pelomedusa subrufa*) has been previously thought to occur in this south-eastern region of Tanzania, but its presence was yet to be confirmed (Spawls *et al.* 2002). During this study the only record of this species was a shell in a dried up rock pool. This species is adapted to arid environments, emerging from underground during the wet season, and therefore more comprehensive results could be unleashed by conducting research during the wet season. A species of skink sighted in this reserve was recognised to resemble either the Rainbow Skink (*Trachylepis margaritifer*) or the Five-lined skink (*Trachylepis quinquetaeniata*). *T. margaritifer* is known to occur in central and south-eastern Tanzania (Spawls *et al.*, 2002). *T. quinquetaeniata* has not been recorded south of the border with Kenya, apart from a record in Kwa Mtoro (north of Dodoma) (Spawls *et al.*, 2002), and its record in the Mtwara Region would therefore represent a range extension. Further research is needed to ascertain this.

²¹ At present *R. petersei* has been recorded to occur only in the Eastern Arc Mountains and in the Coastal Forests as far as the Rufiji River. South of the Rufiji River and further down into Mozambique, *R. cirnei* has been recorded to occur (Rathbun and Butinski, 2005; Corbet, 1970).

Amphibians

For the amphibians a low number of individuals (10) representing seven species were captured along seasonal river beds where a few stagnant pools surrounded by dense vegetation and moist humus soil create an ideal breeding ground (Howell, 1993). Large breeding populations of *Phrynobatrachus* sp. and *Ptychadena* sp. were recorded around these pools. All species recorded are non-forest dwellers, including the Grey tree frog (*Chiromantis xerampelina*), which is typical of dry wooded grassland, and *Kassina* sp.²² (Channing, 2001). The intrusion into forested areas by species that normally inhabit transient open situations is known to be a recurrent characteristic encouraged by the mosaic pattern of the Coastal Forest Mosaic, whereby such species continue breeding in their open habitat but enter the enclosed habitat for refuge, especially during dry periods (Poynton, 2000).

Butterflies

Only one of the 21 species recorded, the Gold banded forester (*Euphaedra neophron littoralis*), is strictly forest dependent, while the Jordan's Sailor (*Neptis jordani*), which was the most frequently captured species (23%), has been previously found in the drier and hotter zones of Africa (Condamin, 1966). This is indicative of the extensive fire disturbance occurring in this reserve and of the sparse and dry understory that has resulted (Kielland and Cordeiro, 2000).

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

The lighting of fires was the largest form of disturbance in Ndechela FR. Fires are probably started deliberately to corner animals for hunting (Burgess *et al.*, 2000b). Conversely, levels of other forms of disturbance were among the lowest in this study, and a possible reason may be the low human population density of the area surrounding the reserve. It also transpired from structured interviews and open discussion that the villagers obtain forest resources from nearby wooded areas that function as a buffer zone to the reserve, and that regular patrols by game officers from Lukwika-Lumesule game reserve keep the reserve under a certain degree of protection.

However, some recently active and old pit sawing sites were observed, together with several traps for small birds and a drift fence to trap large ungulates. Two dead baboons (*Papio cynocephalus*) were found in the river bed, killed by a farmer for raiding his crops, and the Sable antelope (*Hippotragus niger*), a species listed as conservation dependant in the IUCN Red List (2004), was reported to be hunted. These findings emphasised the local people's largely negative attitudes towards the reserve, as it transpired from structured interviews: inhabitants see no reason for the presence of this reserve since they feel that they do not benefit from it.

Bee farming was common here. When material for the construction of beehives is obtained in a sustainable way, apiculture has been found to be ecologically preferable to harvesting of wild honey, as the latter often results in the cutting of the tree to access the hive (Wegner, 2003). However, bee farming in Ndechela FR may also result in tree death, as bark is here used for the construction of beehives and is extracted by ringing and often killing the trees. Since the most desirable piece of bark is a complete circle and as larger pieces of bark result in larger hives, large trees are targeted.

Enquiries at the Department of Natural Resources revealed that minimal management takes place in Ndechela FR. The last management action was boundary clearance in 1997, but village representatives stated that the boundary is no longer evident. The office would like to

²² The identification of the *Kassina* to species level was undertaken by Frontier-Tanzania field staff and is yet to be verified. This frog was found in a state of aestivation, sedentary and with closed eyes. When disturbed the individual shed a layer of skin and slowly became active.

make an estimate of the volume of timber contained in Ndechela, but little money is available for any management. A ‘village fire committee’ had been set up in 1997 to control fires set deliberately within the forest, but this is no longer effective. While there are no by-laws enacted by the villages, regular patrols of the reserve by game officers from Lukwika-Lumesule game reserve provide some level of protection, and future plans include a possible link with the Lukwika-Lumesale Game Reserve.

20. DISCUSSION AND COMPARISON FOR ALL FOREST RESERVES

G. WEGNER AND O. SWEENEY

This section serves to summarise and further discuss results for all flora, fauna and human resources-use from the eight forest reserves surveyed, and to compare their biological importance by assessing values of species richness, diversity, forest dependency, endemism and extinction threat. These comparisons will aid in establishing priorities for future conservation initiatives in the reserves studied.

FLORA

VEGETATION TYPES

The vegetation found in the study area is distinctive of the Coastal Forest Mosaic, being comprised of an assemblage of closed-forest types unique to the Swahilian region *sensu lato*, as well as savanna woodland, thicket, grassland and farmland under cultivation or fallow. This mosaic pattern of vegetation types is a consequence of both the heterogeneous set of abiotic factors (climate, geology, topography, soils etc.) characterising different sites within the study area (see Study Site section), and the various levels of anthropogenic disturbance and management occurring within the reserves (Robertson and Clark, 2000) (see Human Resource-Use and Local Management sections).

Various types of eastern African closed-canopy Coastal Forests were identified in the study area: *Brachystegia* forest, Legume-dominated dry forest, Mixed dry forest, Mixed scrub forest and Riverine forest (Table 20-a).

Brachystegia forest was the most dominant vegetation type, occurring extensively on the well-drained, nutrient poor and heavily leached soils typical of the Makonde escarpment, a landform that encompasses Kambona FR and Makonde Scarp I, II and III proposed FRs, and the northern edge of Mkunya River proposed FR. Here *Brachystegia* forest appears to constitute a non-fire generated climax community, occurring over soils that have become too degraded to support the coastal dry forest vegetation climax original to the eastern African coastal strip (Clarke and Robertson, 2000). The cause of this soil erosion is both anthropogenic (clearance and shifting cultivation) and natural (the rapid erosion of the sandstone plateaux and hills). In the study area *Brachystegia* trees generally form a closed-canopy over a dense to sparse shrub layer, while grasses are thinly distributed or absent. In some of the reserves (Kambona FR, Makonde Scarp I and II, Mkunya River and Mtiniko proposed FRs), the removal of canopy trees for timber has changed the physiognomy of the canopy layer into a more open configuration, and in some cases (Kambona FR, and Mkunya River and Mtiniko proposed FRs) has given way to sub canopy species to dominate in terms of relative abundance. However, the presence of Swahilian endemic species and the sparse character of the grass layer still distinguish this vegetation type from the *Brachystegia* or ‘miombo’ woodland that constitutes the fire-generated climax of the Zambeian regional centre of endemism²³ (Clarke, 2000). The shrub layer that characterises *Brachystegia* forest in the study area varies from sparse (Kambona FR, and Mkunya River and Makonde Scarp III proposed FRs) to dense (Makonde Scarp I and II proposed FRs). On the slopes of the

²³ The *Brachystegia* or ‘miombo’ woodland formations of the Zambeian regional centre of endemism are also dominated by *Brachystegia* sp. (*B. microphylla* or *B. spiciformis*), but they differ from the coastal *Brachystegia* forest of the Swahilian regional centre of endemism in both ecological and physiognomic terms. They are fire-climax vegetations characterised by an open canopy and a dense grass layer, and composed of tree and shrub species restricted in distribution to the Zambeian regional centre of endemism (Clarke, 2000).

Makonde escarpment in Mkunya River proposed FR thin understory vegetation is probably caused by the steepness of the ground, whereby deep soils fail to develop and support dense vegetation. In the other reserves further study will be needed to determine whether the sparsity of the shrub layer is a natural incidence (Robertson and Clarke, 2000) or a consequence of disturbance.

Legume-dominated dry forest was found to still occur in Mtuli Hinju proposed FR and Ndechela FR. This forest type grows on well-drained soils but appears not to be limited by other edaphic conditions (Robertson and Clarke, 2000). In Mtuli Hinju proposed FR it grows on deep, well drained sandy soils of low fertility and moisture holding capacity that have developed from the coastal sandstone sediments of the eastern African coastal strip. In Ndechela it occurs on coarse grained sandy soils that have developed from the pre-Cambrian gneisses and granulites extending west of the coastal sediments and south of Masasi. While in Mtuli Hinju the canopy layer is typically dominated by few species from the Fabaceae family, i.e. *Pterocarpus angolensis* (subfamily Papilionideae) and *Albizia versicolor* (subfamily Mimosoideae), in Ndechela no particular Fabaceae species appear to dominate the canopy and sub canopy layers. Legume-dominated dry forest probably represents a relict of the pre-Miocene pan-African lowland forest that once comprised the now separated blocks of West African Guineo-Congolian Forest and East African Swahilian Coastal Forest. As such, it is possible that prior to human intervention Legume-dominated dry forest covered much of the eastern African coastal strip, constituting the climatic vegetation climax for this ecoregion (Robertson and Clarke, 2000). This plant community is very vulnerable. The seeds of the Fabaceae trees are heavy and not dispersed by wind or animal. Moreover, these seeds do not remain viable in the seed bank for long, do not tolerate desiccation, require a forest microclimate (shade and high-humidity) to germinate and are pyrophobic (Clarke, 2000). Therefore, the complete clearance of this forest type drastically lowers the chances of its regeneration on the same sites. These sites can then become dominated by more easily dispersed pioneer tree species characteristic of mixed dry forest and mixed scrub forest, at the expense of endemic species and plant associations that may be relicts of the ancient Pan-African lowland forest (Clarke, 2000). In both Mtuli Hinju proposed FR and Ndechela FR human disturbance constitutes a threat to the continuity of Legume-dominated dry forest, and it is therefore important to implement conservation measures to protect this vulnerable plant community.

Mixed non-legume-dominated dry forest was found on deep, well-drained sandy soils of low fertility and moisture holding capacity that developed from the coastal sandstone sediments in Mtiniko proposed FR. Here this community may constitute a regeneration climax that has developed in the absence of slower dispersing legume seeds (Clarke and Robertson, 2000). Mixed dry forest is generally characterised by a relatively high degree of species richness and a dense understory, as found in Mtiniko proposed FR.

In Makonde Scarp II proposed FR, Mixed scrub forest constitutes a seral stage that resulted from the clearance of climax forest and the practice of shifting cultivation, whereby farmland is left fallow for at least seven years, allowing grassland first, then Thicket and finally Mixed scrub forest to regenerate. If the clearing cycle was not perpetuated this vegetation type could complete its succession to climax forest (Gillman, 1954).

Finally, small patches of Riverine forest were recorded in Kambona FR and Mkunya River proposed FR. In both cases big canopy trees characteristic of Riverine forest have been removed for use as timber and sub canopy trees have taken over to cover the gaps; what is left is a regenerating stage of this vegetation type.

Thicket, cultivated and fallow farmland were found in all reserves to varying degrees.

Table 20-a Forest types, total number of floral species, diversity index, and number of endemic and threatened floral species found in the eight forest reserves surveyed

Forest Reserve	Vegetation classification	Total no. of species	Shannon diversity index	No. of species endemic to the Swahilian region <i>sensu lato</i>	No. of threatened species
Kambona	Eastern African coastal <i>Brachystegia</i> forest and Riverine forest	79	3.37	7	1 VU 7 PT
Makonde Scarp I	Eastern African coastal <i>Brachystegia</i> forest	73	2.95	9	1 VU 7 PT
Makonde Scarp II	Eastern African coastal <i>Brachystegia</i> forest, Mixed scrub forest and Thicket	76	3.01	7	3 VU 7 PT
Mkunya River	Eastern African coastal <i>Brachystegia</i> forest and Riverine forest	102	2.80	11	1 CR 3 VU 8 PT
Mtiniko	Eastern African coastal mixed dry forest	111	2.78	10	1 VU 9 PT
Mtuli Hinju	Eastern African coastal Legume-dominated dry forest	122	2.21	7	1 VU 9 PT
Makonde Scarp III	Eastern African coastal <i>Brachystegia</i> forest and Thicket	90	2.75	8	2 VU 9 PT
Ndechela	Eastern African coastal Legume-dominated dry forest	78	3.46	10	1 VU 8 PT

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

PT = Potentially Threatened plants in the EACF hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

SPECIES RICHNESS AND DIVERSITY

The floral species richness and diversity observed in the studied sites were assessed by taking in consideration a combination of factors, including the size of the reserve, the types of plant communities present, the level of habitat fragmentation and the degree of disturbance. In this study the sampling intensity was chosen to be proportional to the size of each reserve, and therefore dissimilar sampling intensities were also responsible for the variations recorded (Table 10-a).

In total 265 plant species were recorded by this study. Mtuli Hinju and Mtiniko proposed FRs were found to have the highest floral species richness (122 and 111 species respectively) while Makonde Scarp I and II had the lowest number of species recorded (73 and 76 species respectively) (Table 20-a). Mixed dry forest is generally characterised by a high number of species (Robertson and Clarke, 2000), which may explain the findings from Mtiniko proposed FR. The divergence in species richness between the Legume-dominated forests of Mtuli Hinju proposed FR (122) and Ndechela FR (78) may be attributed to the high level of fire disturbance affecting Ndechela FR, which may be preventing the regeneration of fire intolerant species (Burgess and Clarke, 2000). In Makonde Scarp I and II proposed FRs the high proportion of cultivated land comprising the reserves and the conspicuous extraction of timber taking place accounted for the low number of species found.

The highest Shannon diversity index ($H^1=3.46$) was recorded in Ndechela FR. This is associated with the high number of individual trees found here (314 in total) and the lack of a single or few dominant species, whereby individual trees are evenly distributed among a

number of species (Magurran, 1988; Begon *et al.*, 1996). The high number of trees in Ndechela FR is a consequence of the relatively low level of timber extraction affecting this reserve. Shannon diversity indexes for other forest reserves ranged from 2.75 in Mtiniko proposed FR to 3.37 in Kambona FR (Table 20-a). These relatively high values reflected plant communities in succession (Magurran, 1988), where a comparatively high number of species, particularly understory species, can colonise the area and achieve high population densities following the removal of more competitive canopy trees (Ndangalasi, 1997). If these forests were allowed to fully regenerate, and canopy and sub canopy species to achieve their potential population size, then the species diversity would be expected to decline. In Mtuli Hinju proposed FR the Shannon diversity index was relatively low ($H^1=2.21$) in relation to the total number of species recorded (116), and this reflected a stable community where competitive and productive species have achieved high population densities and have come to dominate (Magurran, 1988; Begon *et al.*, 1996). This forest reserve may have reached a climatic stage because of the low level of human disturbance occurring with respect to encroachment and timber extraction (see Human Resource-Use and Local Management sections).

All forest reserves were subject to some degree of disturbance and this has had a significant impact on the vegetation found. In general, there seems to be a relationship between the degree of disturbance and the species richness occurring in an area (Figure 20). Mtuli Hinju proposed FR was the reserve affected by one of the lowest degrees of disturbance and the one with the highest number of species recorded (122). Encroachment and clearance for cultivation were most severe in Mkunya River, Makonde Scarp I, II and III proposed FRs, where they have noticeably reduced the area covered by forest and consequently the number of species present (Table 20-a, Figure 20). Where timber extraction was most severe (Kambona FR and Makonde Scarp I, II and III proposed FRs) the selective removal of canopy and sub canopy trees has noticeably reduced the species richness: only 73 species were recorded in Makonde Scarp I, 76 in Makonde Scarp II, 79 in Kambona and 90 in Makonde Scarp III (Figure 20, Table 20-a). In Mtiniko proposed FR the illegal off take of timber may be higher than the study shows, but the intrinsic species richness characteristic of its Mixed dry forest may be compensating for this degree of disturbance and may explain the high number of species recorded (111). In Ndechela FR levels of encroachment, timber extraction and hunting were among the lowest recorded in this study, however, extensive and frequent fires may be responsible for the low species richness observed (78 species), since fire inhibits the regeneration of fire intolerant species.

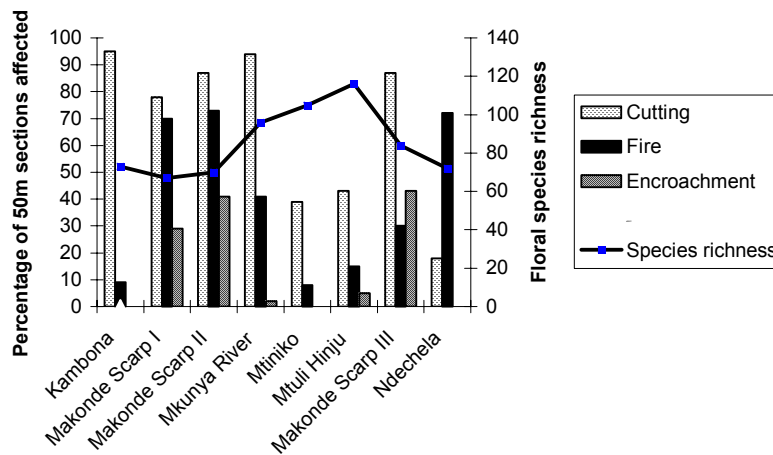


Figure 20 Graph showing the relationship between floral species richness and levels of disturbance

ENDEMISM

In the whole study area 26 of the species found are endemic to the Swahilian region *sensu lato*, being geographically restricted to the coastal strip of eastern tropical Africa, between the equator in Somalia and the Limpopo River in Mozambique (Clarke, 2000) (Table 20-b). These endemic species constitute 6% to 12% of the floral species recorded in each forest reserve and make up 12% of the total number of species recorded throughout the study (265) (Figure 21; Appendix 10). These figures constitute a third of the overall degree of endemism recorded by previous studies in other Coastal Forests of Tanzania, where 33% of vascular plant species were found to be endemic to the Swahilian region *sensu lato* (Clarke, 2000). The relatively low level of endemism found in the surveyed Coastal Forests of the Mtwara Region is likely to be a consequence of the high degree of habitat destruction taking place in the area.

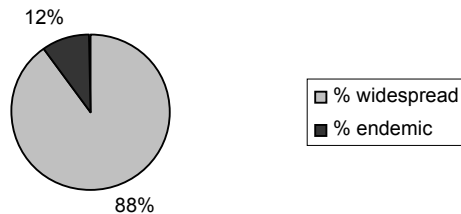


Figure 21 Percentage of endemic (to the Swahilian Region *sensu lato*) and widespread floral species for the whole study site

EXTINCTION THREAT

Five of the species found are listed as threatened on the IUCN Red List (2004), and another 25 are recognised to be potentially threatened (Gereau and Luke, 2006), together constituting 13% of all species recorded (Table 20-b).

Most of the species listed as threatened by IUCN (2004) and recorded during this study are timber trees used by the local communities for a variety of purposes. *Cynometra gillmanii* (Endemic and Critically Endangered) is characterised by a hard wood that is used in construction and for making various tool handles. The wood of *Mesogyne insignis* (Vulnerable) is hard and heavy, and is used for building poles and tool handles and for firewood. The African mahogany (*Khaya anthotheca* - Vulnerable) yields a very valuable, termite resistant timber that resembles that of the South American true Mahogany (*Swietenia macrophylla*), and is demanded on global markets for joinery and cabinet work and for making veneer (Schulman *et. al*, 1998).

None of the plant species recorded by this study are classified as Rare by Knox (2000), i.e. none of them are present in less than two out of the eight FTEA vegetation regions of Tanzania (Polhill, 1988). Such apparent widespread distribution within the Swahilian region *sensu lato* may seem to imply that none of the endemic species recorded are particularly threatened by extinction. However, considering the relatively small area of the Coastal Forest Mosaic, the high degree of habitat loss and fragmentation it suffers (Brooks *et al.*, 2002), and the current criteria for inclusion in the Red List (IUCN, 2004), most endemic species can actually be regarded as ‘threatened species’ (CEPF, 2005). In fact, 17 (65%) of the endemic plant species occurring in the surveyed reserves are already listed as threatened or potentially threatened (Table 20-b). This highlights the importance of the Coastal Forests studied as habitats for the endemic plants still found here, and emphasises the urgent need for

conservation measures to protect them. Unfortunately, even if the remaining forest patches were to be left intact, their endemic species richness may already not be sustainable in the long-term: fragmentation and habitat loss may have caused populations of long-lived endemic species (e.g. trees) to become genetically unviable (Cronk, 1997; Clarke *et al.*, 2000).

Table 20-b Endemic and threatened floral species found in the eight forest reserves surveyed

Family	Species	Endemic status	Threat status	Reserve
ACANTHACEAE	<i>Barleria holstii</i>	E		Kambona, Mtiniko
ANACARDIACEAE	<i>Ozoroa obovata</i>	E		Makonde Scarp I
ANNONACEAE	<i>Monodora grandidieri</i>	E		Makonde II, Mtiniko
ANNONACEAE	<i>Monanthes fornicata</i>	E	PT	Makonde II
ANNONACEAE	<i>Monanthes trichocarpa</i>		PT	Makonde II
ARALIACEAE	<i>Cussonia zimmermannii</i>	E	PT	Makonde III, Ndechela
BOMBACACEAE	<i>Bombax rhodognaphalon</i>	E	PT	Mtiniko, Makonde III
BURSERACEAE	<i>Commiphora zanzibarica</i>	E	PT	Makonde I, Mkunya River, Ndechela
CELASTRACEAE	<i>Maytenus mossambicensis</i>		PT	Mtuli Hinju
DILLENIACEAE	<i>Tetracera boiviniana</i>	E	PT	Kambona, Makonde II and III, Mtiniko, Mtuli Hinju, Ndechela
EUPHORBIACEAE	<i>Cleistanthus schlechteri</i>	E		Kambona, Mkunya River, Mtiniko, Mtuli Hinju
EUPHORBIACEAE	<i>Drypetes natalensis</i>		PT	Kambona, Makonde I and III, Mkunya River, Mtiniko
FABACEAE (CAES)	<i>Cassia abbreviata</i>		PT	Makonde II and III, Mtuli Hinju, Ndechela
FABACEAE (CAES)	<i>Cynometra gillmanii</i>	E	CR	Mkunya River
FABACEAE (CAES)	<i>Scorodophloeus fischeri</i>	E	PT	Mkunya River, Makonde III, Ndechela
FABACEAE (MIM)	<i>Acacia nilotica</i>		PT	Mtuli Hinju
FABACEAE (MIM)	<i>Entada stuhlmannii</i>	E	PT	Ndechela
FABACEAE (PAP)	<i>Baphia punctulata</i>		PT	Kambona
FABACEAE (PAP)	<i>Craibia brevicaudata</i>		PT	Kambona, Makonde II, Mtiniko, Mtuli Hinju
FABACEAE (PAP)	<i>Erythrina schliebenii</i>	E	PT	Kambona, Makonde I, Mkunya River, Mtiniko, Mtuli Hinju
FABACEAE (PAP)	<i>Milletia impressa</i>		PT	Makonde I and II, Mkunya River, Ndechela
FLACOURTIACEAE	<i>Xylothea tettensis</i>	E	PT	Mkunya River, Mtuli Hinju, Makonde III
MELIACEAE	<i>Khaya anthotheca</i>		VU	Kambona, Makonde II and III
MORACEAE	<i>Mesogyne insignis</i>		VU	Mkunya River, Mtiniko, Mtuli Hinju, Makonde III
MYRTACEAE	<i>Syzygium cordatum</i>		PT	Kambona
RUBIACEAE	<i>Gardenia transvenulosa</i>	E	VU	Makonde II, Ndechela
RUBIACEAE	<i>Lamprothamnus zanguebaricus</i>	E	PT	Makonde I and II, Mkunya River
RUBIACEAE	<i>Lasianthus kilimandscharicus</i>		PT	Mtuli Hinju, Makonde III

Family	Species	Endemic status	Threat status	Reserve
RUBIACEAE	<i>Rytigynia decussata</i>	E	PT	Kambona, Makonde I, Mkunya River, Mtiniko, Mtuli Hinju
SAPOTACEAE	<i>Mimusops schliebenii</i>	E		Kambona, Makonde I, Mkunya River
STERCULIACEAE	<i>Cola clavata</i>	E	PT	Mtiniko, Mtuli Hinju
STERCULIACEAE	<i>Sterculia appendiculata</i>	E		Makonde I and III, Mkunya River, Ndechela
TILIACEAE	<i>Grewia forbesii</i>	E		Mkunya River
TILIACEAE	<i>Grewia lepidopetala</i>	E		Kambona, Makonde II and III, Mtiniko, Mtuli Hinju, Ndechela
VERBENACEAE	<i>Vitex mossambicensis</i>	E	PT	Makonde I, Mtiniko, Ndechela
VERBENACEAE	<i>Vitex zanzibarensis</i>	E	VU	Makonde I and II, Mkunya River
VIOLACEAE	<i>Rinorea angustifolia</i>		PT	Mtiniko
VIOLACEAE	<i>Rinorea elliptica</i>	E		Mtiniko
ZINGIBERACEAE	<i>Aframomum orientale</i>	E	PT	Makonde III

E = Species endemic to the Swahilian region *sensu lato* (Clarke and Robertson, 2000)

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

PT = Potentially Threatened plants in the EACF Hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

When comparing the forest reserves in terms of percentage endemic and threatened species, Makonde Scarp I and III proposed FRs and Ndechela FR contain the highest ratio of endemic species (12%), while Mtuli Hinju proposed FR is characterised by the lowest ratio (6%). The percentage of threatened species in all reserves ranges between 8-12%. However, no pattern could be identified when relating the relative proportion of threatened and endemic species recorded in each forest reserve to either the vegetation type where the species occur or the degree of disturbance affecting the reserves (Figure 22).

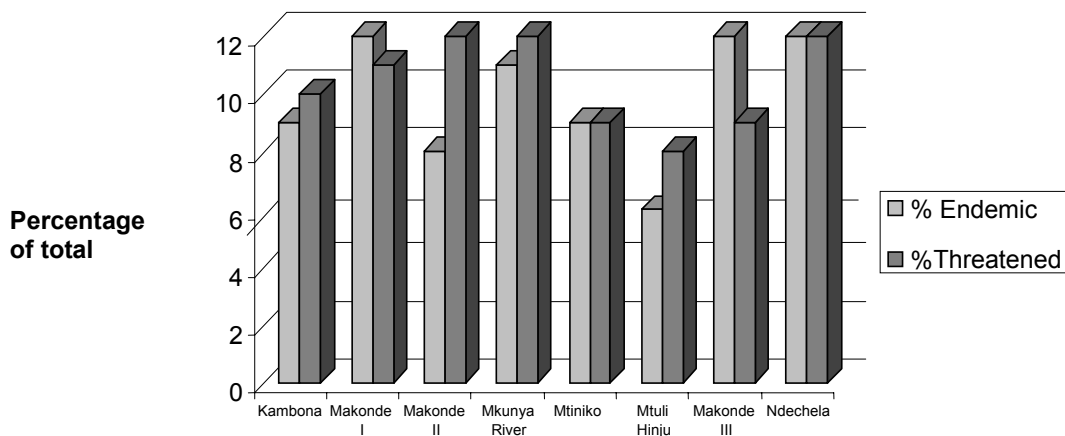


Figure 22 Percentage of endemic (to the Swahilian Region *sensu lato*) and threatened floral species for each forest reserve

FAUNA

SPECIES RICHNESS

The faunal species richness observed in the studied sites was determined by taking in consideration a combination of factors, including the size of the reserve (Figure 23), the structure of the plant communities present, the level of habitat fragmentation and the degree of disturbance (Figure 24). In this study the sampling intensity was chosen to be proportional to the size of each reserve, and therefore dissimilar sampling intensities were also responsible for the variations recorded (Table 10-a).

Table 20-c Total number of faunal species found in each forest reserve for all studied taxa and, in brackets, their percentage contribution to the number of species recorded as a whole in each forest reserve

Taxa	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	Total number of species for all reserves
Large mammals	14 (13)	19 (14)	11 (11)	17 (10)	7 (8)	6 (7)	8 (9)	28 (16)	38
Small mammals	8 (7)	6 (4)	7 (7)	10 (6)	5 (6)	5 (6)	5 (5)	8 (5)	16
Bats	0	1 (1)	0	2 (1)	0	0	0	2 (1)	5
Birds	57 (53)	78 (57)	64 (65)	103 (59)	56 (64)	56 (66)	49 (53)	97 (56)	159
Reptiles	4 (4)	9 (7)	7 (8)	12 (7)	2 (2)	1 (1)	5 (5)	10 (6)	30
Amphibians	5 (5)	5 (4)	2 (2)	8 (5)	1 (1)	6 (7)	3 (3)	8 (5)	21
Butterflies	19 (17)	20 (14)	8 (8)	24 (14)	17 (19)	11 (13)	23 (25)	21 (12)	71
TOTAL	107	138	99	176	88	85	93	174	340

The highest numbers of species were recorded in Mkunya River proposed FR and Ndechela FR (176 and 174 respectively); while Mtiniko, Mtuli Hinju and Makonde Scarp III proposed FRs had the lowest number of species (88, 85 and 93 respectively). The high numbers recorded for Mkunya River and Ndechela reflect the fact that they were the largest reserves surveyed, that they were among the least disturbed by agricultural encroachment, and that a high sampling intensity had been applied to them (Table 10-a, Figure 23 and Figure 24). The low number of species recorded in Mtiniko and Makonde Scarp III proposed FRs is mainly a consequence of the high level of human disturbance that affects both (Figure 24). In Mtiniko FR, results from structured interviews suggested that encroachment and illegal off take of timber may be higher than the study shows (see Results and Discussion sections). The low

species richness recorded in Mtuli Hinju proposed FR is likely to mainly reflect its small size, as the level of disturbance was relatively low in this reserve (Figure 23 and Figure 24).

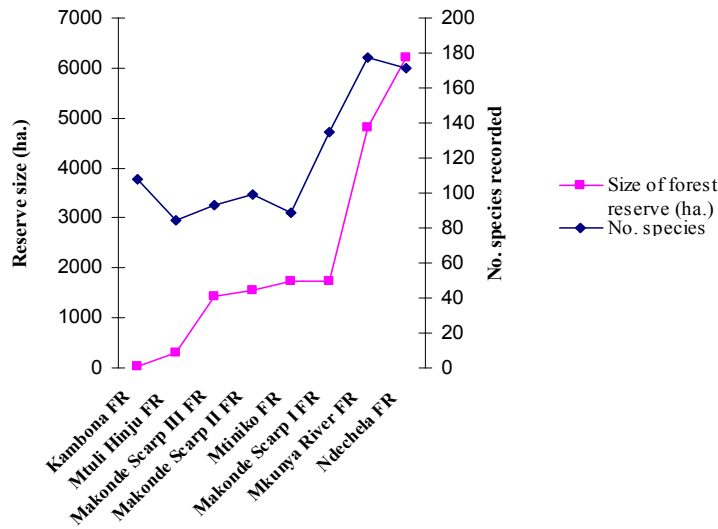


Figure 23 Graph showing the relationship between faunal species richness and forest reserve size

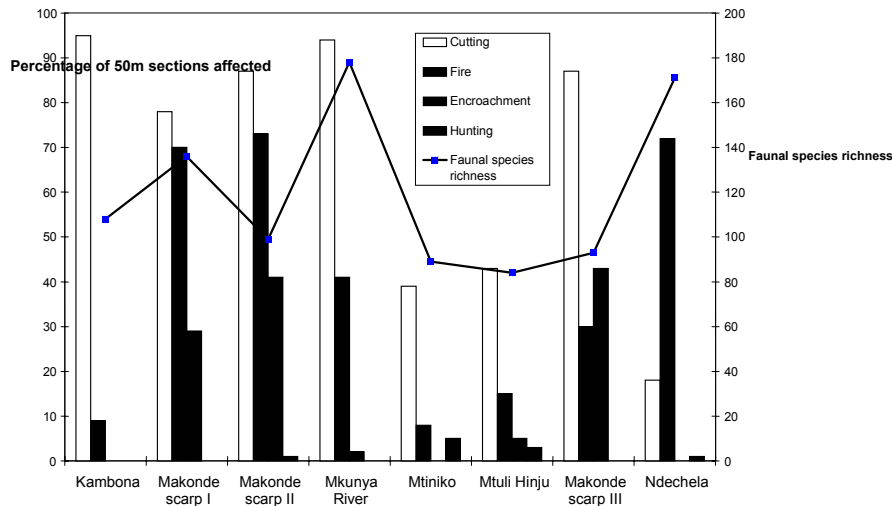


Figure 24 Graph showing the relationship between faunal species richness and levels of disturbance

Birds

For all forest reserves, birds accounted for the highest proportion of species recorded, ranging from 53% to 66% of all records (Table 20-c). This study confirms the direct link between bird species richness and the size of the study site observed by Mlingwa *et al* (2000): the highest numbers of birds were recorded in Mkunya River proposed FR (103) and Ndechela FR (97), which were the largest reserves in the study area (Table 9-a). Accordingly, Kambona FR and

Mtuli Hinju proposed FR were the smallest reserves surveyed and had low numbers of bird species recorded (57 and 56 respectively). It has been considered that vegetation structure is more important than habitat continuity in determining the composition of bird communities (Waiyaki, 1995 in Mlingwa *et al.*, 2000): 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. This may explain why in some of the forest reserves that have disjunct patches of dense understory forest (Makonde Scarp I and II proposed FRs), the number of bird species recorded was relatively high (78 and 64 respectively). Where the vegetation was instead characterised by a sparse shrub layer (Kambona FR and Makonde Scarp III proposed FR), a lower number of species seemed to occur (57 and 49 respectively). In Mtiniko proposed FR the number of species recorded (56) was surprisingly low considering the dense understory of the Mixed dry forest found here (see Flora section). However, this figure may not be indicative of the real level of species richness and instead it may reflect the fact that a particularly closed-canopy and dense understory made sightings more difficult than in other reserves. In Ndechela FR the large size of the reserve (6,216ha) appeared to compensate for the evident absence of a dense shrub layer following extensive fire disturbance, and may therefore explain the high number of bird species found (97). Another factor responsible for variations in bird species richness among the reserves is their proximity to the ridges of the Makonde Scarp, where the topographic variation of the escarpment creates an array of habitats and nesting sites for birds. Mkunya River and Makonde Scarp I and II proposed FRs are all located along the ridges of the Makonde scarp and have high levels of species richness (103, 78 and 64 respectively).

Butterflies

Butterflies contributed the second highest number of species within almost all of the reserves surveyed, ranging from 8-24% of all records (Table 20-c). Butterfly species richness seemed to be mainly determined by the size of the reserve and the presence of dense and moisture rich vegetation (Kielland, 2000). Mkunya River proposed FR, which was one of the largest reserves (Table 9-a), had the highest numbers of butterfly species recorded (24). Accordingly, Mtuli Hinju proposed FR was one of the smallest reserves in this study and had one of the lowest numbers recorded (11). Where a dense understory was present in at least some patches of forest (Makonde scarp I and III, Mtiniko, Mkunya River and Kambona FRs), a high number of species was recorded, ranging between 17 and 27. For the same reason, the low species richness found in Makonde Scarp II (8 species) may be a consequence of the open and dry nature of the vegetation covering most of this reserve (see Flora section). A high proportion of species were recorded in small pockets of Riverine forest in Kambona FR and Mkunya River proposed FR, confirming a preference for a shaded and moisture rich environment by many species. In Ndechela FR extensive fire disturbance has created a sparse and dry understory, and the relatively high number of species recorded (21) can therefore be attributed to the size of the reserve more than to the structure of the vegetation.

Large mammals

Large mammals contributed the third highest number of species within each reserve, ranging from 8% to 16% of all records. Most large mammals have extensive home ranges, so the size of suitable habitat available is the main factor affecting both the number of species present and the size of the populations that can be supported (Begon *et al.*, 1996). Ndechela FR was found to contain the highest number of large mammal species (28), a consequence of both the continuity of suitable habitat sites within this reserve and its contiguity to the Lukwika-Lumesale Game Reserve. On the contrary, Makonde Scarp III and Mtuli Hinju proposed FRs had the lowest species richness (8 and 6 species respectively), reflecting their high level of fragmentation and the small size of forest habitat remaining. Considering that Mtuli Hinju was the least disturbed and fragmented of all the reserves surveyed, the number of large mammals recorded was unexpectedly low, though it may be reflective of the small size of the

reserve and the low sampling intensity applied to it (Table 10-a). The number of individuals detected for each species was low in most of the reserves. This suggests that the populations of most species are suppressed due to a significant degree of disturbance recorded in most of the reserves (see Human Resource-Use and Local Management sections), a factor that has decreased the extent of suitable habitat and ecological requirements (e.g. prey, shelter) necessary to support larger populations.

Bats

Bats were recorded only in three reserves (Makonde Scarp I, Mkunya River and Ndechela), and only five species in total were recorded. However, the sampling intensity applied to this study was not sufficient to effectively assess the much wider cross section of species known to inhabit the Coastal Forests (up to 58 species) (Burgess *et al.*, 2000a).

Small mammals

Small mammal species richness ranged from five to eight species in all reserves. These figures are particularly low, considering that a minimum of 12 and a maximum of 36 species have been previously recorded in individual forests of the Coastal Forest Mosaic (Burgess *et al.*, 2000a). Such a poor small mammal community in the study sites probably reflects the generally open and dry habitat (Zullini, 2003; Begon *et al.*, 1996) that has resulted from the various degrees of agricultural encroachment, timber extraction and fire occurring in the reserves (see Human Resource-Use and Local Management sections).

Reptiles and amphibians

Reptiles and amphibians made up the lowest proportion of all species captured, ranging between 1–8% and 1–7 % of all records respectively (Table 20-c). The number of species recorded from these taxa was generally low in all survey sites. This is in part a consequence of the rapid nature of this study, which did not permit comprehensive collection of data during the wet season and the study of fossorial species (Broadley and Howell, 2000). Higher numbers of individuals were generally found in small patches of vegetation surrounding a water body (in Kambona and Ndechela FRs, and in Mkunya River and Mtuli Hinju proposed FRs), where dense vegetation and moist humus soil create an ideal breeding ground for these species (Howell, 1993). Of the reserves containing a water body, the highest species richness was recorded along the Mkunya River (12 for reptiles and 8 for amphibians), reflecting the high sampling intensity applied to this reserve. In Kambona FR and Mtuli Hinju proposed FR the overall number of species was lower than expected (4 reptiles and 5 for amphibians in Kambona FR; 1 for reptiles and 6 for amphibians in Mtuli Hinju proposed FR) and may reflect the low sampling intensity chosen (Table 10-a). Lower numbers were recorded in those reserves not endowed with a sufficiently large water source and where severe levels of encroachment, timber extraction and burning have created a largely open and dry environment (Makonde Scarp I, II and III proposed FRs) (Table 20-c) (Zullini, 2003; Begon *et al.*, 1996). In Ndechela FR the reptile species composition and species richness (10 species) were typically determined by the presence of numerous rocky microhabitats, which may have compensated for the absence of moisture rich habitats. However, the amphibian community in this reserve remains characterised by a low number of species (8) mainly captured from a few stagnant pools along seasonal river beds.

FOREST DEPENDENCE

The number of forest dependent faunal species found in any given reserve was generally low, indicating that large portions of the study sites have been converted into a more open and dry habitat, leaving only a few, and often small, patches of suitable forest habitat.

Forest dependent species were mainly recorded in the dense understory of *Brachystegia* forest (in Makonde scarp I and III proposed FR), Mixed dry forest (in Mtiniko) and Riverine forest

(in Mkunya River and Kambona). The highest number of forest dependent species (14) and individuals were recorded in Mtiniko proposed FR, reflecting the extensive area of undisturbed forest occurring in this reserve. A high number of forest dependent species was expected in Mtuli Hinju proposed FR, as relatively dense and undisturbed Legume-dominated dry forest covers most of this reserve. However, only five forest dependent species were recorded here (Table 20-d), which may be explained by the small size of this reserve (296ha) and/or the low sampling intensity applied to it (Table 10-a).

In general, in most of the reserves studied forest dependent species rely on fragmented patches of remaining forest and are therefore locally threatened by further degradation of their habitat.

Mammals

When compared to the West African Guineo-Congolian forests, the proportion of forest dependent mammals in the East African Swahilian Coastal Forests is low: on average, only 20% of mammal species are forest dependent (compared to 70% in the Guineo-Congolese Forest), 42% are forest dwelling and 37% are habitat generalists or not known (Burgess *et al.*, 2000a). The dominance of non-forest species may be due to the fact that the Coastal Forests are naturally fragmented, surrounded by open habitats and dry for part of the year. In the Mtwara Region these characteristics are further accentuated by high levels of encroachment and disturbance, and this explains the even lower proportion of mammal forest dependent species recorded here. None of the small mammal species recorded are forest dependent, one bat species (*Epomophorus wahlbergi*) is forest dwelling but not forest dependent, and only five of the large mammals are forest dependent, constituting 13% of all large mammal species recorded and including the Moloney's monkeys (*Cercopithecus mitis* sub sp.), the Red-bellied coastal squirrel (*Paraxerus palliatus*), the Blue duiker (*Cephalophus monticola*), the Natal duiker (*Cephalophus natalensis*) and the Suni (*Neotragus moschatus*) (Table 20-d). Many of these forest dependent species were recorded in small pockets of forest amidst large areas of disturbed habitat and are therefore locally threatened by the limited size of suitable forest habitat available and the scarcity of ecological requirements (e.g. food, shelter) necessary to support viable populations.

Most other large mammals recorded only occasionally frequent the forest and are therefore less affected by degradation of the forest habitat. Nonetheless, these species may need the forest reserves as a corridor between suitable patches of habitat or for alternative sources of food and shelter. Predators such as the Lion (*Panthera leo* - Vulnerable, CITES II) and the Spotted hyena (*Crocuta crocuta* - conservation dependent) are able to utilise different habitats and to adapt well to changes in their environment, and so are likely to be less threatened by further forest degradation. Nevertheless, any reduction in habitat will reduce the visits of these animals as shelter and populations of preyed animals are likely to decrease. Further research needs to be conducted to assess the extent of reliance of large mammals and predators on the eight forest reserves studied.

Birds

Forest dependent bird species rely on a canopy-shaded and dense understory (Mlingwa *et al.*, 2000). This explains why forest dependent species were observed to occur only among the dense lianas and shrubs of the Mixed dry forest in Mtiniko proposed FR and in small but dense patches of *Brachystegia*, Legume-dominated and/or Riverine forest in Mkunya River, Mtuli Hinju, and Makonde Scarp I and III proposed FRs. These species include the African crowned eagle (*Stephanoaetus coronatus*), the African broadbill (*Smithornis capensis*), the Yellow streaked greenbul (*Phyllastrephus flavostriatus*), the Fischer's greenbul (*P. fischeri*), the East coast akalat (*Sheppardia gunningi*), the Blue-mantled crested flycatcher (*Trochocercus cyanomelas*) and the Reichenow's batis (*Batis reichenowi*) (Table 20-d). The

total number of forest dependent species (7) is surprisingly low when considering that 33 bird species in total have been recognised as forest dependent by previous studies in the Coastal Forests (Mlingwa, 2000). This low number of forest dependent species is a consequence of the largely disturbed nature of the forests in the study area, whereby the few patches of suitable forest habitat remaining are often too small to sustain viable populations of forest bird species.

Reptiles

For the reptiles, of all the species recorded only the Tropical plated lizard (*Cordylus tropidosternum*) and the Rufus egg-eater (*Dasypeltis medici*) are known to favour a forested habitat, and even these species were only found in one forest reserve each (Makonde Scarp I and Kambona respectively). This paucity of forest dwelling and forest dependent reptile species in the studied sites is striking when considering that 50% of reptile species recorded by previous studies in the Coastal Forests are forest dependent (Broadley and Howell, 2000).

Amphibians

For the amphibians, only the Yellow-spotted tree frog (*Leptopelis flavomaculatus*), the Spotted reed frog (*Hyperolius punctulatus*) and the Squeakers (*Arthroleptis* sp.) are known to favour a forested habitat (Schiotz, 1999; Channing, 2001). The paucity of forest dwelling and forest dependent amphibian species is a recurrent characteristic of the Coastal Forests, as the majority of species recorded by previous studies are open-site breeders rather than strictly forest-limited species. The intrusion into forested areas by species that normally inhabit transient open situations is known to be a recurrent characteristic encouraged by the heterogeneous pattern of the Coastal Forest Mosaic, whereby such species breed in their open habitat but enter the enclosed habitat for refuge, especially during dry periods (Poynton, 2000). The Squeakers recorded by this study (*Arthroleptis stenodactylus* and *A. xenodactyloides*) are common species that were found in all reserves studied. However, these species favour a forested habitat as they rely on the presence of damp soil and loose leaf mould protected from shrub and canopy cover to lay their eggs (Howell, 1993), so they may become locally threatened by further loss of forest habitat.

Butterflies

For the butterflies, nine species are thought to be forest dependent (Larsen, 1996), and were mainly recorded in the dense understory of *Brachystegia* forest (in Makonde scarp I and III proposed FR), Mixed dry forest (in Mtiniko) and Riverine forest (in Mkunya River and Kambona) (Table 20-d).

Table 20-d Forest dependent faunal species found in the eight forest reserves surveyed

Taxon	Species	Common name	Forest Reserve found
Mammals	<i>Cercopithecus mitis</i> (sub sp.)	Moloney's monkey	Mkunya River, Mtiniko, Makonde Scarp III, Ndechela
	<i>Paraxerus palliatus</i>	Red bellied coastal squirrel	Kambona, Mkunya River, Mtiniko
	<i>Cephalophus monticola</i>	Blue duiker	Makonde Scarp I, Mtuli Hinju, Ndechela
	<i>Cephalophus natalensis</i>	Natal duiker	Makonde Scarp II, Mkunya River
	<i>Neotragus moschatus</i>	Suni	Kambona, Makonde Scarp I
Birds	<i>Stephanoaetus coronatus</i>	African crowned eagle	Makonde Scarp I
	<i>Smithornis capensis</i>	African broadbill	Makonde Scarp I and III, Mkunya River, Mtiniko and Mtuli Hinju
	<i>Phyllastrephus flavostriatus</i>	Yellow streaked greenbul	Mtiniko

Taxon	Species	Common name	Forest Reserve found
	<i>Phyllastrephus fischeri</i>	Fischer's greenbul	Mtiniko
	<i>Sheppardia gunningi</i>	East coast akalat	Mtiniko
	<i>Trochocercus cyanomelas</i>	Blue-mantled crested flycatcher	Kambona, Mkunya River, Mtiniko, Mtuli Hinju and Makonde Scarp III
	<i>Batis reichenowi</i>	Reichenow's batis	Mtiniko
Butterflies	<i>Gnophodes betsimena diversa</i>	Banded evening brown	Makonde Scarp III
	<i>Bematistes epaea epitellus</i>	-	Kambona
	<i>Charaxes lasti lasti</i>	Silver striped charaxes	Mkunya River, Mtiniko, Mtuli Hinju, Makonde Scarp III
	<i>Charaxes protoctlea azota</i>	Flame bordered charaxes	Kambona, Mkunya River and Makonde Scarp III
	<i>Cymothoe herminia</i>	-	Makonde Scarp III
	<i>Euphaedra neophron littoralis</i>	Gold banded forester	Mkunya River, Mtiniko, Makonde Scarp III, Ndechela
	<i>Euxanthe wakefieldi</i>	Forest queen	Makonde Scarp I and III
	<i>Harma theobene blassi</i>	Glider	Mtiniko, Makonde Scarp III
	<i>Neptis alta</i>	Common sailor	Mtuli Hinju and Makonde Scarp III

ENDEMISM

A total of four species recorded, including one bird (*Batis reichenowi*), one reptile (*Platysaurus maculatus*), one amphibian (*Mertensophryne micranotis*) and one butterfly (*Charaxes lasti lasti*) are recognised to be strictly endemic to the Coastal Forests alone or the Eastern Arc Mountains and Coastal Forests (Table 20-e). These species constitute only 1-2% of all species recorded in each forest reserve, no reserve containing more than two strictly endemic species, and make up less than 2% of the total number of species recorded (340) (Figure 25, Table 20-e). This values are low when compared to those recorded by previous studies in the Swahilian region *sensu lato*, according to which up to 7% of the mammals, 10% of the birds, 57% of the reptiles, 36% of the amphibians and 19% of the butterflies are Eastern Arc Mountains and/or Coastal Forests endemics (Burgess and Clarke, 2000; CEPF, 2005). This discrepancy between our and previous findings in the Coastal Forests reflects the small size of forest habitat remaining within the reserves studied, which is a consequence of the high degree of agricultural encroachment and human disturbance occurring here.

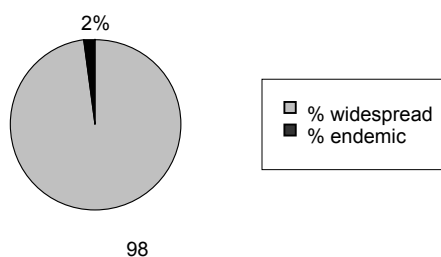


Figure 25 Percentage of strictly endemic and widespread faunal species for the whole study site

No major differences can be observed when comparing the forest reserves in terms of their faunal endemism, all reserves being characterised by a low proportion of such species. The highest number of endemic species was found in Mtiniko proposed FR (2) (Table 20-e) (Figure 27).

Birds

The Reichenow's batis (*Batis reichenowi*) was recorded only in Mtiniko proposed FR. This species has been recognised as a separate species from the Forest batis (*Batis mixta*) by Mlingwa *et al.* (2000) and Baker and Baker (2002). According to this classification, *B. reichenowi* is strictly endemic to the Coastal Forests, representing the only example of such strict endemism for this study. On the contrary, IUCN (2004) and BirdLife International (2005) have classified both species of batis as *B. mixta*, and under this classification this bird is considered to be more widespread than if it was a separate species, and therefore of less interest. The East coast akalat (*Sheppardia gunningi* - Vulnerable) is not a strictly endemic species, but it has a restricted distribution in the Coastal Forests and a few other forest types in Tanzania, Kenya, Malawi, and Coastal Mozambique. Another eight of the birds recorded are broadly endemic, being restricted to eastern Africa (*Lybius melanopterus*), or south-eastern Africa (*Erythrocerus livingstonei*, *Batis soror*, *Ploceus subareus*, *Nicator gularis* and *Phyllastrephus flavostriatus*).

Reptiles

The Spotted flat-lizard (*Platysaurus maculatus*) is strictly endemic to northern Mozambique and the Masasi district in south-eastern Tanzania. This species has a specific habitat requirement: it only inhabits rock outcrops of granite, gneiss and sandstone that weather to produce thin fissures where it seeks refuge (Spawls *et al.*, 2002). During this study, this lizard was only recorded in Ndechela FR, but here it was found to be abundant due to the presence of granite kopjes protruding from the plain up to 800m and creating a large quantity of rocky microhabitats.

Amphibians

The 'true' toad *Mertensophryne micranotis* is a strictly endemic species restricted in its habitat range to the Eastern Arc lowland and the Coastal Forest Mosaic of south-eastern Kenya and eastern Tanzania, occurring mainly in closed-canopy forest, but also in thicket and miombo woodland within the mosaic (Conservation International, 2005; IUCN *et al.*, 2004). This bufonidae species was found in an area of regenerating *Brachystegia* forest, demonstrating that this species can also survive in modified secondary habitats, as long as there is good cover necessary to provide moisture rich crevices where eggs are laid and larvae develop (Howell *et al.*, 2000).

Mammals

None of the mammal species recorded by this study are strictly endemic to the Coastal Forests alone or the Eastern Arc Mountains and Coastal Forests. However, it is likely that shrews (*Crocidura* sp.) collected from this survey will yield interesting results once taxonomic verification is accomplished. The shrews of the Coastal Forests of Tanzania are poorly known and already there are five unidentified species that have been collected from these forests, each from a separate site (Burgess and Clarke, 2000). Two of the mammals found, the Small-eared bushbaby (*Otolemur garnetti* - CITES II) and the Lesser pouched rat (*Beamys hindei* - near threatened) are not strictly endemic species, but are rare species with restricted distribution in eastern Africa. *Otolemur garnetti* is a forest dwelling species endemic to the Coastal Forests and a few other habitats in coastal eastern Africa (Burgess *et al.*, 2000). This galagonidae species was only recorded in small pockets of riverine forest in Kambona FR and Makonde Scarp I proposed FR, suggesting that the local persistence of this species may be threatened. *Beamys hindei* is a relic species endemic to a few forest types in Kenya and Tanzania, including the Eastern Arc Mountains and Coastal Forests. Until recently it was regarded as one of the rarest rodents in Africa (Groombridge, 1994) but it is now known to be more widespread (Burgess *et al.*, 2000). Our survey in the Mtwara Region seems to support this evidence, with most of the surveyed reserves holding relatively abundant populations. The highest abundance for *Beamys* was however found in Kambona FR and Mtiniko

proposed FR, where the quality of the forest was better than in most other reserves (see Results sections).

Butterflies

Only one endemic species was found, the Silver striped charaxes (*Charaxes lasti lasti*), which is restricted to the closed-canopy lowland forest of the Eastern Arc and Coastal Forests of Kenya and Tanzania (Congdon and Bampton, 2005) (Appendix 17). Consequently, even though the relatively high species richness of the butterfly communities observed accounts for the biological importance of the studied sites, these sites are not characterised by the unique butterfly fauna found in other Coastal Forests of Tanzania (Kielland and Cordeiro, 2000).

Table 20-e Endemic faunal species found in the eight forest reserves surveyed

Taxon	Species and their region of endemism	Common name	Forest Reserve found
Small mammals	<i>Beamys hindei</i> (EACF and a few other forest types in Kenya and Tanzania)	Lesser pouched rat	Kambona, Makonde Scarp I and III, Mkunya River, Mtiniko
Large mammals	<i>Otolemur garnetti</i> (CF and a few other habitats in coastal E Africa)	Small-eared galago	Kambona, Makonde Scarp I
Birds	<i>Batis reichenowi</i> (CF)	Reichenow's batis	Mtiniko
	<i>Sheppardia gunningi</i> (CF and a few other forest types in Tanzania, Kenya, Malawi, and coastal Mozambique)	East coast akalat	Mtiniko
Reptiles	<i>Platysaurus maculatus</i> (N Mozambique and Masasi district in SE Tanzania)	Spotted flat lizard	Ndechela
Amphibians	<i>Mertensophryne micranotis</i> (EAC lowland)		
Butterflies	<i>Charaxes lasti lasti</i> (EAC lowland)		Mkunya River, Mtiniko, Mtuli Hinju, Makonde Scarp III

CF= species with limited ranges in the Coastal Forests alone; EACF= species with limited ranges in the Eastern Arc Mountains and Coastal Forests (Burgess *et al.*, 2000a)

E Africa = eastern Africa; SE Tanzania = south-eastern Tanzania

EXTINCTION THREAT

The proportion of threatened faunal species (i.e. listed as Critically Endangered, Endangered or Vulnerable in the IUCN Red List and/or in CITES Appendix I) recorded by this study was low. Only seven threatened species were found, including four large mammals (*Rhynchocyon cirnei*, *Loxodonta africana*, *Panthera leo* and *Panthera pardus*), two birds (*Sheppardia gunningi* and *Falco peregrinus*), and one amphibian (*Arthroleptis xenodactyloides*) which together constitute 2% of all fauna recorded by this study (Figure 25). However, according to IUCN's current (2004) criteria for classification of threatened species, the small area of the Coastal Forest Mosaic and the high degree of threat it faces imply that the few endemic species recorded (*Batis reichenowi*, *Platysaurus maculatus*, *Mertensophryne micranotis* and *Charaxes lasti lasti*) can also be considered 'threatened species' (CEPF Portfolio, 2005).

No major differences can be observed when comparing the forest reserves in terms of their richness of threatened species, all reserves being characterised by a generally low proportion of such species. The largest number of threatened species was found in Mtiniko proposed FR

(3) and Ndechela FR (3) (Table 20-f). When including species with a lower degree of threat (i.e. near threatened and conservation dependent) in the comparative analysis, Ndechela still scores as the reserve hosting the highest number of species of conservation status (four mammals and two birds), followed by Mkunya River (three mammals and one bird) and Kambona (two mammals and one bird).

Mammals

Among the threatened mammals recorded, the Chequered elephant shrew (*Rhynchocyon cirnei* - Vulnerable) was the most frequently recorded, being sighted in Kambona and Ndechela FRs and Mkunya River, Mtiniko and Mtuli Hinju proposed FRs. The elephant shrews (*Rhynchocyon* sp.) observed in this study range in colour from light grey with white marks to dark grey and rufous with very indistinct chequers, with intermediate variations between these. These colour variations match those described for several subspecies of the Chequered elephant shrew (*Rhynchocyon cirnei*). The particularly dark elephant shrew observed in Mkunya River and Mtiniko proposed FRs is likely to represent a sub-species of the Chequered elephant shrew (*Rhynchocyon cirnei macrurus*) rather than a range extension for the similar looking Black and rufous elephant shrew (*R. petersi*) (Rathbun, 2005; Corbet, 1970).²⁴ The finding of *Rhynchocyon cirnei* in these reserves confirms the Coastal Forests to be a globally important area for the elephant shrews, closely followed by the Eastern Arc Mountains (Rathbun, 2005; Burgess *et al.*, 2000a). *Rhynchocyon* species are forest-dwellers that rely on dense vegetation cover to produce the thick leaf litter they require for foraging and nest construction (Rathbun, 2005). *R. cirnei* may therefore become locally threatened should further habitat destruction ensue.

The Elephant (*Loxodonta Africana* - Vulnerable, CITES I) was only recorded in Ndechela from an old footprint and the extent of its occurrence in the studied area needs further clarification.

The Leopard (*Panthera pardus*) was found to inhabit sheltered areas near the cliff face in Makonde Scarp II proposed FR and was reported by local residents to occur in the adjacent Makonde Scarp I proposed Fr and Kambona FR. This species is listed on CITES Appendix I (2005) as threatened with extinction and therefore excluded from international trade. If its presence in these sites will be confirmed then its protection will be necessary.

Mammal species Red listed with a lower degree of threat were also recorded in various reserves. These included one near threatened mammal species - the Lesser pouched rat (*Beamys hindei*), and seven conservation dependent mammal species - the Spotted hyena (*Crocuta crocuta*), the Buffalo (*Syncerus caffer*), the Greater kudu (*Tragelaphus strepsiceros*), the Natal duiker (*Cephalophus natalensis*), the Sable antelope (*Hippotragus niger*), the Suni (*Neotragus moschatus*) and the Klipspringer (*Oreotragus oreotragus*).

Birds

The East coast akalat (*Sheppardia gunningi* - Vulnerable) was only recorded in Mtiniko proposed FR (Figure 26). *S. gunningi* has a restricted distribution in the Coastal Forests and a few other forest types in Tanzania, Kenya, Malawi, and Coastal Mozambique, and therefore the relatively high number of individuals captured (five during 37.5 hours of mist netting) indicates that Mtiniko proposed FR is an important area for this threatened species. The presence of more than a threshold population of this bird would also confirm the designation of Mtiniko proposed FR as a Bird Important Area (Baker and Baker, 2002).

²⁴ At present *R. petersi* has been recorded to occur only in the Eastern Arc Mountains and in the Coastal Forests as far as the Rufiji River. South of the Rufiji River and further down into Mozambique, *R. cirnei* has been recorded to occur (Rathbun and Butinski, 2005; Corbet, 1970).



Figure 26 The East coast akalat (*Sheppardia gunningi*) photographed in Mtiniko proposed FR

The Peregrine falcon (*Falco peregrinus*) was observed on cliffs in Makonde Scarp II proposed FR and in Mtiniko proposed FR. This bird is listed on CITES Appendix I (2005) as a species threatened with extinction and further endangered by international trade, from which is therefore excluded. Three near threatened bird species were also recorded in various reserves: the Southern Banded snake eagle (*Circaetus fasciolatus*), a Lovebird (*Agapornis lilianae*), and the Grey-crested helmet shrike (*Prionops poliophus*).

Amphibians

The Dwarf squeaker (*Arthroleptis xenodactyloides*) is a forest dwelling species that was commonly captured in *Brachystegia* forest in Kambona FR, Mkunya River proposed FR, and Makonde Scarp I and II proposed FRs. This species favours a forested habitat as it relies on the presence of damp soil and loose leaf mould protected from shrub and canopy cover to lay their eggs (Howell, 1993), and it is consequently threatened by further loss of forest habitat.

Table 20-f Threatened faunal species found in the eight forest reserves surveyed

Taxon	Species	Common name	IUCN	Forest Reserve found
Large mammals	<i>Rhynchocyon cirnei</i>	Chequered Elephant shrew	VU	Kambona, Mkunya River, Mtiniko, Mtuli Hinju, Ndechela
	<i>Loxodonta Africana</i>	African elephant	VU	Ndechela
	<i>Panthera leo</i>	Lion	VU	Ndechela
	<i>Panthera pardus</i>	Leopard	CITES I	Makonde II, Ndechela
Birds	<i>Sheppardia gunningi</i>	East coast akalat	VU	Mtiniko
	<i>Falco peregrinus</i>	Peregrine falcon	CITES I	Makonde Scarp II, Mtiniko
Amphibians	<i>Arthroleptis xenodactyloides</i>	Dwarf squeaker	VU	Kambona, Makonde Scarp I and III, Mkunya River

CR= Critically Endangered; EN= Endangered; VU= Vulnerable (IUCN, 2004)

CITES I = Threatened with extinction and excluded from international trade; CITES II = Not yet threatened with extinction, but may be so if trade is not regulated, thus export permits are required (CITES, 2005)

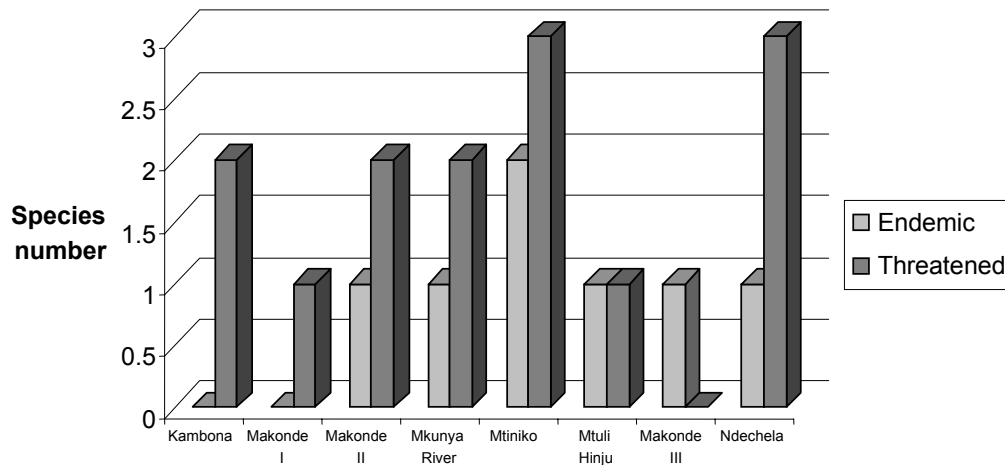


Figure 27 Number of strictly endemic and threatened faunal species for each forest reserve

IMPORTANT BIRD AREAS (IBA)

Five of the forests reserves studied (Mtiniko, Mkunya River, and Makonde Scarp I, II and III proposed FRs) have been designated as Important Bird Areas (IBAs) of Tanzania (BirdLife International, 2005; Baker and Baker, 2002). Our findings for the avifauna of these reserves seem to confirm their designations.

Mtiniko proposed FR has been selected to constitute the Mtwara District Coastal Forests IBA (TZ052 - category A1) (BirdLife International, 2005) because of the presence of more than a threshold population of the Southern banded snake eagle (*Circaetus fasciolatus*), a species categorized by the IUCN Red List (2004) as near threatened. Currently, Mtiniko proposed FR is recognised as the only forest comprising the TZ052 IBA. *Circaetus fasciolatus* was recorded in Mtiniko proposed FR during this study, along with another IUCN threatened species (*Sheppardia gunningi* - Vulnerable), confirming the classification of this reserve as an IBA. Mtiniko proposed FR is also where the highest number of forest dependent bird species (6) was recorded during this study, reflecting the extensive area of undisturbed forest occurring in this reserve. Moreover, if the Reichenow's batis (*Batis reichenowi* - Coastal Forests Endemic) found here was to be confirmed as a separate species from the Forest batis (*B. mixta*), then this IBA would become part of a Secondary or Full Endemic Bird Area (EBA) (Baker and Baker, 2002).

Mkunya River and Makonde Scarp I, II and III proposed FRs constitute the Newala District Coastal Forests IBA (TZ053 - category A1) (BirdLife International, 2005). They were also selected because of the presence of more than a threshold population of *C. fasciolatus*, and findings of this bird in Makonde Scarp II seem to confirm this designation. *C. fasciolatus* was not recorded in Mkunya River proposed FR during this study, nor were other IUCN threatened species. Nevertheless, the importance of Mkunya River proposed FR for birds is highlighted by the fact that it contains the highest species richness recorded during this study (103 species).

Circaetus fasciolatus was also recorded in Kambona FR, which is adjacent to the Makonde escarpment. If more than a threshold population of this species was found to be present in

Kambona FR than this reserve could be designated as a component of the Newala District Coastal Forests IBA. Further research is required to confirm this.

RANGE EXTENSIONS AND NEW RECORDS

The study revealed some interesting range extensions (Table 20-g), i.e. species found to occur outside their previously documented habitat and/or geographical range (see Methods section). These include the Lesser bushbaby (*Galago moholi*), the Grey-crested helmet shrike (*Prionops poliophus* - near threatened), the Red-headed bluebill (*Spermophaga ruficapilla*) and one sub-species of the Savanna vine snake (*Thelotornis capensis oatesi*).

The Lesser bushbaby (*Galago moholi* - CITES II)²⁵ is an arboreal species usually found in the semiarid scrub woodlands and savanna grasslands of central southern Africa (Alvarado, 2000). The finding of this species in the closed-canopy Coastal Forests of southern Tanzania (in Makonde Scarp I, Mtiniko and Mtuli Hinju proposed FRs) therefore represents an extension of both the habitat range and the geographical range documented for this species.

The Grey-crested helmet shrike (*Prionops poliophus* - near threatened)²⁶ has been previously recorded to inhabit open woodland and wooded grassland, including *Acacia/Tarchonanthus* vegetation (1,200-2,200m), in a restricted area of south-western Kenya and adjacent areas of northern Tanzania (BirdLife International, 2005). The Red-headed bluebill (*Spermophaga ruficapilla*) has been formerly reported to be a fairly common resident of primary forest and secondary growth in western Kenya and a scarcer one in north-eastern Tanzania. Records of these species in the Coastal Forests of southern Tanzania (in Mkunya River proposed FR and Ndechela FR) therefore indicate a range extension.

A species of Vine snake (*Thelotornis* sp.) characterised by high ventral counts and a black and pink Y-shape on the head was recorded in Makonde Scarp II proposed FR and was recognised to be a sub-species of the Savanna vine snake (*Thelotornis capensis oatesi*)²⁷. This species has been previously recorded to occur across the Tanzanian border at Mbala, Zambia (Spawls *et al.*, 2002). If the identification is confirmed then this record represents a range extension of this specie into Tanzania.

A species of skink sighted in Makonde Scarp II proposed FR and Ndechela FR was recognised to resemble either the Rainbow Skink (*Trachylepis margaritifera*) or the Five-lined skink (*Trachylepis quinquetaeniata*). *T. margaritifera* is already known to occur in central and south-eastern Tanzania. *T. quinquetaeniata*, on the contrary, has not been recorded to occur south of the border with Kenya, apart from a record in Kwa Mtoro (north of Dodoma) (Spawls *et al.*, 2002), and its record in the Mtwara Region would therefore represent a range extension. Further research is needed to ascertain this.

Finally, some of the widespread and common bird species observed during this study are likely to constitute new records in the studied area, among which the Verreaux's eagle (*Aquila verreauxii* - CITES II), the White-naped raven (*Corvus albicollis*), the White-browed sparrow-weaver (*Plocepasser mahali*), the Black saw-wing (*Psalidoprocne holomelas*), the Lesser seedcracker (*Pyrenestes minor*), the African wood owl (*Strix woodfordii* - CITES II) and the Red-faced crombec (*Sylvietta whytii*) (Jacob Kiure's personal comms, 2005).

Some of the butterflies were also recorded in the Mtwara Region for the first time. Such species include the Constantine's swallowtail (*Papilio constantinus constantinus*), the

²⁵ The field identification of *Galago moholi* was undertaken by Frontier-Tanzania research team.

²⁶ The field identification of *Prionops poliophus* was undertaken by Jacob Kiure (Appendix 1).

²⁷ The field identification of *Thelotornis capensis oatesi* was undertaken by Michele Menegon (Appendix 1). We are awaiting taxonomic confirmation.

Cambridge vagrant (*Nepheronia thalassina*), the Coastal hairstreak (*Hypolycaena pachalica*), a Novice species (*Amauris ochlea ochlea*), *Coenyropsis carcassoni*, the Savannah charaxes (*Charaxes etesipe*), the Silver striped charaxes (*Charaxes lasti lasti*), *Cymothoe herminia*, the Gold banded forester (*Euphaedra neophron littoralis*), the Golden piper (*Eurytela dryope angulata*), *Neptidopsis fulgurata platyptera*, the Lilac tree nymph (*Sallya amulia rosa*) and the Black tipped acraea (*Acraea equatorialis anaemia*) (Davenport, 2001; Larsen, 1996; Kielland, 1990).

Table 20-g Species found to occur outside their documented range. See Appendix 2 for the GPS co-ordinates of the base camps in each reserve

Taxon	Genus	Species	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
Mammals	<i>Galago</i>	<i>moholi</i>		0			0	0		
Bird	<i>Prionops</i>	<i>Poliolophus</i>				s				s
	<i>Spermophaga</i>	<i>ruficapilla</i>				X				
Reptiles	<i>Thelotornis</i>	<i>capensis oatesi</i>			X					

X = Confirmed by specimen, s = sight records, 0 = calls or signs

HUMAN RESOURCE-USE AND LOCAL MANAGEMENT

The level of disturbance was found to be high throughout the eight forest reserves surveyed. Table 20-h displays and compares the percentage of 50m sections that were subject to disturbance and, more specifically, the incidence of different forms of disturbance. In four forest reserves over 90% of sections showed some sign of disturbance (Makonde Scarp III - 100%, Makonde Scarp II - 96%, Mkunya River and Kambona - 95%). Lower percentages were recorded for Mtuli Hinju (57%) and Mtiniko (60%). However, different types of disturbance affect the forest reserves with varying degrees.

Table 20-h Percentage of different types of disturbance found in the eight forest reserves surveyed, recorded as occurring in 50m sections along transect lines

	% disturbance	% of cultivation	% of cutting	% of fire	% of paths	% of bark ringing	% of traps
Kambona	95	0	95	9	27	9	0
Makonde Scarp I	87	29	78	70	8	2	0
Makonde Scarp II	96	41	87	73	19	3	1
Mkunya River	95	2	94	41	8	0	0
Mtiniko	60	0	39	8	15	0	5
Mtuli Hinju	57	5	43	15	8	0	3
Makonde Scarp III	100	43	87	30	22	0	0
Ndechela	74	0	18	72	9	0	1

Agricultural encroachment

Burgess *et al.* (2000b) cite conversion to agriculture as the most destructive use of the Coastal Forests of eastern Africa, since it involves the complete removal of the native flora and the fauna it hosts, and their replacement with a monoculture. This problem is exacerbated by the common practice of shifting cultivation, where people clear new land after exhausting the fertility of the previously cultivated land. This is a traditional cultivation practice that has become unsustainable due to population growth and an increase of demand on land that exceeds the regeneration capacity of the forest.

The reserves most affected by agricultural encroachment are Makonde Scarp I (29%), II (42%) and III (43%) proposed FRs. Here even the cultivation of slopes that are unsuitable for



Figure 28 Cultivation on steep slopes in Makonde Scarp III Proposed FR

agriculture was attempted (Figure 28). In fact, the soils of the escarpment are infertile and vulnerable to erosion by heavy seasonal rains characteristic of this part of Tanzania (Clarke, 2000). Although our study indicated a low level of encroachment in Mkunya River proposed FR (2% of sections), in fact the valleys cutting through the escarpment have been largely transformed into cashew nut (*Anacardium occidentale*) plantations. On the contrary, in Kambona, Mtiniko and Ndechela FRs encroachment was negligible or absent, but it occurs right up to the reserve boundaries. It was observed that encroachment into reserves occurs more extensively where the forest boundaries are not clearly demarcated, and farmers seem to be more reluctant to encroach into an area if it is clearly marked as being a reserve.

Pole and timber extraction

Timber extraction was calculated by Burgess and Mbwana (2000) by looking at logging volumes and commercial value. This type of analysis was not in the scope of this study, therefore stringent comparisons with our findings cannot be carried out and further study will be needed to monitor levels of extraction in the future.

Five of the eight reserves had overall levels of pole cutting above the 7% average value reported by Burgess *et al.* (2000b) from previous studies of Coastal Forests. Furthermore, pole cutting in all of these five reserves was above the upper limit of 16% found by Burgess *et al.* (2000b). This suggests that levels of pole cutting in the Coastal Forests of the Mtwara Region are high relative to other Coastal Forest regions. Kambona and Mkunya River FRs were found to be severely affected by pole and timber cutting (>90% of sections), followed by Makonde Scarp I, II and III (78-87%), whereas Ndechela, Mtiniko and Mtuli Hinju FRs were relatively less affected (18, 39 and 43% respectively).

In all studied sites, pole cutting and timber harvesting were selective. As this study and previous evidence illustrate, the most desirable species are utilised first until supplies for commercial use are exhausted, at which point a different species is targeted (Milledge and Kaale, 2005; Burgess and Mbwana, 2000). Findings from this study seem to match those obtained by TRAFFIC East/Southern Africa in the regions south of the Rufiji River in 2001-2, with the Gum copal (*Hymenaea verrucosa*), the African teak (*Pterocarpus angolensis*), the Snake bean tree (*Swartzia madagascariensis*) and the Pod mahogany (*Azalia quanzensis*) being reported by local inhabitants as popular hard wood timber species, followed by *Millettia stuhlmannii*, *Milicia excelsa* (near threatened) and *Dalbergia melanoxylon* (near threatened). Selective pole and timber harvesting is ecologically destructive as it alters the plant species composition of an area (Mremi, 1998), which can in turn affect the faunal species utilising that area (Vallan *et al.*, 2004). Selective timber extraction has been shown to affect such diverse taxa as amphibians (Vallan *et al.*, 2004) and birds (Robinson and Robinson, 1999). Furthermore, because tree species differ greatly in their dispersal abilities (Russo 2003; Cordeiro *et al.* 2004; McEuan and Curran, 2004; White *et al.*, 2004) the ability of species to recolonise an area after local extinction is far from certain.

The degree of pole and timber cutting was observed to be linked to the density of the population living nearby the reserves. The high population growth rate of the Mtwara Region (Luanda, 1998), especially around Kambona FR and the Makonde Scarp as a whole, combined with the fact that approximately 300 poles are required per house (Burgess *et al.*, 2000b), implies that levels of pole cutting will increase in the future. This harvesting is destructive and mitigation measures need to be put in place (see Conservation Recommendations section).

In addition to timber and pole cutting, pit sawing was found to be widespread, with five of the eight studied reserves containing at least one recently active or old pit-sawing site (Figure 29). Burgess and Mbwana (2000) state that pit sawing is usually carried out by individuals from outside the area where it occurs, with the result that local inhabitants do not benefit from the activity. Hence, they lose their natural resources with no gain. Milledge and Elibariki (2005) also highlighted the discrepancy in levels of income earned by local people and those who



Figure 29 Pit sawing site in Mtiniko proposed FR

export the timber – the price is 100 times lower at the village level. Their study also illustrates that districts in the Mtwara Region accounted for a low proportion of those timber licences that were issued in 2001-2002. This implies that either commercial timber harvesting is lower here than in other regions (Rufiji district accounts for the majority of licenses) or it is taking place illegally.

Fuelwood

Most of the fuelwood collected from the eight forest reserves surveyed was said to be obtained from dead trees and branches, including those from cashew nut (*Anacardium occidentale*) plantations. This supports findings from previous studies on fuel use in the Coastal Forests (Burgess *et al.*, 2000b). Consequently, at present fuelwood collection is not the major threat to the forests of the Mtwara Region. However, as population grows (Milledge and Kaale, 2005; Luanda, 1998) the demand for fuelwood is set to increase and natural death of trees may become insufficient to satisfy an additional demand. Milledge and Kaale (2005) have estimated that 2.1 million m³ of wood is burnt every year in seven districts of the Coast Region, Lindi Region and Mtwara Region, Tanzania. Further studies aimed at determining sustainable levels of firewood extraction in the Mtwara Region will be needed.

Tools and utensils

Results from this study add to the list of species used for the construction of tool handles and cooking utensils presented in Burgess *et al.* (2000b). Four of the eight studied forests were found to contain ringed trees, but anecdotal evidence from interviews and discussions suggested that bark ringing also takes place in the other forest reserves. Kambona had the highest intensity of bark ringing, with 9% of 50m sections being affected. Discussion with local people indicated that bark ringing occurs in order to remove bark, which is then used for ropes, beehives and medicine. Many of the species that were said to be used for firewood overlap with those used for bark removal, indicating that trees die from the removal of bark and are then used for firewood. However, people who carry out the exploitation appeared to be unaware of the lethal impact that this activity has upon trees. As population in the Mtwara Region grows (Milledge and Kaale, 2005; Luanda, 1998), the demand for bark and wood is set to increase and may exceed the trees regeneration capacity. Further research to determine the sustainable level of bark and wood extraction in the studied area is needed.

Edible non-timber forest products

The extraction of fruits (such as those from *Sclerocarya birrea* and *Strychnos* sp.) was found to occur within all forest reserves on a small scale. Harvesting of fruit in the study area was not observed to result in the death of trees and is therefore likely to have minimal impact on the species utilised. It is uncertain whether the commercial exploitation of *Dioscorea hirtiflora* has a negative impact on the species. Although not witnessed in this study, food harvesting has been previously shown to cause damage to plant species (Wegner, 2003). Damage can result from felling high trees to access fruits, or from harvesting fruit before it has fully ripened, thus decreasing the reproductive success of the individual. Similarly, root harvesting can cause the death of individuals should removal be too extensive. A follow-on study to determine the impact of food harvesting would be necessary in the studied area.

Apiculture

Honey was found to be produced and sold locally in Makonde Scarp II proposed FR and Ndechela FR. When material for the construction of beehives is obtained in a sustainable way, apiculture has been found to be ecologically preferable to harvesting of wild honey, as the latter often results in the cutting of the tree to access the hive (Wegner, 2003). However, results from this study show that bee farming in the Mtwara Region may also result in tree death, as bark is used for the construction of beehives and is extracted by ringing and often killing the trees. Since the most desirable piece of bark is a complete circle and as larger pieces of bark result in larger hives, large trees are targeted.

Medicinal plants

Extraction of medicinal plants takes place in all forest reserves but at a level that does not appear to have a significant impact on their ecology. Nevertheless, it is a possibility that trees are ringed to obtain bark for the production of medicinal compounds. Roots are also used to

extract medicinal compounds, and extensive root removal can have a negative impact on individual trees. Moreover, interviews and open discussions illustrate that the extraction of bark and roots for medicines is selective and therefore has potential to damage populations of particular species should it not occur in a sustainable manner.

Hunting

Hunting takes place in most of the studied areas to different degrees. Mtiniko and Mtuli Hinju proposed FRs had the highest density of traps recorded (in 5% and 3% of 50m sections respectively). In most cases the traps recorded were snares targeting ungulate species and traps placed in the riverbed to catch small birds, while a drift fence was detected in Ndechela. It is possible that fire is also employed as a hunting tool in this reserve, as it has been observed in other Coastal Forests (Burgess *et al.*, 2000b). This study did not reveal that meat from animals is sold on the market, as it has been found to be the case in other Coastal Forests (Burgess *et al.* 2000a). Observation of baboons (*Papio cynocephalus*) being killed due to crop



raiding supports other findings in the Coastal Forests (Burgess *et al.*, 2000b) (Figure 30). Hunting in Kambona, Makonde Scarp I and Ndechela involves the Chequered elephant shrews (*Rhynchocyon cirnei*), a species listed as Vulnerable, and the Natal duiker (*Cephalophus natalensis*) and the Sable antelope (*Hippotragus niger*), two species listed as conservation dependent in the IUCN Red List (2004).

Figure 30 Baboons killed by local farmers because raiding crops adjacent to Ndechela FR

Fires

Another particularly destructive form of disturbance is extensive and recurring burning, since it destroys the soil top layer and the micro-fauna that lives within it, therefore reducing the availability of nutrients for plants and other animals in the food-web. Moreover, severe fires can destroy the forest's understorey, which constitutes the main habitat for many forest dwelling and forest dependent species. The forest reserves most affected by burning were Ndechela and Makonde Scarp I and II ($\geq 70\%$ of sections), whereas in Mtiniko and Kambona FRs only 8 and 9% of sections respectively were subject to this form of disturbance.

Paths

The density of paths observed in all reserves emphasises the high level of human presence in these areas. No one forest reserve had less than 8% of sections bisected by paths, and the largest number was observed in Kambona FR (27%) and Makonde Scarp II (19%) and III (22%) proposed FRs.

Local management

Local management was defined as action taken by local residents (i.e. inhabitants of adjacent and nearby villages) to regulate resource use and exploitation in their area. Management ranged from absent to ineffective among forest reserves. An attempt at local management is in place in Mtuli Hinju proposed FR, where an Environmental Committee has been formed to patrol the boundaries. In Mkunya River proposed FR village committees were observed to spend time educating the local inhabitants about the importance of the water source, and

anyone found to be encroaching on the reserve boundary or harvesting poles or timbers was said to be fined by the village committee. In those reserves where management has been discontinued or has not been initiated yet the reasons appeared to be twofold: lack of will or lack of funds. The inhabitants of some areas (e.g. Makonde Scarp II, Mtiniko and Ndechela) do not view their reserve positively because they see no benefits coming from them. This translates into lack of an incentive to protect them. In areas where the reserves are instead viewed positively, for example Mkunya River proposed FR and Kambona FR because of their water supplies, no money is currently available to enforce any local bylaw that may be in place or to conduct patrols of the boundaries. The lack of enforcement of national forest legislation in the study site and absence of local by-laws constitute another problem that hampers the management of most of the reserves.

21. CONCLUSION AND PRIORITISATION

G. WEGNER

Findings from this study of the Coastal Forests of the Masasi, Mtwara Rural, Newala and Tandahimba districts, Mtwara Region, show that the eight forest reserves studied are of important environmental value to the surrounding human population, providing it with precious water, abundant forest resources and protection from soil erosion. However, the very presence of conditions that make the area favourable for human settlement may have indirectly contributed, by encouraging human population growth, to the severe curtailment of its biological value. High population growth rate, accompanied by severe poverty and lack of environmental awareness, have resulted in the extensive conversion of these Coastal Forests into farmland, the unsustainable exploitation of their natural resources, and the conspicuous decrease of their biodiversity and endemism.

The Coastal Forests are a naturally vulnerable ecosystem. Much of their habitat heterogeneity and fragmentation, and the biological endemism resulting from these characteristics, are primarily natural and relictual, being the result of a highly heterogeneous set of abiotic factors (climate, geology, topography, soils etc.). The level of encroachment and natural resources extraction recorded in the Coastal Forests of the Mtwara Region has contributed to further accentuate their small size and fragmented character, reducing their capability to sustain viable populations of forest dependent and endemic plants and animals.

As a consequence of the high degree of habitat destruction taking place in the area, only small patches of closed-canopy Coastal Forests remain in the study area. *Brachystegia* forest was the most dominant forest type, while the more vulnerable Legume-dominated dry forest was found to be rarer, the clearance of this forest drastically lowering its chances of regeneration on the same sites.

The loss of suitable forest habitat explains the low proportion of forest dependent and endemic faunal species in the study. On average, less than 2% of the animal species recorded are strictly endemic to the Coastal Forests and/or Eastern Arc Mountains, against 26% of animal species from the same taxa being found to be endemic in other Coastal Forests. The proportion of Red List threatened faunal species is also low, constituting about 2% of all fauna recorded. Therefore, within the context of the EACF hotspot and on a global level these forests are of modest faunal biological importance.

For the flora, the discrepancy of endemism between the surveyed forests and other Coastal Forests is less accentuated, with up to 12% of the plant species recorded being endemic to the Swahilian region *sensu lato* against 33% recorded by other studies. This figure is not negligible, especially if considering that most Coastal Forests endemics are likely to face a degree of threat: given the relatively small area of the Coastal Forest Mosaic and the high degree of habitat loss and fragmentation it suffers, endemic species here are often regarded as ‘threatened species’. This highlights the importance of the Coastal Forests studied as habitats for the endemic and threatened plants still found here, and emphasises the urgent need for conservation measures to protect them. Unfortunately, even if the remaining forest patches were to be left intact, their endemic species richness may already not be sustainable in the long-term: fragmentation and habitat loss may have caused populations of long-lived endemic species (e.g. trees) to become genetically unviable.

Beyond their biological value, the Coastal Forests of the Masasi, Mtwara Rural, Newala and Tandahimba districts are of vital environmental importance to the local populations. Their

future capability to provide precious water, natural resources and protection from soil erosion and landslides will depend on effective and sustained conservation action. The development and implementation of a management plan for the safeguard of the reserves and sustainable use of their resources is therefore crucial.

It is important that the conservation of the Coastal Forests is not considered only on a reserve-by-reserve basis. The Coastal Forests are part of a mosaic system and rely on the stability of the whole system for the continuity of their floral and faunal communities. Adequate conservation measures need therefore to be taken in as many of the Coastal Forests as possible, and efforts should be made to restore and increase connectivity among fragmented forest patches.

However, no conservation plan can be successful if a holistic approach aiming at reducing poverty and limiting population growth in the Mtwara Region is not developed. Within the context of a poorly developed national and regional economy, local inhabitants have limited access to viable sources of revenue and therefore often rely on the land and natural resources of the forest for their livelihoods, posing unsustainable demands on it and overcoming its regeneration capacity. Only by complementing major efforts to improve the life standards of the local communities can national law enforcement and environmental awareness promotion succeed in preserving the highly threatened Coastal Forests of the Mtwara Region for present and future generations. Considering that the majority of the people in the Mtwara Region heavily depend on natural resources from the forest for their livelihoods, improved forest management and sustainable utilisation of natural resources constitute two fundamental elements of any strategy aiming at the mitigation of poverty.

PRIORITY SITES FOR THE CONSERVATION OF BIODIVERSITY

All the forest reserves studied are worth of conservation for various reasons. Conservation efforts should concentrate on those sites that contain the highest concentration of Coastal Forests endemic and endangered species and communities, but also aim at preserving the capacity of the forests to provide local inhabitants with environmental services and natural resources. What follows is a prioritisation of the sites studied on the basis of their biodiversity value.

1. Mtiniko Proposed Forest Reserve:

This reserve is covered by Mixed dry forest and affected by a low degree of encroachment (Figure 12). As a consequence, this reserve is one of the richest with floral species (Table 20-a; Figure 24) and contains among the highest numbers of forest dependent, endemic and threatened faunal species for this study (Table 20-d, Table 20-e and Table 20-f; Figure 27). For the plants, *Mesogyne insignis* (Vulnerable), *Bombax rhodognaphalon*, *Tetracera boiviniana*, *Erythrina schliebenii*, *Rytigynia decussata*, *Cola clavata* and *Vitex mossambicensis* (Endemic and Potentially Threatened) are among the most important. Mtiniko proposed FR is certainly the most important reserve in terms of avifauna, and it has been classified by BirdLife International (2005) as an Important Bird Area (TZ052 - category A1). It hosts the Reichenow's batis (*Batis reichenowi* - Coastal Forests Endemic), the East coast akalat (*Sheppardia gunningi* - Vulnerable) and the Peregrine falcon (*Falco peregrinus*), which are the only Coastal Forests endemic and threatened birds recorded by this study. The highest number of forest dependent bird species (6) was also recorded here, including the African broadbill (*Smithornis capensis*), the Reichenow's batis (*Batis reichenowi*), the East coast akalat (*Sheppardia gunningi*), the Yellow streaked greenbul (*Phyllastrephus flavostriatus*), the Blue-mantled crested flycatcher (*Trochocercus cyanomelas*) and the Fischer's greenbul (*Phyllastrephus fischeri*). Mtiniko also contains large populations of forest dependent butterfly

species, including the Silver striped charaxes (*Charaxes lasti lasti*), the Flame bordered charaxes (*C. protoctlea azota*) and the Gold banded forester (*Euphaedra neophron littoralis*), and one butterfly (*Charaxes lasti lasti*) that is strictly endemic to the Eastern Arc lowland and Coastal Forests. Few threatened and forest dependent mammal species were also found to occur here, including the Chequered elephant shrew (*Rhynchocyon cirnei* - Vulnerable), the Moloney's monkey (*Cercopithecus mitis* - forest dependent) and the Red-bellied coastal squirrel (*Paraxerus palliatus* - forest dependent). Mtiniko proposed FR should be immediately gazetted in order to protect the Mixed dry forest unique to the EACF hotspot and the endemic and threatened species it hosts. Conservation measures can follow those listed in the Conservation Recommendations section below.

2. Ndechela Forest Reserve:

The flora of Ndechela FR is particularly worth of notice. This reserve is comprised of Legume-dominated dry forest, which is the most vulnerable plant community of the Coastal Forests. Even though encroachment is among the lowest in this reserve (Table 20-h; Figure 19 and Figure 24), extensive and frequent fires constitute a threat to the continuity of this forest type, and it is therefore important to implement conservation measures to protect it. Among the most important plants found here are *Gardenia transvenulosa* (Endemic and Vulnerable), *Bombax rhodognaphalon*, *Commiphora zanzibarica*, *Entada stuhlmannii*, and *Scorodophloeus fischeri* (Endemic and Potentially Threatened). Ndechela FR is also singular for the presence of granite kopjes dramatically protruding from the plain and reaching up to 800m, which contribute to the scenic beauty of this site and create a variety of rocky microhabitats for a rich reptile community. Among the reptiles found here, the Spotted flat lizard (*Platysaurus maculatus*) is the only example of strictly endemic reptile recorded during this study, being found only in northern Mozambique and the Masasi district in south-eastern Tanzania. Due to the close proximity of this reserve to the Lukwika-Lumesule Game Reserve the highest number of large mammal species was also found here (26) (Table 20-c), as well as the larger number of threatened mammal species (4). These include the Elephant (*Loxodonta africana* - Vulnerable, CITES I), the Lion (*Panthera leo* - Vulnerable, CITES II) and the Chequered elephant shrews (*Rhynchocyon cirnei* - Vulnerable), as well as two species (*Loxodonta africana* and *Panthera pardus*) listed on CITES Appendix I (2005) as threatened with extinction and therefore excluded from international trade. Few forest dependent species were also recorded here, including the Moloney's monkey (*Cercopithecus mitis* - CITES II) and the Blue duiker (*Cephalophus monticola* - CITES II). Ndechela FR is unique among the eight studied reserves for having a relatively small human population living around its boundaries. As a result, much forest that lies outside the borders is not appreciably different from that inside the reserve. This represents an excellent opportunity to extend the boundaries of the reserve to create and protect more habitat for the plants and animals. It would be highly beneficial to designate this area as a National Park incorporating Ndechela FR, the Lukwika-Lumesule Game Reserve and possibly a reserve across the river in Mozambique. Conservation measures can follow those listed in the Conservation Recommendations section below.

3. Mkunya River and Makonde Scarp I, II and III Proposed Forest Reserves

Mkunya River and Makonde Scarp I, II and III proposed FRs are the most affected by agricultural encroachment and the practice of shifting cultivation (Table 20-h; Figure 5, Figure 7, Figure 9 and Figure 16), which have conspicuously reduced the area covered by forest and consequently the number of faunal species present (table 20-c; Figure 24). In Makonde Scarp I, II and III proposed FRs timber extraction was also most severe (Table 13-f, Table 14-h, Table 18-f and Table 20-h; Figure 24), and the selective removal of canopy and sub canopy trees has noticeably reduced the floral species richness of the *Brachystegia* forest found here (Table 20-a). Nevertheless, several endemic and a highly threatened plant species were recorded to still occur, including *Cynometra gillmanii* (Endemic and Critically Endangered), *Gardenia transvenulosa* and *Vitex zanzibarensis* (Endemic and Vulnerable), *Khaya anthotheca* and *Mesogyne insignis* (Vulnerable). Even though these reserves are highly fragmented, yet the small patches of *Brachystegia* and Riverine forest remaining are characterised by a dense understory capable hosting several bird species, including forest dependent species such as the African broadbill (*Smithornis capensis*), the Blue-mantled crested flycatcher (*Trochocercus cyanomelas*) and the African crowned eagle (*Stephanoaetus coronatus* - CITES II). Moreover, the topographic variation of the Makonde escarpment creates an array of habitats and nesting sites that further promote a rich bird community. As a result, these four reserves have been classified by BirdLife International (2005) as an Important Bird Area (TZ053 - category A1). Mkunya River proposed FR is also important because of the presence of the Mkunya River, which creates a moist habitat most suitable for butterflies and herpetofauna, which are both represented here by a relatively high number of species (Table 20-c). Important amphibian species found here are the ‘true’ toad *Mertensophryne micranotis*, a species strictly endemic to the Eastern Arc lowland and the Coastal Forest Mosaic, and the Dwarf squeaker (*Arthroleptis xenodactyloides*), a species listed as Vulnerable by IUCN (2004). Among the butterflies, the Silver striped charaxes (*Charaxes lasti lasti*) is endemic to the closed-canopy lowland forest of the Eastern Arc and Coastal Forests of Kenya and Tanzania. On the contrary, the level of fragmentation and the small size of forest habitat remaining mean that these reserves may not be capable of sustaining high numbers and viable populations of mammal species. Forest dependent species such as the Moloney’s monkey (*Cercopithecus mitis* - CITES II), the Suni (*Neotragus moschatus* - conservation dependent), the Natal duiker (*Cephalophus natalensis* - conservation dependent), the Blue duiker (*Cephalophus monticola* - CITES II) and the Red-bellied coastal squirrel (*Paraxerus palliatus*) are still found in very small patches of forest and are therefore locally threatened. The Leopard (*Panthera pardus*) and the Peregrine falcon (*Falco peregrinus*), species listed on CITES Appendix I (2005), were observed to occur on the Makonde scarp in sheltered areas near the cliff face. It would be advisable for the whole of the Makonde Scarp to be protected as one large reserve in order to connect highly fragmented and narrow patches of forest habitat that otherwise may not have the capacity to give refuge to viable populations of mammals. Conservation measures can follow those listed in the Conservation Recommendations section below.

4. Mtuli Hinju

The importance of this reserve resides in its Legume-dominated dry forest and its wetland. Legume-dominated dry forest is the most vulnerable plant community of the Coastal Forests. In this reserve encroachment is among the lowest (Table 20-h; Figure 14 and Figure 20) and a species rich and stable plant community has therefore developed, with important species such as *Mesogyne insignis* (Vulnerable), *Tetracera boiviniana*, *Erythrina schliebenii*, *Xylothea tettensis*, *Rytigynia decussata* and *Cola clavata* (Endemic and Potentially Threatened). Nevertheless, the small size of this reserve constitutes a threat to the continuity of this forest type should disturbance ensue. Even though the total number of faunal species, including endemic and threatened species, was among the lowest recorded in this study (Table 20-c, Table 20-e and Table 20-f; Figure 23 and Figure 27), the wetland harbours important species of birds and amphibians, including some forest dependent birds such as the African broadbill (*Smithornis capensis*), the Blue-mantled crested flycatcher (*Trochocercus cyanomelas*) and the African crowned eagle (*Stephanoaetus coronatus* - CITES II). Few threatened and forest dependent mammals were also found to occur here, including the Chequered elephant shrew (*Rhynchocyon cirnei* - Vulnerable) and the Suni (*Neotragus moschatus* - forest dependent). Conservation measures can follow those listed in the Conservation Recommendations section below.

5. Kambona

Kambona FR is a small reserve affected by severe timber extraction (Table 20-h; Figure 3) that has noticeably reduced the floral species richness (Table 20-a; Figure 20). Nevertheless, this reserve harbours some important plant species, among which *Khaya anthotheca* (Vulnerable), *Tetracera boiviniana*, *Erythrina schliebenii* and *Rytigynia decussata* (Endemic and Potentially Threatened). Moreover, a water source hosts relatively large populations of reptiles and amphibians. Few threatened and forest dependent mammals were also observed, including the Chequered elephant shrew (*Rhynchocyon cirnei* - Vulnerable), the Dwarf squeaker (*Arthroleptis xenodactyloides* - Vulnerable), the Suni (*Neotragus moschatus* - forest dependent) and the Red-bellied coastal squirrel (*Paraxerus palliatus* - forest dependent). Conservation measures can follow those listed in the Conservation Recommendations section below.

PRIORITY SITES FOR THE PROTECTION OF ENVIRONMENTAL SERVICES

All of the forest reserves surveyed are important because they provide local communities with clean water, natural resources and protection from soil erosion. Some forest reserves are however more important in terms of the level of environmental services that they provide.

CONSERVATION OF WATER SOURCES

Priority sites for the conservation of water sources include:

- **Mkunya River and Makonde Scarp III Proposed Forest Reserves**

The rivers found in Mkunya River and Makonde Scarp III proposed FRs provide a vital water supply to two large towns: Newala and Mahuta respectively. The continued presence of undisturbed forest around these rivers is imperative if they are to supply water to these large settlements for many years to come. Conservation measures can follow those listed in the Conservation Recommendations section below.

- **Kambona Forest Reserve**
The small spring found here is the sole water supply for the villages of Chidya and Chiwata. The dependence of these communities on this supply highlights the need for conservation action to be carried out as soon as possible. Conservation measures can follow those listed in the Conservation Recommendations section below.

- **Mtuli Hinju**
The pond found here is the sole water supply for the villages of Mtuli Hinju and Njengwa. Another six villages (Chiwindi, Majengo, Migombani, Mtalala, Nang'awanga and Najenga) rely on it seasonally when alternative ponds and wells dry up. The dependence of these communities on this water source highlights the need for conservation action to be carried out as soon as possible. Conservation measures can follow those listed in the Conservation Recommendations section below.

PROTECTION FROM SOIL EROSION

Soil erosion is a significant threat to the livelihoods of thousands of people because it both affects the fertility of farmland and encourages landslides and floods. The threat of soil erosion is particularly evident on and at the foot of the Makonde Scarp. The forest along the escarpment protects the land from soil erosion and the people living there from catastrophic landslides. All forest reserves located along the escarpment are therefore a priority. These include:

- **Makonde Scarp I proposed FR**
- **Makonde Scarp II proposed FR**
- **Makonde Scarp III proposed FR**
- **Mkunya River proposed FR**

Makonde Scarp II and III have been subject to extensive cultivation of land on the steep sides of the escarpment and therefore conservation efforts should be directed here primarily. Conservation measures can follow those listed in the Conservation Recommendations section below.

22. CONSERVATION RECOMMENDATIONS

R. SALTER AND O. SWEENEY

The level of disturbance observed throughout the eight forest reserves surveyed poses a severe threat to the continued presence of plant and animal species and to the environmental functions of the forests. Effective and sustained conservation action is needed to promote the conservation of biodiversity in these areas and to make sure that essential environmental services are maintained.

The major threat to the Mtwara Coastal Forests is the combination of a high population growth rate registered in the region, severe poverty affecting this population, and its heavy dependence on natural resources from the forest. Unfortunately, in many cases local inhabitants were found to be uninformed about issues of sustainability, and in some instances they were unaware of their reliance on the forest cover for the protection of water sources and the soil. Also apparent was the lack of information about the reasons behind the potential or actual designation of the reserves, and about the biodiversity value of the forests. In fact, where the importance of a reserve to the local communities is not made evident by the presence of a water source, a negative or apathetic view of the forests has often developed (e.g. in Makonde Scarp II and Mtiniko proposed FRs and in Ndechela FR): inhabitants see no direct benefit in the preservation of the forests but rather a limit to the free use of land and resources.

The conservation approach used should concentrate on developing an effective management plan for the safeguard of the reserves and the sustainable use of resources, and on promoting awareness of the values of the forests studied, including their provision of natural resources, their protection of water sources and soil, and their unique biodiversity.

The Coastal Forests of Mtwara: a Kiswahili layman's report (Frontier-Tanzania, 2005) was produced during the FT MRP for distribution to district natural resources offices, community groups and schools in close proximity to the forest reserves, to act as a tool for environmental education and awareness promotion. While this is the first step, further measures will need to be taken if these areas are to be protected effectively. A list of Conservation Recommendations based on the findings of the Mtwara Reconnaissance Project and applicable to all forest reserves is given below.

1. **Full gazettement of proposed forest reserves** (Makonde I, II and III, Mkunya River, Mtiniko and Mtuli Hinju proposed FRs) is imperative to regain the respect of residents for boundaries and regulations. Inhabitants perceive the lack of gazettement, management and regulations as a lack of interest on behalf of the government, and therefore they no longer appreciate the value of these sites.
2. **Boundary reassessment and demarcation** are required to remove ambiguity over where the boundary lies and reduce encroachment. No boundaries have been demarcated properly for many years and at present the boundaries as perceived by local forest officers and residents are very different to those defined on land cover and land use maps (Institute of Resource Planning, UDSM).
3. **Capacity building** needs to be intensified by the central government through the Forestry and Beekeeping Division (FBD), and through the development of **management plans** and the allocation of **adequate budgets** for both gazetted and proposed forest reserves.

4. **Compensation** needs to be paid to people who were moved out of the reserve when the boundaries were first cleared. Because this was never done people have continued to cultivate within the reserves. This is particularly relevant for Makonde I, II and III proposed FRs.
5. **Environmental committees** need to be formed in all villages in close proximity to the forest reserves to address and act on important conservation issues. Bylaws will need to be introduced and the committees empowered financially and organisationally to combat illegal and unsustainable exploitation of resources. In some areas (for example Ndechela) it may be possible to permit a sustainable level of timber and non-timber resources harvesting.
6. **Patrols** need to be carried out on a regular basis to control and assess levels of disturbance. In the knowledge that a reserve is being patrolled illegal pole and timber cutting and hunting are expected to decrease. Patrols need to be conducted by Forest Officers in collaboration with village committees.
7. **Fines** need to be levied and enforced by Forest Officers and/or local committees to make practices such as pit sawing and hunting unprofitable.
8. **Awareness promotion** is necessary among local communities on the importance of the forests for the protection of water sources and the soil, as well as on the biodiversity value of the reserves and the uniqueness of the species found within them. It should be the responsibility of local environmental committees to carry this out, but external financial and technical support will also be needed. The Kiswahili layman's report (Frontier-Tanzania, 2005) produced during the Mtwara Reconnaissance Project 2005 can act as an educational tool.
9. **Tree planting** is required to replace cultivated and fallow land with native trees inside the reserves. A particular effort will have to be made to plant tree species that were formerly present, especially endemic species and plant associations, and to discourage encroachment by more easily dispersed pioneer species characteristic of mixed dry and mixed scrub forest. Particular attention should be paid to steep slopes where the risk of soil erosion is high. Tree planting outside of the reserve is also important, since trees can act as a buffer zone to the reserves and provide residents with an alternative supply of resources (see below). Such initiatives should be coordinated by governmental and non-governmental bodies in collaboration with local environmental committees.
10. **Investment in rural development** is necessary to establish essential services and infrastructures (e.g. roads, access to credit etc.), and to help local inhabitants to make production and marketing of agricultural products more effective, in order to help alleviate the need to cultivate within forest reserves.
11. **Development of affordable alternative sources of energy** needs to be prioritised at the national level and introduced at the regional level in order to reverse the current deforestation trends.
12. **Encouragement of sustainable resource use** is of paramount importance. It may not be realistic or appropriate to put an outright ban on subsistence harvesting within forest reserves, but sustainable practices need to be promoted in order to limit the potential damage of high demand for resources. The following measures should be encouraged:
 - **Poles, timber and firewood**
 - Regulation of timber harvesting through licenses issued by local environmental committees is crucial. This would require clear guidelines on sustainable harvesting levels, for which further research will be necessary.
 - Removal of large peripheral branches rather than killing of whole trees from the most commercially desirable species (*Hymenaea verrucosa*,

Pterocarpus angolensis, *P. rotundifolius*, *Swartzia madagascariensis*, *Azelia quanzensis*, *Dalbergia melanoxylon* and *Milicia excelsa*) should be encouraged. However, it is unlikely that there are enough individuals for this practice to satisfy the demand for commercial timber.

- Pole cutting should be spread among a number of different trees to lower the impact on one particular individual or species; cutting single stemmed individuals should also be avoided.
 - Extensive tree planting in buffer zones is important. Rodgers and Burgess (2000b) suggest planting quick growing species (such as *Eucalyptus*, *Casuarina* and *Cassia*) on the borders of protected areas to meet the demands of the local populations for timber and firewood. However, the introduction of alien species can also cause ecological problems if not carefully evaluated first (e.g. *Acacia mearnsii* in South Africa) (Van Wyk, 1997)
- ***Edible and medicinal plants***
 - Fruit harvesting should take place when fruit is ripe so that the plant has a chance to reproduce; hooks and sticks should be used to access high branches rather than felling trees (Wegner, 2003).
 - When root digging, only peripheral roots should be removed to ensure that the individual is able to regenerate lost roots and survive (Wegner, 2003).
 - Planting species commonly used for food and medicine (e.g. *Dioscorea hirtiflora* and *Strychnos* sp.) in a buffer zone around the reserve may help to decrease reliance on the reserve itself.
 - **Tools and utensils**
 - Removal of bark should take place on peripheral branches and be spread between a number of different trees in order to decrease pressure on one particular individual or species.
 - The use of materials other than bark for the construction of tools, utensils and beehives should be explored.
 - ***Hunting***
 - Government bodies should set either limits or an outright ban on hunting depending on the size of animal populations. Hunting of endemic and endangered species should be severely forbidden and monitored.
 - Where hunting is allowed, an educational programme should promote its sustainability by discouraging the killing a species in large numbers, as well as the killing of the young, the females and those animals that are not used as food.
 - Destructive hunting practices, such as fire and drift fences that capture a large number of animals at once, should be discouraged and less invasive methods suggested.
 - Shooting of animals such as baboons (*Papio cynocephalus*) to defend crops from raiding should be discouraged and alternative methods introduced: fences could be erected or a rotation system put in place for inhabitants to guard crops.
 - Population levels of endemic and threatened species that are hunted (e.g. *Rhynchocyon cirnei*) need to be accurately assessed.

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APPENDICES

APPENDIX 1 - LIST OF TAXONOMISTS

BOTANY

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ZOOLOGY

Mammals:

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Amphibians:

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Butterflies: Dr. T. Davenport	Southern Highlands Conservation Programme	Mbeya, Tanzania tdavenport@wcs.org

APPENDIX 2 - GPS CO-ORDINATES OF BASE CAMPS FOR ALL FOREST RESERVES

FR code	Site no.	Waypoint	Latitude (S)	Longitude (E)	Grid ref (E)	Grid ref (N)	Altitude (m)
Kambona	1	BC-KAM	10° 37' 25.5"	039° 01' 07.0"	0502036	8825715	700
Makonde Scarp I	2	BC-MS1	10° 38' 35.2"	039° 02' 36.3"	0504748	8823586	600
Makonde Scarp II	3	BC-MS2	10° 50' 12.3"	039° 10' 55.0"	0519887	8802175	720
Mkunya River site 1	4	BC-MR1	11° 00' 37.5"	039° 23' 47.0"	0543303	8782951	110
Mkunya River site 2	5	BC-MR2	10° 59' 03.0"	039° 26' 48.3"	0548809	8785844	80
Mtiniko	6	BC-MT	10° 35' 28.9"	039° 56' 14.7"	0602551	8829156	195
Mtuli Hinju	7	BC-MH	10° 35' 25.9"	039° 47' 06.7"	0585899	8829294	215
Makonde Scarp III	8	BC-MS3	10° 53' 11.4"	039° 24' 13.6"	0544128	8796650	500
Ndechela site 1	9	BC-ND1	11° 06' 35.6"	038° 09' 59.6"	0408980	8771852	250
Ndechela site 2	10	BC-ND2	11° 04' 21.1"	038° 12' 33.0"	0413623	8775997	280

APPENDIX 3 - GPS COORDINATES OF VEGETATION PLOTS FOR ALL FOREST RESERVES

Forest Reserve	Veg plot id.	Waypoint	Latitude (S)	Longitude (E)	Grid ref (E)	Grid ref (N)	Altitude (m)
Kambona	1	T1-KAM	10° 37' 11.1"	039° 01' 09.7"	502117	8826170	680
	2	V2-KAM	10° 37' 11.1"	039° 01' 26.1"	502617	8826170	680
	3	T2-KAM	10° 37' 04.6"	039° 01' 07.0"	502035	8826370	680
	4	V4-KAM	10° 37' 04.6"	039° 01' 18.5"	502385	8826370	680
Makonde I	1	V1-MK1	10° 39' 06.4"	039° 02' 41.4"	504903	8822629	600
	2	V2-MK1	10° 39' 14.5"	039° 02' 49.6"	505153	8822379	600
	3	T1E-MS1	10° 39' 24.4"	039° 02' 15.3"	504110	8822076	600
	4	T2-MS1	10° 39' 31.3"	039° 02' 37.3"	504778	8821866	600
	5	VS-MS1	10° 39' 46.6"	039° 02' 39.2"	504836	8821395	600
	6	V6-MS1	10° 40' 02.9"	039° 02' 39.2"	504836	8820895	600
	7	T3-MS1	10° 38' 15.5"	039° 02' 51.0"	502591	8822829	600
	8	V8-MS1	10° 38' 14.8"	039° 03' 06.6"	505670	8824214	600
	9	V9-MS1	10° 38' 14.2"	039° 03' 22.7"	506158	8824232	600
Makonde II	1	T1-MS2	10° 50' 41.0"	039° 10' 53.8"	519850	8801291	550
	2	V2-MS2	10° 50' 24.8"	039° 10' 53.7"	519848	8801790	650
	3	BC-MS2	10° 50' 12.3"	039° 10' 55.0"	519887	8802175	720
	4	T2-MS2	10° 52' 55.2"	039° 14' 01.8"	525555	8797168	780
	5	V5-MS2	10° 52' 57.5"	039° 13' 46.5"	525091	8797098	765
	6	V6-MS2	10° 52' 58.6"	039° 13' 31.1"	524623	8797062	750
	7	T3-MS2	10° 49' 58.2"	039° 10' 08.9"	518487	8802607	730
	8	V8-MS2	10° 49' 58.9"	039° 09' 52.9"	518003	8802586	750
	9	V9-MS2	10° 50' 01.1"	039° 09' 40.3"	517620	8802518	590
	10	T4-MS2	10° 50' 31.5"	039° 11' 58.4 "	521813	8801582	750
	11	V11-MS2	10° 50' 35.7"	039° 11' 43.8"	521370	8801453	670
	12	V12-MS2	10° 50' 38.3"	039° 11' 28.9"	520916	8801375	615
Mkunya River 1	1	T1-MR1	11° 01' 00.6"	039° 22' 57.2"	541791	8782242	250
	2	V2-MR1	11° 00' 50.9"	039° 23' 09.4"	542162	8782541	180
	3	V3-MR1	11° 00' 44.9"	039° 23' 23.5"	542590	878273	150

Forest Reserve	Veg plot id.	Waypoint	Latitude (S)	Longitude (E)	Grid ref (E)	Grid ref (N)	Altitude (m)
	4	T2-MR1	11° 00' 46.9"	039° 23' 40.6"	543107	8782661	120
	5	V5-MR1	11° 00' 33.0"	039° 23' 45.7"	543263	8783088	130
	6	V6-MR1	10° 52' 58.6"	039° 13' 31.3"	543404	8783536	150
	7	T3-MR1	11° 00' 18.5"	039° 24' 10.0"	544001	8783534	130
	8	V8-MR1	11° 00' 10.4"	039° 24' 23.9"	545423	8783781	140
	9	V9-MR1	11° 00' 06.1"	039° 24' 38.2"	544858	8783913	195
Mkunya River 2	1	T1-MR2	10° 58' 46.6"	039° 26.5' 9.8"	549158	8786347	110
	2	V2-MR2	10° 58' 31.3"	039° 26' 56.5"	549060	8786818	125
	3	V3-MR2	10° 58' 14.9"	039° 26' 56.5"	549060	8787320	130
	4	T2-MR2	10° 59' 34.8"	039° 25' 35.9"	546610	8784871	125
	5	V5-MR2	10° 59' 23.9"	039° 25' 47.3"	546957	8785207	130
	6	V6-MR2	10° 59' 13.5"	039° 25' 59.5"	547327	8785524	135
	7	T3-MR3	10° 58' 52.5"	039° 26' 36.9"	548462	8786168	100
	8	V8-MR2	10° 58' 46.8"	039° 26' 22.3"	548022	8786343	130
	9	V9-MR2	10° 58' 41.0"	039° 26' 07.5"	547571	8786522	130
	10	ND-BDR	10° 58' 36.1"	039° 27' 52.7"	550763	8786666	88
	11	V11-MR2	10° 58' 34.0"	039° 27' 36.0"	550259	8786734	120
	12	V12-MR2	10° 58' 30.5"	039° 27' 22.0"	549832	8786843	130
Mtiniko	1	Z-MT	10° 35' 26.7"	039° 56' 06.6"	602306	8829222	195
	2	V2-MT	10° 35' 12.1"	039° 56' 01.6"	602155	8829222	195
	3	V3-MT	10° 34' 57.7"	039° 55' 58.3"	602056	8830116	185
	4	T2-MT	10° 34' 56.9"	039° 56' 11.2"	602449	8830138	195
	5	V5-MT	10° 34' 41.7"	039° 56' 09.4"	602395	8830604	155
	6	V6-MT	10° 34' 26.6"	039° 56' 04.8"	602257	8831069	170
	7	T3-MT	10° 35' 30.8"	039° 55' 05.8"	600459	8829103	210
	8	V8-MT	10° 35' 15.0"	039° 55' 05.8"	600459	8829103	210
	9	V9-MT	10° 35' 00.0"	039° 55' 04.8"	600431	8830050	185
	10	T4-MT	10° 34' 03.7"	039° 56' 46.1"	603514	8831768	200
	11	V11-MT	10° 34' 05.7"	039° 56' 30.4"	603037	8831709	200
	12	V12-MT	10° 34' 07.0"	039° 56' 14.4"	602550	8831671	180

Forest Reserve	Veg plot id.	Waypoint	Latitude (S)	Longitude (E)	Grid ref (E)	Grid ref (N)	Altitude (m)
Mtuli Hinju	1	T1-MH	10° 35' 29.5"	039° 47' 17.5"	586226	8829181	230
	2	V2-MH	10° 35' 27.0"	039° 47' 32.6"	586685	8829181	230
	3	V3-MH	10° 35' 29.4"	039° 47' 03.4"	585796	8829181	235
	4	T2-MH	10° 35' 32.2"	039° 46' 49.1"	585435	8829102	260
	5	V5-MH	10° 35' 16.2"	039° 46' 48.0"	585405	585405	260
Makonde III	1	Z-MS3	10° 53' 34.6"	039° 24' 24.2"	544450	8795938	400
	2	V2-MS3	10° 53' 49.9"	039° 24' 26.8"	544526	8795468	370
	3	V3-MS3	10° 54' 05.2"	039° 24' 30.1"	544628	8794997	340
	4	T2-MS3	10° 53' 43.6"	039° 24' 57.6"	545463	8795658	455
	5	V5-MS3	10° 53' 59.5"	039° 24' 58.8"	545498	8795177	415
	6	V6-MS3	10° 54' 14.8"	039° 25' 00.2"	545540	8794701	375
	7	T3-MS3	10° 53' 33.1"	039° 24' 06.4"	543910	8795983	430
	8	V8-MS3	10° 53' 53.1"	039° 24' 06.6"	543913	8795370	440
	9	V9-MS3	10° 54' 01.0"	039° 24' 07.9"	543953	8795127	435
Ndechela 1	1	T1-ND1	11° 06' 15.1"	038° 09' 40.5"	408401	8772482	250
	2	V2-ND1	11° 05' 59.9"	038° 09' 45.8"	408560	8772948	270
	3	V3-ND1	11° 05' 44.7"	038° 09' 52.5"	408760	8773417	250
	4	T2-ND1	11° 05' 23.9"	038° 08' 57.5"	407091	8774049	260
	5	V5-ND1	11° 05' 09.3"	038° 08' 57.6"	407091	8774500	280
	6	V6-ND1	11° 04' 55.1"	038° 08' 46.1"	406742	8773945	290
	7	T3-ND1	11° 04' 38.3"	038° 08' 24.8"	406094	8775549	260
	8	V8-ND1	11° 04' 21.8"	038° 08' 24.4"	406080	8775956	275
	9	V9-ND1	11° 04' 05.9"	038° 08' 25.6"	406117	8776445	275
	10	T4-ND1	11° 05' 38.1"	038° 10' 58.1"	410751	8773624	330
	11	V11-ND1	11° 05' 23.7"	038° 10' 55.7"	410677	8774066	315
	12	V12-ND1	11° 05' 07.9"	038° 10' 53.6"	410610	8774551	310
Ndechela 2	1	T5-ND2	11° 03' 39.5"	038° 12' 50.0"	414135	8777275	330
	2	V14-N2	11° 03' 42.1"	038° 12' 34.0"	413649	8777196	310
	3	V15-N2	11° 03' 44.6"	038° 12' 17.8"	413159	8777115	290
	4	T6-ND2	11° 05' 53.3"	038° 14' 08.8"	416536	8773173	280

Forest Reserve	Veg plot id.	Waypoint	Latitude (S)	Longitude (E)	Grid ref (E)	Grid ref (N)	Altitude (m)
	5	V17-N2	11° 05' 56.8"	038° 13' 53.2"	416063	8773064	290
	6	V18-N2	11° 06' 00.4"	038° 13' 37.1"	415575	8772953	295
	7	T7-ND2	11° 05' 09.4"	038° 13' 39.4"	415641	8774520	340
	8	V20-N2	11° 05' 05.8"	038° 13' 56.4"	416157	8774631	350
	9	V21-N2	11° 05' 03.6"	038° 14' 11.9"	416628	8774701	320

APPENDIX 4 - DESCRIPTION OF VEGETATION PLOTS FOR ALL FOREST RESERVES

Forest Reserve	Plot ID	Topography	Altitude (masl)	Slope (deg)	Aspect	Vegetation type	Tree canopy (% cov.)	Ground layer (% cov.)	Shrub layer (% cov.)	Canopy height (m)	Disturbance category	Feature of interest	No. Indiv.	No. Species	Dominant species
Kambona	1	lowland plan	690	0	0	open woodland	10-50	10-50	10-50	10 -20	cutting	roads/tracks	16	5	<i>Bauhinia petersiana</i> and <i>Diplorhynchus condylocarpon</i>
	2	lowland plan	650	0	0	open woodland	<10	10-50	10-50	10 -20	cutting	none	13	8	<i>Syzygium cordatum</i>
	3	gentle lower slope	680	0	0	woodland	10-50	>50	>50	10 -20	cutting	none	20	12	<i>Combretum zeyheri</i>
	4	gentle lower slope	670	0	0	open woodland	10-50	10-50	10-50	10 -20	cutting	none	18	14	<i>Brachystegia spiciformis</i> and <i>Bauhinia petersiana</i>
Makonde I	1	gentle upper slope	600	0	0	secondary woodland	10-50	10-50	10-50	10 -20	cutting	none	18	3	<i>Brachystegia microphylla</i>
	2	lowland plan	600	0	0	secondary woodland	10-50	10-50	<10	10 -20	cutting	none	23	13	<i>Brachystegia spiciformis</i>
	3	gentle lower slope	600	10	0	secondary woodland	10-50	10-50	10-50	10 -20	cutting	none	31	12	<i>Brachystegia spiciformis</i> , <i>Julbernardia globiflora</i> and <i>Combretum hereroense</i>
	4	gentle mid-slope	600	0	0	secondary woodland	10-50	10-50	10-50	10 -20	other	none	19	8	<i>Brachystegia spiciformis</i> and <i>Brachystegia longifolia</i>
	5	gentle mid-slope	600	0	0	secondary woodland	10 -50	10-50	10 -50	10 -20	fire	none	26	10	<i>Brachystegia spiciformis</i> , <i>Brachystegia longifolia</i> and <i>Julbernardia globiflora</i>
	6	valley floor	600	0	0	riverine forest	10 -50	10-50	<10	10 -20	other	none	8	5	<i>Bauhinia petersiana</i>

Forest Reserve	Plot ID	Topography	Altitude (masl)	Slope (deg)	Aspect	Vegetation type	Tree canopy (% cov.)	Ground layer (% cov.)	Shrub layer (% cov.)	Canopy height (m)	Disturbance category	Feature of interest	No. Indivs	No. Species	Dominant species
	7	gentle mid-slope	640	0	0	open woodland	<10	10-50	10 -50	10 -20	cutting, logging, path	Path	20	5	<i>Brachystegia spiciformis</i>
	8	gentle mid-slope	610	0	0	open woodland	10 -50	>50	10 -50	<10	other	none	34	17	<i>Combretum paniculatum</i> and <i>Strychnos madagascariensis</i>
	9	gentle upper slope	643	10	0	open woodland	10 -50	10-50	10 -50	10 -20	cutting	none	22	12	<i>Diplorhynchus condylocarpon</i>
Makonde II	1	gentle lower slope	550	5	S	cultivation	<10	<10	<10	n/a	cutting, cultivation	roads/tracks	5	5	<i>Albizia versicolor</i> , <i>Brachystegia microphylla</i> and <i>Pterocarpus angolensis</i>
	2	steep upper slope	650	30	S	scrub/ thicket/ bush	<10	<10	>50	<10	none	none	0	0	<i>No tree recorded</i>
	3	top of the scarp	720	5	0	wooded grassland	10 - 50	>50	< 20	< 10	none	roads/tracks	4	12	<i>Parinari curatellifolia</i>
	4	top of the scarp	780	0	0	scrub/ thicket/ bush	10 - 50	< 10	> 50	< 10	none	none	2	9	<i>Cassia didymobotrya</i>
	5	top of the scarp	750	0	0	scrub/ thicket/ bush	< 10	< 10	> 50	< 10	fire	none	0	0	<i>No tree recorded</i>
	6	top of the scarp	750	0	0	wooded grassland	10 - 50	> 50	< 10	< 10	cutting	roads/tracks	5	8	<i>Brachystegia spiciformis</i> and <i>Strychnos madagascariensis</i>

Forest Reserve	Plot ID	Topography	Altitude (masl)	Slope (deg)	Aspect	Vegetation type	Tree canopy (% cov.)	Ground layer (% cov.)	Shrub layer (% cov.)	Canopy height (m)	Disturbance category	Feature of interest	No. Indivs	No. Species	Dominant species
	7	top of the scarp	750	0	0	cultivation	< 10	< 10	< 10	n/a	fire	cultivation	0	0	<i>No tree recorded</i>
	8	top of the scarp	730	0	0	wooded grassland	10 - 50	> 50	< 10	< 10	fire	none	9	19	<i>Parinari curatellifolia</i>
	9	scarp slope	590	0	0	open woodland	> 50	< 10	< 10	< 10	cultivation , fire	rocky outcrops	15	26	<i>Diplorhynchus condylocarpon</i> and <i>Pteleopsis myrtifolia</i>
	10	top of the scarp	750	0	0	cultivation	< 10	<10	<10	n/a	cultivation , fire, cutting	none	1	1	<i>Brachystegia spiciformis</i> , <i>Brachystegia longifolia</i> and <i>Brachystegia utilis</i>
	11	scarp slope	670	0	0	cultivation	<10	<10	<10	n/a	cultivation	none	0	0	<i>No tree recorded</i>
	12	scarp slope	615	0	0	scrub/ thicket/ bush	<10	<10	>50	<10	fire	none	0	0	<i>No tree recorded</i>
Mkunya River	1	gentle mid-slope	250	20	N E	open woodland	10 - 50	10 - 50	10 – 50	10 -20	none	rocky outcrops	5	16	<i>Brachystegia spiciformis</i> , <i>B. longifolia</i> , <i>B. utilis</i>
	2	lowland plan	180	0	0	woodland	10 -50	10-50	10-50	10-20	cultivation	none	4	14	<i>Brachystegia spiciformis</i> , <i>B. longifolia</i> , <i>B. utilis</i>
	3	gentle mid-slope	150	15	S	open woodland	<10	>50	10-50	<10	cutting	none	5	9	<i>Combretum molle</i>
	4	gentle mid-slope	120	25	N	open woodland	<10	10-50	>50	10-20	cutting	rocky outcrops	5	11	<i>Brachystegia spiciformis</i> and <i>Diplorhynchus condylocarpon</i>
	5	lowland plan	130	0	0	riverine forest	<10	10-50	<10	10-20	cultivation	none	4	7	<i>Albizia versicolor</i> and <i>Azelia quanzensis</i>

Forest Reserve	Plot ID	Topography	Altitude (masl)	Slope (deg)	Aspect	Vegetation type	Tree canopy (% cov.)	Ground layer (% cov.)	Shrub layer (% cov.)	Canopy height (m)	Disturbance category	Feature of interest	No. Indivs	No. Species	Dominant species
	6	gentle mid-slope	150	20-25	S	woodland	10-50	<10	>50	10-20	cutting	rocky outcrops	13	24	<i>Diplorhynchus condylocarpon</i> and <i>Brachystegia spiciformis</i>
	7	gentle lower slope	130	0	0	open woodland	<10	>50	10-50	10-20	cutting	rocky outcrops	3	7	<i>Diplorhynchus condylocarpon</i>
	8	gentle lower slope	140	0	0	woodland	>50	10-50	10-50	10-20	cutting, fire	rocky outcrops	10	22	<i>Diplorhynchus condylocarpon</i>
	9	gentle lower slope	195	0	0	open woodland	10-50	10-50	10-50	10-20	none	rocky outcrops	7	12	<i>Pterocarpus angolensis</i> and <i>Strychnos madagascariensis</i>
	10	gentle lower slope	110	0	0	open woodland	10-50	>50	10-50	10-20	cutting	none	3	11	<i>Brachystegia spiciformis</i> , <i>Diplorhynchus condylocarpon</i> and <i>Combretum paniculatum</i>
	11	gentle mid-slope	125	0	0	open woodland	<10	10-50	10-50	<10	cutting	none	4	5	<i>Brachystegia longifolia</i>
	12	valley floor	130	0	0	scrub/thicket/bush	<10	10-50	10-50	<10	cutting	none	4	4	<i>Brachystegia spiciformis</i> and <i>B. longifolia</i>
	13	valley floor	125	0	0	open woodland	<10	10-50	10-50	10-20	cutting	none	8	16	<i>Diplorhynchus condylocarpon</i>
	14	gentle mid-slope	130	0	0	open woodland	10-50	10-50	10-50	10-20	cutting	none	2	4	<i>Brachystegia spiciformis</i> and <i>Combretum paniculatum</i>
	15	gentle upper slope	135	0	0	open woodland	10-50	10-50	10-50	10-20	cutting, logging, path	none	7	10	<i>Diplorhynchus condylocarpon</i>

Forest Reserve	Plot ID	Topography	Altitude (masl)	Slope (deg)	Aspect	Vegetation type	Tree canopy (% cov.)	Ground layer (% cov.)	Shrub layer (% cov.)	Canopy height (m)	Disturbance category	Feature of interest	No. Indivs	No. Species	Dominant species
	16	gentle upper slope	100	15	W	open woodland	10-50	>50	10-50	10-20	none	rocky outcrops	3	8	<i>Diplorhynchus condylocarpon</i>
	17	gentle mid-slope	130	15	W	open woodland	10-50	10-50	10-50	10-20	cutting	rocky outcrops	7	12	<i>Pterocarpus angolensis</i> and <i>Strychnos madagascariensis</i>
	18	lowland plan	130	0	0	cultivation	<10	10-50	10-50	<10	cultivation	roads/tracks	0	0	<i>No tree recorded</i>
	19	gentle mid-slope	120	0	0	open woodland	10-50	10-50	10-50	10-20	none	rocky outcrops	0	0	<i>No tree recorded</i>
	20	gentle mid-slope	130	0	0	open woodland	10-50	10-50	10-50	10-20	cutting	none	0	0	<i>No tree recorded</i>
	21	gentle upper slope	90	0	0	woodland	10-50	>50	>50	10-20	cutting	none	0	0	<i>No tree recorded</i>
Mtiniko	1	lowland plan	195	0	0	dry lowland forest	10-50	>50	>50	10-20	traps	roads/tracks	11	19	<i>Tetracera boiviniana</i> and <i>Grewia mollis</i>
	2	lowland plan	200	0	0	dry lowland forest	<10	10-50	10-50	<10	cutting	none	7	13	<i>Commiphora africana</i> and <i>Grewia mollis</i>
	3	gentle mid-slope	185	0	0	bamboo	10-50	10-50	10-50	<10	cutting	roads/tracks	9	22	<i>Hymenocardia ulmoides</i> and <i>Tetracera boiviniana</i>
	4	lowland plan	195	0	0	dry lowland forest	<10	>50	>50	<10	cutting	roads/tracks	10	16	<i>Azelia quanzensis</i> and <i>Hymanaea verrucosa</i>
	5	valley floor	185	0	0	dry lowland forest	>50	>50	>50	10-20	cutting	none	8	17	<i>Hymanaea verrucosa</i>
	6	lowland plan	170	0	0	dry lowland forest	10-50	10-50	10-50	10-20	cutting	none	9	32	<i>Grewia mollis</i> and <i>Tetracera boiviniana</i>

Forest Reserve	Plot ID	Topography	Altitude (masl)	Slope (deg)	Aspect	Vegetation type	Tree canopy (% cov.)	Ground layer (% cov.)	Shrub layer (% cov.)	Canopy height (m)	Disturbance category	Feature of interest	No. Indivs	No. Species	Dominant species
	7	lowland plan	210	0	0	dry lowland forest	10-50	10-50	10-50	10-20	cutting, fire	roads/tracks	10	28	<i>Hymanaea verrucosa</i> and <i>Grewia mollis</i>
	8	valley floor	160	0	0	dry lowland forest	>50	>50	>50	10-20	cutting, fire	none	7	16	<i>Pteleopsis myrtifolia</i> and <i>Tetracera boiviniana</i>
	9	gentle mid-slope	185	0	0	dry lowland forest	10-50	10-50	10-50	10-20	cutting	roads/tracks	8	14	<i>Hymanaea verrucosa</i> and <i>Brachystegia microphylla</i>
	10	lowland plan	200	0	0	dry lowland forest	<10	10-50	10-50	10-20	fire	none	8	24	<i>Pteleopsis myrtifolia</i> and <i>Tetracera boiviniana</i>
	11	lowland plan	200	0	0	dry lowland forest	<10	10-50	10-50	<10	none	none	9	20	<i>Hymenocardia ulmoides</i> and <i>Tetracera boiviniana</i>
	12	lowland plan	180	0	0	dry lowland forest	<10	10-50	10-50	<10	none	none	9	20	<i>Grewia mollis</i> , <i>Cola greenwayi</i> and <i>Hymenocardia ulmoides</i>
Mtuli Hinju	1	gentle lower slope	230	0	0	open woodland	<10	10-50	10-50	<10	cutting	roads/tracks	8	17	<i>Albizia gummifera</i> , <i>Pseudolachnostylis maprouneifolia</i> and <i>Combretum paniculatum</i>
	2	gentle mid-slope	240	0	0	scrub/thicket/bush	<10	10-50	10-50	<10	cutting	none	0	0	<i>No tree recorded</i>
	3	gentle lower slope	230	0	0	open woodland	<10	10-50	10-50	10-20	cutting	none	7	9	<i>Pterocarpus angolensis</i> and <i>Combretum molle</i>
	4	gentle mid-slope	260	0	0	open woodland	10-50	10-50	10-50	10-20	cutting, logging, path	roads/tracks	6	12	<i>Pterocarpus angolensis</i> and <i>Crossopteryx febrifuga</i>

Forest Reserve	Plot ID	Topography	Altitude (masl)	Slope (deg)	Aspect	Vegetation type	Tree canopy (% cov.)	Ground layer (% cov.)	Shrub layer (% cov.)	Canopy height (m)	Disturbance category	Feature of interest	No. Indivs	No. Species	Dominant species
	5	gentle lower slope	235	0	0	open woodland	<10	10-50	10-50	10-20	cutting, logging, path	roads/tracks	3	6	<i>Pterocarpus angolensis</i> and <i>Combretum molle</i>
Makonde III	1	gentle lower slope	400	0	S	scrub/thicket/bush	<10	10-50	10-50	<10	cutting	roads/tracks	5	10	<i>Sorindeia madagascariensis</i> and <i>Milicia excelsa</i>
	2	gentle upper slope	355	0	0	open woodland	<10	10-50	10-50	<10	cultivation	none	1	1	<i>No tree recorded</i>
	3	steep lower slope	340	0	0	woodland	10-50	10-50	10-50	10-20	cutting	none	7	8	<i>Diplorhynchus condylocarpon</i> and <i>Crossopteryx febrifuga</i>
	4	lowland plan	455	0	0	lowland forest	<10	10-50	10-50	<10	cutting	roads/tracks	3	5	<i>Pterocarpus angolensis</i> and <i>Pseudolachnostylis maprouneifolia</i>
	5	gentle mid-slope	415	0	0	woodland	10-50	10-50	10-50	10-20	cutting	none	8	13	<i>Brachystegia microphylla</i>
	6	gentle lower slope	375	0	S	woodland	10-50	10-50	10-50	10-20	none	none	5	14	<i>Julbernardia globiflora</i> and <i>Diplorhynchus condylocarpon</i>
	7	valley floor	410	0	0	cultivation	<10	<10	<10	<10	none	none	3	15	<i>Brachystegia microphylla</i>
	8	gentle mid-slope	440	0	0	woodland	10-50	10-50	10-50	10-20	cutting	roads/tracks, rocky outcrop	3	4	<i>Diplorhynchus condylocarpon</i> and <i>Crossopteryx febrifuga</i>
	9	gentle mid-slope	435	0	0	cultivation	<10	10-50	10-50	<10	cutting, cultivation	none	10	12	<i>Diplorhynchus condylocarpon</i>

Forest Reserve	Plot ID	Topography	Altitude (masl)	Slope (deg)	Aspect	Vegetation type	Tree canopy (% cov.)	Ground layer (% cov.)	Shrub layer (% cov.)	Canopy height (m)	Disturbance category	Feature of interest	No. Indivs	No. Species	Dominant species
Ndechela	1	gentle lower slope	250	0	0	open woodland	10-50	10-50	10-50	10-20	cutting	rocky outcrops	5	19	<i>Terminalia brownii</i> and <i>Combretum molle</i>
	2	gentle lower slope	270	0	0	woodland	>50	>50	10-50	10-20	fire	rocky outcrops	10	26	<i>Milletia stuhlmannii</i>
	3	lowland plan	260	0	0	open woodland	10-50	10-50	10-50	10-20	fire	none	10	23	<i>Milletia stuhlmannii</i>
	4	gentle lower slope	260	0	0	open woodland	>50	>50	10-50	10-20	none	none	0	0	<i>No tree recorded</i>
	6	gentle lower slope	250	0	0	open woodland	<10	10-50	10-50	10-20	none	none	2	5	<i>Diplorhynchus condylocarpon</i> and <i>Pteleopsis myrtifolia</i>
	7	gentle lower slope	260	0	0	open woodland	10-50	10-50	10-50	10-20	cutting, fire	none	6	13	<i>Lonchocarpus bussei</i> and <i>Combretum paniculatum</i>
	8	gentle lower slope	274	0	0	open woodland	10-50	10-50	10-50	10-20	none	none	6	20	<i>Milletia stuhlmannii</i> and <i>Combretum molle</i>
	9	lowland plan	275	0	0	open woodland	<10	10-50	<10	<10	fire	none	2	4	<i>Combretum molle</i> and <i>Strychnos madagascariensis</i>
	10	lowland plan	330	0	0	open woodland	10-50	10-50	10-50	10-20	fire	none	13	21	<i>Combretum paniculatum</i> and <i>Strychnos madagascariensis</i>
	11	gentle lower slope	315	0	0	open woodland	10-50	10-50	10-50	10-20	none	none	7	16	<i>Terminalia bownii</i> and <i>Combretum paniculatum</i>
	12	gentle lower slope	310	0	0	open woodland	10-50	10-50	10-50	10-20	fire	none	8	11	<i>Schrebera trichoclada</i>

Forest Reserve	Plot ID	Topography	Altitude (masl)	Slope (deg)	Aspect	Vegetation type	Tree canopy (% cov.)	Ground layer (% cov.)	Shrub layer (% cov.)	Canopy height (m)	Disturbance category	Feature of interest	No. Indivs	No. Species	Dominant species
	13	lowland plan	330	0	0	open woodland	10-50	10-50	10-50	10-20	fire	none	6	19	<i>Diplorhynchus condylocarpon</i> and <i>Pteleopsis myrtifolia</i>
	14	lowland plan	310	0	0	open woodland	10-50	10-50	<10	10-20	fire	none	3	12	<i>Brachystegia spiciformis</i> and <i>B. longifolia</i>
	15	lowland plan	250	0	0	open woodland	10-50	10-50	10-50	10-20	none	none	7	19	<i>Pseudolachnostylis maprouneifolia</i>
	16	lowland plan	280	0	0	open woodland	10-50	10-50	10-50	10-20	cutting, fire	roads/tracks	6	23	<i>Dichrostachys cinerea</i> and <i>Diplorhynchus condylocarpon</i>
	17	lowland plan	290	0	0	open woodland	10-50	10-50	10-50	10-20	fire	cutting nearby	8	17	<i>Commiphora africana</i> and <i>Grewia mollis</i>
	18	gentle lower slope	295	0	0	open woodland	10-50	10-50	10-50	10-20	fire	none	6	10	<i>Hymenocardia ulmoides</i> and <i>Tetracera boiviniana</i>
	19	lowland plan	340	0	0	open woodland	10-50	10-50	10-50	10-20	none	none	8	16	<i>Combretum molle</i> and <i>Terminalia brwonii</i>
	20	ridge/hill top/peak	350	0	0	scrub/thicket/bush	<10	<10	<10	<10	none	rocky outcrops	6	15	<i>Brachystegia spiciformis</i> and <i>B. longifolia</i>
	21	lowland plan	320	0	0	open woodland	10-50	<10	<10	10-20	cutting, fire pitsawing	none	8	13	<i>Pseudolachnostylis maprouneifolia</i>

APPENDIX 5 - DESCRIPTION OF REGENERATION PLOTS FOR ALL FOREST RESERVES

Forest Reserve	Regen. Plot ID	Cover (%)				Dominance (%)				Soil texture	Soil colour	No. Individ.	No. Species
		Herbs	Bare soil	Litter	Rocks	Grasses	Forbs	Mosses/lichens	Ferns				
Kambona	1	10	40	20	0	10	0	0	0	sandy-loam	black	17	7
	2	5	20	5	0	60	0	0	0	sandy-loam	black	15	4
	3	40	10	5	0	20	0	0	0	sandy-loam	black	21	7
	4	30	50	5	0	10	0	0	0	sandy-loam	black	10	5
Makonde I	1	15	5	5	5	70	0	0	0	sandy-loam	light grey	12	5
	2	20	10	10	0	60	0	0	0	sandy-loam	light grey	16	6
	3	10	10	10	0	60	0	0	0	sandy-loam	light grey	16	5
	4	20	10	10	0	50	0	0	0	sandy-loam	light grey	8	5
	5	15	20	5	0	50	0	0	0	sandy-loam	light grey	19	7
	6	15	20	15	0	30	0	0	0	sandy-loam	dark grey	9	4
	7	20	25	10	0	30	0	0	0	sandy-loam	red brown	17	6
	8	40	0	20	0	35	0	0	0	sandy-loam	light grey	24	9
	9	20	20	5	0	40	0	0	0	sandy-loam	light grey	13	5
Makonde II	1	40	20	10	0	0	0	0	0	sandy-loam	light grey	5	20
	2	2	10	5	10	0	0	0	0	sandy-loam	light grey	9	27
	3	30	0	10	0	60	0	0	0	sandy-loam	light grey	6	23
	4	20	0	40	0	0	0	0	0	sandy-loam	light grey	8	25
	5	30	0	20	0	30	0	0	0	sandy-loam	light grey	8	21
	6	5	10	10	2	60	0	0	0	sandy-loam	red brown	7	19
	7	0	0	0	0	0	0	0	0	sandy-loam	light grey	7	16
	8	30	0	20	0	40	0	0	0	sandy-loam	light grey	8	22
	9	20	15	10	5	40	0	0	0	loam	red brown	7	31

Forest Reserve	Regen. Plot ID	Cover (%)				Dominance (%)				Soil texture	Soil colour	No. Individ.	No. Species
		Herbs	Bare soil	Litter	Rocks	Grasses	Forbs	Mosses/lichens	Ferns				
	10	20	0	30	0	0	0	0	0	sandy-loam	light grey	9	22
	11	20	0	40	20	5	0	0	0	sandy-loam	red brown	7	28
	12	20	2	60	0	10	0	0	0	sandy-loam	light grey	9	32
Mkunya	1	10	0	30	20	40	0	0	0	rocky	light grey	6	34
	2	20	0	15	0	60	0	0	0	sandy-loam	dark grey	3	14
	3	0	0	15	5	70	0	0	0	sandy-loam	light grey	4	23
	4	2	0	5	15	60	0	0	0	sandy-loam	light grey	3	7
	5	20	0	60	0	2	0	0	0	loam	black	9	19
	6	15	0	10	20	40	0	0	0	sandy-loam	light grey	6	26
	7	10	0	20	20	50	0	0	0	sandy-loam	light grey	7	23
	8	10	0	5	10	70	0	0	0	sandy-loam	light grey	9	35
	9	10	0	5	10	70	0	0	0	sandy-loam	light grey	5	13
	10	10	5	0	0	85	0	0	0	sandy	light grey	3	8
	11	20	0	5	0	70	0	0	0	sandy-loam	light grey	4	23
	12	20	0	30	0	20	0	0	0	sandy-loam	dark brown	5	19
	13	10	0	10	0	70	0	0	0	sandy-loam	light grey	6	28
	14	5	0	0	30	60	0	0	0	sandy	light grey	5	30
	15	5	5	0	40	30	0	0	0	sandy-loam	light grey	6	14
	16	5	0	0	10	80	0	0	0	sandy-loam	light grey	7	21
	17	5	0	10	10	70	0	0	0	sandy-loam	light grey	9	20
	18	20	0	20	0	40	0	0	0	sandy-loam	light grey	8	16
19	30	0	25	3	30	0	0	0	sandy-loam	light grey	7	19	
20	10	0	10	40	30	0	0	0	sandy-loam	light grey	7	20	
21	5	0	20	40	20	0	0	0	sandy-loam	light grey	4	13	

Forest Reserve	Regen. Plot ID	Cover (%)				Dominance (%)				Soil texture	Soil colour	No. Individ.	No. Species
		Herbs	Bare soil	Litter	Rocks	Grasses	Forbs	Mosses/lichens	Ferns				
Mtiniko	1	35	0	50	0	10	0	0	0	sandy-loam	light grey	11	46
	2	30	0	60	0	10	0	0	0	sandy-loam	light grey	7	18
	3	40	0	60	0	0	0	0	0	sandy-loam	light grey	4	30
	4	40	0	60	0	0	0	0	0	sandy-loam	light grey	7	17
	5	60	0	40	0	0	0	0	0	sandy-loam	light grey	7	18
	6	30	0	60	0	5	0	0	0	sandy-loam	light grey	9	20
	7	30	0	60	0	2	0	0	0	sandy-loam	light grey	7	16
	8	40	0	60	0	0	0	0	0	sandy-loam	dark brown	8	22
	9	60	0	40	0	0	0	0	0	sandy-loam	light grey	8	20
	10	0	0	30	0	70	0	0	0	sandy-loam	light grey	5	16
	11	40	0	40	0	0	0	0	0	sandy-loam	light grey	8	22
	12	20	0	40	0	0	0	0	0	sandy-loam	light grey	6	25
Mtuli Hinju	1	0	0	20	0	80	0	0	0	sandy-loam	light grey	7	22
	2	25	0	30	0	0	0	0	0	sandy-loam	light grey	5	41
	3	0	0	20	0	80	0	0	0	sandy-loam	light grey	6	14
	4	30	10	30	0	10	0	0	0	sandy-loam	light grey	8	36
	5	10	5	20	0	60	0	0	0	sandy-loam	light grey	6	15
Makonde III	1	5	0	30	10	30	0	0	0	sandy-loam	dark brown	6	33
	2	15	15	15	0	50	0	0	0	sandy-loam	light grey	7	33
	3	10	10	10	0	60	0	0	0	sandy-loam	light grey	8	31
	4	30	0	20	0	40	0	0	0	sandy-loam	dark brown	6	30
	5	15	5	30	0	40	0	0	0	sandy-loam	dark grey	7	28
	6	3	20	15	0	60	0	0	0	sandy-loam	dark grey	5	15
	7	40	0	30	0	10	0	0	0	sandy-loam	dark brown	5	30

Forest Reserve	Regen. Plot ID	Cover (%)				Dominance (%)				Soil texture	Soil colour	No. Individ.	No. Species
		Herbs	Bare soil	Litter	Rocks	Grasses	Forbs	Mosses/lichens	Ferns				
	8	10	30	20	10	20	0	0	0	sandy-clay	light grey	6	18
	9	30	0	20	5	10	0	0	0	sandy-loam	light grey	7	21
Ndechela	1	15	0	50	25	25	0	0	0	sandy-loam	light grey	3	30
	2	5	0	80	5	0	0	0	0	sandy-loam	light grey	3	30
	3	20	0	30	0	30	0	0	0	sandy-loam	light grey	5	25
	4	5	0	5	30	50	0	0	0	rocky	dark brown	4	22
	5	30	5	40	0	20	0	0	0	sandy-loam	light grey	5	19
	6	10	0	80	0	5	0	0	0	loam	dark brown	0	0
	7	20	0	20	0	40	0	0	0	loam	dark brown	4	14
	8	0	0	20	0	60	0	0	0	sandy-loam	dark brown	4	12
	9	20	0	40	5	30	0	0	0	sandy-loam	light grey	4	13
	10	0	0	0	0	0	0	0	0	sandy-loam	light grey	4	11
	11	20	0	30	0	40	0	0	0	loam	dark brown	0	0
	12	<5	0	60	0	30	0	0	0	loam	red brown	4	12
	13	5	0	40	0	50	0	0	0	loam	red brown	5	18
	14	5	0	30	0	60	0	0	0	loam	dark brown	4	9
	15	5	0	5	0	80	0	0	0	sandy-loam	light grey	6	22
	16	10	0	5	0	80	0	0	0	loam	dark brown	4	19
	17	10	0	30	0	60	0	0	0	sandy	light grey	3	8
	18	5	0	30	0	60	0	0	0	loam	dark brown	5	29
	19	0	0	20	80	0	0	0	0	rocky	dark grey	3	13
	20	0	0	0	0	0	0	0	0	loam	dark brown	3	9
MEAN		17.47	4.47	24.18	5.33	35.21	0	0	0			7.2	19

APPENDIX 6 - GPS CO-ORDINATES AND DESCRIPTION OF ZOOLOGICAL TRAP SITES FOR ALL FOREST RESERVES

Forest Reserve	Waypoint	Description of location and habitat notes	Latitude (S)	Longitude (E)	Grid ref (E)	Grid ref (N)	Altitude (m)
Kambona	Z-KAMB	200m from the forest boundary near Chidya Secondary School, in open woodland	10° 37' 09.4"	039° 01' 14.8"	502271	8826223	670
Makonde I	Z-MS1	On edge of regenerating woodland	10° 38' 56.3"	039° 02' 45.3"	505023	8822940	600
Makonde II	Z1-MS2	At the base of the escarpment in a pocket of regenerating woodland	10° 50' 25.3"	039° 10' 46.2"	519619	8801776	650
Makonde II	Z2-MS2	On edge of escarpment in open woodland/grassland	10° 50' 19.9"	039° 10' 51.0"	519768	8801939	720
Mkunya River site 1	Z-MR1	300m from water pumping station. One bucket line in riverine forest, one in open woodland	10° 50' 27.5"	039° 23' 54.1"	543518	8783258	130
Mkunya River site 2	Z-MR2	Half way up the escarpment, 500m east of base camp, in open woodland	10° 58' 44.4"	039° 26' 58.4"	549115	8786416	120
Mtiniko	Z-MT	200m from the forest boundary/base camp, in coastal forest/thicket	10° 35' 26.7"	039° 56' 06.6"	602306	8829222	195
Mtuli Hinju	Z-MH	300m from base camp. One bucket line in open woodland/grassland, one in coastal forest/thicket	10° 35' 27.6"	039° 47' 11.2"	586035	8829241	215
Makonde III	Z-MS3	At the base of the escarpment. One near the water source in thicket, one in regenerating cultivated land.	10° 53' 34.6"	039° 24' 24.2"	544450	8795938	400
Ndechela site 1	Z-ND1	By dry river bed in open woodland/grassland. Fire damage evident.	11° 06' 16.8"	038° 09' 43.1"	408477	8772428	250
Ndechela site 2	Z-ND2	300m from base camp in open woodland/grassland. Fire damage evident.	11° 04' 27.0"	038° 12' 32.0"	413593	8775816	280

APPENDIX 7 - GPS COORDINATES AND SITE DESCRIPTION OF TRANSECTS FOR ALL FOREST RESERVES

FR code	Site no.	Transect number	Waypoint	Description of location	Latitude (S)	Longitude (E)	Grid ref (E)	Grid ref (N)	Altitude (m)
Kambona	1	1	T1-KAM	FR edge	10° 37' 11.1"	039° 01' 09.7"	502117	8826170	700
	1	2	T2-KAM	FR edge	10° 37' 04.6"	039° 01' 18.5"	502385	8826370	700
Makonde I	2	1	V1-MS1	FR edge	10° 39' 06.4"	039° 02' 41.4"	504903	8822629	600
	2	2	T2-MS1	FR edge	10° 39' 31.3"	039° 02' 37.3"	504778	8821866	600
	2	3	T3-MS1	Edge of cultivated land	10° 38' 15.5"	039° 02' 51.0"	505196	8824192	610
Makonde II	3	1	T1-MS2	FR edge	10° 50' 41.0"	039° 10' 53.8"	519850	8801291	550
	3	2	T2-MS2	FR edge	10° 52' 55.2"	039° 14' 01.8"	525555	8797168	780
	3	3	T3-MS2	FR edge	10° 49' 58.2"	039° 10' 08.9"	518487	8802607	730
	3	4	T4-MS2	FR edge	10° 50' 31.5"	039° 11' 58.4"	521813	8801582	750
Mkunya River	4	1	V3-MR1	FR edge	11° 00' 44.9"	039° 23' 23.5"	542590	878273	150
	4	2	T2-MR1	FR edge	11° 00' 46.9"	039° 23' 40.6"	543107	8782661	120
	4	3	T3-MR1	FR edge	11° 00' 18.5"	039° 24' 10.0"	544001	8783534	130
	5	1	T1-MR2	FR edge	10° 58' 46.6"	039° 26.5' 9.8"	549158	8786347	110
	5	2	T2-MR2	FR edge	10° 59' 34.8"	039° 25' 35.9"	546610	8784871	125
	5	3	T3-MR3	FR edge	10° 58' 52.5"	039° 26' 36.9"	548462	8786168	100
	5	4	ND-BDR	FR edge	10° 58' 36.1"	039° 27' 52.7"	550763	8786666	88
Mtiniko	6	1	Z-MT	Near zoo site	10° 35' 26.7"	039° 56' 06.6"	602306	8829222	195
	6	2	T2-MT	FR edge	10° 34' 56.9"	039° 56' 11.2"	602449	8830138	195
	6	3	T3-MT	FR edge	10° 35' 30.8"	039° 55' 05.8"	600459	8829103	210
	6	4	T4-MT	FR edge	10° 34' 03.7"	039° 56' 46.1"	603514	8831768	200

FR code	Site no.	Transect number	Waypoint	Description of location	Latitude (S)	Longitude (E)	Grid ref (E)	Grid ref (N)	Altitude (m)
Mtuli Hinju	7	1	T1-MH	Near Zoo site	10° 35' 29.5"	039° 47' 17.5"	586226	8829181	230
	7	2	T2-MH	FR edge	10° 35' 32.2"	039° 46' 49.1"	585435	8829102	260
Makonde III	8	1	Z-MS3	Near zoo site	10° 53' 34.6"	039° 24' 24.2"	544450	8795938	400
	8	2	T2-MS3	FR edge	10° 53' 43.6"	039° 24' 57.6"	545463	8795658	455
	8	3	T3-MS3	Thicket in valley	10° 53' 33.1"	039° 24' 06.4"	543910	8795983	430
Ndechela	9	1	T1-ND1	FR edge	11° 06' 15.1"	038° 09' 40.5"	408401	8772482	250
	9	2	T2-ND1	FR edge	11° 05' 23.9"	038° 08' 57.5"	407091	8774049	260
	9	3	T3-ND1	FR edge	11° 04' 38.3"	038° 08' 24.8"	406094	8775549	260
	9	4	T4-ND1	By old road	11° 05' 38.1"	038° 10' 58.1"	410751	8773624	330
	10	1	T5-ND2	Near road to Nakopi	11° 03' 39.5"	038° 12' 50.0"	414135	8777275	330
	10	2	T6-ND2	FR edge	11° 05' 53.3"	038° 14' 08.8"	416536	8773173	280
	10	3	T7-ND2	Near road to Nakopi	11° 05' 09.4"	038° 13' 39.4"	415641	8774520	340

APPENDIX 8 - LIST OF PITSAWING SITES THAT WERE RECORDED WITH GPS

Reserve	Waypoint	Latitude (S)	Longitude (E)	Grid ref (E)	Grid ref (N)
Makonde Scarp I	PS-MS1	10° 39' 18.7"	039° 02' 39.3"	504838	8822254
Makonde Scarp I	P2-MS1	10° 38' 34.1"	039° 03' 05.6"	505641	8823621
Mkunya River	P1-MK	10° 58' 36.1"	039° 27' 52.7"	350763	8786666
Mtiniko	PS-MT	10° 35' 07.8"	039° 56' 03.9"	602225	8829803
Mtiniko	P2-MT	10° 35' 24.6"	039° 55' 04.8"	600428	8829293
Mtiniko	P3-MT	10° 34' 45.0"	039° 56' 47.1"	603542	8830502
Mtiniko	P4-MT	10° 35' 02.1"	039° 56' 50.7"	603650	8829974
Mtuli Hinju	PS-MH	10° 35' 27.3"	039° 46' 48.6"	585346	8829252

APPENDIX 9 - LIST OF PLANT SPECIES FOR ALL FOREST RESERVES. TAXONOMY BASED ON THE FLORA OF TROPICAL EAST AFRICA (PUBLISHED FAMILIES) AND THE LEAP DATABASE

a) List of plant species recorded in vegetation plots

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
ANACARDIACEAE	<i>Rhus</i>	<i>natalensis</i>	Krauss	1-3000	<i>K1-7; T1-8,Z,P; Som</i>	S		Not listed				X					
	<i>Sclerocarya</i>	<i>birrea</i>	(A. Rich.) Hochst	100-1600	<i>K1-4,6,7; T1-4,6</i>	T		Not listed	Mng'ongo						X		X
	<i>Sorindeia</i>	<i>madagascariensis</i>	DC., Prodr.	1-1830	<i>K4,7; T2,3,5-8,P,Z; Moz</i>	T		Not listed								X	
ANNONACEAE	<i>Annona</i>	<i>senegalensis</i>	Pers.	0-1800	<i>K5,7; T1-4,6,8,Z,P;</i>	S/T		Not listed	Mtopetope	X	X		X	X	X		X
	<i>Monodora</i>	<i>grandidieri</i>	Baill.	0-900	<i>K7; T3,6, Z; Som; Moz</i>	S/T	E	Not listed				X	X				
	<i>Monodora</i>	<i>junodii</i>	Engl. & Diels	1-1590	<i>T3,5,6,8; Moz</i>	S		Not listed					X				
	<i>Uvariadendron</i>	sp.	-	-	-	-	-	-				X					
	<i>Xylopia</i>	<i>aethiopica</i>	(Dunal) A. Rich.	800-1200	<i>T1,3,6,8; Moz</i>	S/T		Not listed						X			
APOCYNACEAE	<i>Diplorhynchus</i>	<i>condylocarpon</i>	(Müell. Arg.) Pichon	500-1400	<i>T1,3-8; Moz</i>	S/T		Not listed		X	X	X	X			X	X
	<i>Holarrhena</i>	<i>pubescens</i>	(Buch.-Ham.) G. Don	0-1250	<i>K7; T1,3-8; Moz</i>	S/T		LC									X

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
ARALIACEAE	<i>Cussonia</i>	<i>arborea</i>	A. Rich	300-2470	<i>K2-5; T1,2,4-8</i>	T		Not listed			X	X	X				
	<i>Cussonia</i>	<i>zimmermannii</i>	Harms	0-400	<i>K7; T3,6,8; Moz</i>	T	E	PT								X	X
	<i>Schefflera</i>	<i>barteri</i>	Harms	900-2000	<i>T2,3,6,8</i>	S/T		Not listed			X					X	
ASTERACEAE	<i>Brachylaena</i>	sp.				T		Not listed									X
BALANITACEAE	<i>Balanites</i>	<i>aegyptiaca</i>	(L.) Delile	1200-2500	<i>K1-7 T3,5-8;</i>	T		Not listed		X	X	X					
BIGNONIACEAE	<i>Markhamia</i>	<i>acuminata</i>	(Klotzsch) K. Schum.	70	<i>T3,6,7; Moz</i>	T		Not listed	Mtandavwala	X							
	<i>Markhamia</i>	<i>obtusifolia</i>	(Baker) Sprague	400	<i>T1,3,5,6,7; Moz</i>	T		Not listed	Mtandavwala					X	X	X	X
BOMBACACEAE	<i>Bombax</i>	<i>rhodognaphalon</i>	K. Schum.	20-700	<i>K7; T3,6,8,P; Moz</i>	T	E	PT	Msufipori					X		X	
BORAGINACEAE	<i>Ehretia</i>	sp.	-	-	-	S/T	-	-								X	
BURSERACEAE	<i>Commiphora</i>	<i>africana</i>	(A. Rich.) Engl.	5-1780	<i>K1,3,4,6,7; T2,3,6-8,Z,P; Som; Moz</i>	S/T		Not listed	Mng'orola			X		X			X
	<i>Commiphora</i>	<i>ugensis</i>	Engl.	800-1400	<i>T1,2,4,5,7</i>	T		Not listed	Mng'orola				X	X			
	<i>Commiphora</i>	<i>zanzibarica</i>	(Baill.) Engl.	2-510	<i>K7; T6,8,Z; Moz</i>	T	E	PT	Mng'orola								X
CAPPARIDACEAE	<i>Maerua</i>	<i>angolensis</i>	DC.	0-1500	<i>K1,4-7; T1-8; Som</i>	T		Not listed			X						
CELASTRACEAE	<i>Hippocratea</i>	sp.	-	-	-	-	-	-				X					
	<i>Salacia</i>	<i>madagascariensis</i>	(Lam.) DC.	600-1300	<i>K7; T3,6-8,Z,P; Som; Moz</i>	C/S		Not listed		X	X	X	X		X	X	

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
CHRYSOBALANACEAE	<i>Parinari</i>	<i>curatellifolia</i>	Benth.	1700	K5; T1,4-7,Z,P; Moz	T		Not listed	Mbula		X	X	X				
FLUSIACEAE	<i>Garcinia</i>	<i>livingstonei</i>	T. Anderson	0-1650	K4-7; T1-8,Z; Som	S		Not listed		X				X	X		
COMBRETACEAE	<i>Combretum</i>	<i>hereroense</i>	Schinz		K3,4,7; T3,6,8; Moz	S		Not listed	Chinama			X	X	X	X		X
	<i>Combretum</i>	<i>molle</i>	G. Don	30-2300	K1-7; T1-8	T		Not listed	Chinama	X	X	X	X	X	X	X	X
	<i>Combretum</i>	<i>paniculatum</i>	Vent.	10-2000	K3-5,7; T1-8,Z; Moz	C		Not listed	Chinama	X	X	X	X	X			X
	<i>Combretum</i>	<i>zeyheri</i>	Sond.	10-1600	K4; T1-8; Moz	T		Not listed	Chinama		X		X				
	<i>Pteleopsis</i>	<i>myrtifolia</i>	(M. A. Lawson) Engl. & Di	0-1600	K; T2,3,6,8; Moz	T		Not listed	Mmala	X	X	X	X	X	X	X	X
	<i>Terminalia</i>	<i>sambesiaca</i>	Engl. & Diels	70-830	K7; T2,3,6-8; Moz	T		Not listed		X							X
	<i>Terminalia</i>	<i>sericea</i>	DC.	450-1300	T1-8; Moz	T		Not listed			X						X
DICHAPETALACEAE	<i>Dichapetalum</i>	<i>stuhmannii</i>	Engl.	50-1600	T4,6,8; Moz	S/T		Not listed						X			
DILLENACEAE	<i>Tetracera</i>	<i>boiviniana</i>	Baill.	50-350	K7; T3,6,8; Moz	S/T	E	PT	Namachili	X		X		X	X		
EBENACEAE	<i>Diospyros</i>	<i>Kirkii</i>	Hiern.	450-1350	T1,4,6-8; Moz	T		Not listed						X			

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	
EUPHORBIACEAE	<i>Bridelia</i>	<i>cathartica</i>	Bertol. f.	0-2000	K7; T1-8,Z,P; Som	S		Not listed			X	X	X	X	X			
	<i>Bridelia</i>	<i>micrantha</i>	(Hochst) Baill.	50-2300	K1-7; T1-8,Z,P	S/T		Not listed		X	X	X	X	X		X	X	
	<i>Croton</i>	<i>pseudopulchellus</i>	Pax	0-1800	K1,6,7; T3,6,Z; Som; Moz	S/T		Not listed	Mnyao								X	
	<i>Drypetes</i>	<i>gerrardii</i>	Hutch.	1150-2300	K1,4-7; T1-4,7	S/T		Not listed	Mnyumbu				X	X	X			
	<i>Drypetes</i>	<i>natalensis</i>	(Harv.) Hutch	125-1500	K4; T2-6,8; Moz	S/T		PT	Mnyumbu	X	X		X					
	<i>Jatropha</i>	<i>curcas</i>	L.	see level-1700	K4,5,7; T1,3-8,Z	S/T		Not listed	Mhogopori					X		X		
	<i>Maprounea</i>	<i>africana</i>	Muell. Arg.	5-1130	T4-8,Z	S/T		Not listed				X						
	<i>Pseudolachnosty lis</i>	<i>maprouneifolia</i>	Pax	340-1600	T1,2,4-8; Moz	S/T		Not listed		X				X	X	X	X	
	<i>Spirostachys</i>	<i>africana</i>	Sond.	15-900	K7; T2,3,6,8	S/T		Not listed										X
	<i>Suregada</i>	<i>zanzibarensis</i>	Baill.	0-1600	K7; T3,6,8,Z,P; Som; Moz	S		Not listed						X	X			
FABACEAE (CAES)	<i>Afzelia</i>	<i>quanzensis</i>	Welw.	0-1350	K7; T1-8,Z,P; Som, Moz	T		Not listed	Mbambakofi					X		X	X	
	<i>Bauhinia</i>	<i>petersiana</i>	Bolle	150-1830	T4-8; Moz	T		Not listed		X							X	
	<i>Bauhinia</i>	<i>tomentosa</i>	L.	0-1520	K1,3,4,7; T2,3,6,8	T		Not listed		X	X		X					
	<i>Brachystegia</i>	<i>longifolia</i>	Benth.	275-2000	T4,6-8; Moz	T		Not listed	Mchinji	X	X		X			X	X	

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Brachystegia</i>	<i>microphylla</i>	Harms	300-2200	<i>T1-8; Moz</i>	T		Not listed	Mchenga		X	X	X	X	X	X	
	<i>Brachystegia</i>	sp.	-	-	-	T	-	-			X						
	<i>Brachystegia</i>	<i>spiciformis</i>	Benth.	2350	<i>K7; T1-8; Moz</i>	T		Not listed	Mchenga	X	X	X	X	X	X	X	X
	<i>Brachystegia</i>	<i>utilis</i>	Burt. Davy & Hutch.	300-1830	<i>T4,5,7,8; Moz</i>	T		Not listed	Mchengavwala				X				
	<i>Caesalpinia</i>	<i>decapetala</i>	(Roth) Alston	880-2130	<i>K4,5; T1-3,6,7</i>	S		Not listed			X		X				
	<i>Cassia</i>	<i>abbreviata</i>	Oliv.	220-1520	<i>T1,4,5,7,8; Moz</i>	T		PT	Mjohoro			X					
	<i>Cassia</i>	<i>didymobotrya</i>	Fresen.	900-2440	<i>K3-7; T1-8; Moz</i>	S		Not listed	Mjohoro			X					
	<i>Cassia</i>	<i>petersiana</i>	Bolle	12-2130	<i>K3-5; T1,4,6-8,Z</i>	S		Not listed	Mjohoromaji			X		X	X		
	<i>Cassia</i>	<i>singueana</i>	Delile	0-2130	<i>K1,3-5,7; T1-8</i>	T		Not listed	Mjohoro								X
	<i>Cordyla</i>	<i>africana</i>	Lour.	10-900	<i>K7,T2,3,6,8,Z, Moz</i>	T		Not listed	Mwembepori		X		X				
	<i>Cynometra</i>	<i>gillmanii</i>	J. Léon		<i>T8</i>	T	E	CR B1+2a bcde,c 2b					X				
	<i>Hymenaea</i>	<i>verrucosa</i>	Gaertner					Not listed	Mtondo				X	X		X	
	<i>Julbernardia</i>	<i>globiflora</i>	(Benth.) Troupin	490-1830	<i>T1,3-8; Moz</i>	T		Not listed	Mchinji	X	X		X			X	
	<i>Piliostigma</i>	<i>thonningii</i>	(Schumach) Milne-Redh	0-1830	<i>K2-7; T1-8,P</i>	T		Not listed		X							

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Swartzia</i>	<i>madagascariensis</i>	Desv.	450-1260	<i>T1,4-8; Moz</i>	S		Not listed	Msekeseke		X		X				X
FABACEAE (MIM)	<i>Acacia</i>	<i>polycantha</i>	Willd.	0-1830	<i>K2,4-7; T1-8</i>	T		Not listed	Mtalala								X
	<i>Acacia</i>	<i>xanthophloea</i>	Benth.	600-1980	<i>K1,3,4,6,7; T2-5,7; Moz</i>	T		Not listed									X
	<i>Albizia</i>	<i>amara</i>	(Roxb.) Boivin	820	<i>K1; T8</i>	T		Not listed	Mtangambuzi			X					
	<i>Albizia</i>	<i>gummifera</i>	(J.F. Gmel.) C.A. Sm.	0-2440	<i>K3-7; T2-8,Z</i>	T		Not listed	Mtangadume	X		X		X	X	X	X
	<i>Albizia</i>	<i>petersiana</i>	(Bolle) Oliv.	380-1700	<i>K6,7; T1-8; Moz</i>	T		Not listed	Mtanga			X	X				
	<i>Albizia</i>	<i>versicolor</i>	Welw. ex Oliv.	0-1680	<i>K7; T1,3-8</i>	T		Not listed	Mtanga			X			X	X	
	<i>Dichrostachys</i>	<i>cinerea</i>	(L.) Wight & Arn.	300-1625	<i>K4; T1,4-8</i>	S		Not listed								X	X
	<i>Entada</i>	<i>stuhmannii</i>	(Taub.) Harms	15-1600	<i>T6,8; Moz</i>	C	E	PT									
FABACEAE (PAP)	<i>Craibia</i>	<i>brevicaudata</i>	(Vatke) Dunn	1500	<i>T4,7,8</i>	T		PT				X					
	<i>Dalbergia</i>	<i>armata</i>	E. Mey.	240-660	<i>T8; Moz</i>	S		Not listed	Mpingo kamba							X	
	<i>Dalbergia</i>	<i>nitidula</i>	Baker	350-1650	<i>T1,3-8; Moz</i>	T		Not listed	Mpingo			X	X	X			
	<i>Dalbergia</i>	<i>obovata</i>	E. Mey.	0-1050	<i>T3,5,6; Moz</i>	T		Not listed		X					X		
	<i>Lonchocarpus</i>	<i>bussei</i>	Harms	0-1350	<i>K1,7; T3,5-8; Moz</i>	T		Not listed	Mlungulungu		X	X	X	X	X		X

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Lonchocarpus</i>	<i>capassa</i>	Rolfe	150-1650	<i>T1,4-8</i>	T		Not listed	Mlungulungu	X			X				X
	<i>Millettia</i>	<i>impressa</i>	Harms	10-200	<i>T6,8; Moz</i>	C		PT	Mpangapanga			X	X				X
	<i>Millettia</i>	<i>stuhmannii</i>	Taub.	10-900	<i>T6,8; Moz</i>	T		Not listed	Mpangapanga		X		X				X
	<i>Pericopsis</i>	<i>angolensis</i>	(Baker) Meeuwen	900-1650	<i>T1,4-8; Moz</i>	T		Not listed	Muwanga						X		
	<i>Pterocarpus</i>	<i>angolensis</i>	DC	300-1650	<i>T1,2,3,4,5,6,7,8 S.Afr, Ang, Zai</i>	T		Not listed	Mtumbati	X	X	X	X		X	X	X
	<i>Pterocarpus</i>	<i>rotundifolius</i>	(Sond.) Druce	300-900	<i>T6,8; Moz</i>	T		Not listed	Mtumbatimaji	X	X	X		X			
	<i>Tephrosia</i>	sp.	-	-	-	S	-	-					X				
	<i>Xeroderris</i>	<i>stuhmannii</i>	(Taub.) Mendonça & E.C.Sousa	100-1650	<i>K7; T1-8</i>	T		Not listed					X				X
FLACOURTIACEAE	<i>Flacourtia</i>	<i>indica</i>	(Burm. f.) Merr	0-2400	<i>K2-5,7; T1-8,Z</i>	S		Not listed	Mkung'u		X		X				X
	<i>Xylothea</i>	<i>tettensis</i>	(Klotzsch) Gilg	200-600	<i>T6-8; Moz</i>	S	E	PT							X		
GUTTIFERAE	<i>Psorospermum</i>	<i>febrifugum</i>	Spac	50-1950	<i>K5; T1,4,6-8</i>	S		Not listed				X		X			
HYMENOCARDIACEAE	<i>Hymenocardia</i>	<i>ulmoides</i>	Oliv.	50-1550	<i>T3,5,6,8</i>	T		Not listed	Mhindi					X	X	X	
LOGANIACEAE	<i>Strychnos</i>	<i>cocculoides</i>	Baker	400-2000	<i>T1,4-8</i>	S		Not listed				X					
	<i>Strychnos</i>	<i>madagascariensis</i>	Poir.	900-1500	<i>T4-6,9; Moz</i>	S		Not listed			X	X	X	X	X		

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Strychnos</i>	<i>spinosa</i>	Lam.	400-2200	<i>K2,4; T1,3-8</i>	S		Not listed			X	X	X		X		
	<i>Strychnos</i>	<i>usambarensis</i>	Gilg	75-2000	<i>K4,6; T3,5; Moz</i>	T		Not listed				X					
MELIACEAE	<i>Khaya</i>	<i>anthotheca</i>	(Welw.)	120-1525	<i>T3-8; Moz</i>	T		VU A1cd		X		X					
MORACEAE	<i>Ficus</i>	<i>natalensis</i>	Hochst.	10-2200	<i>K1,4-7; T1-3,5-8,Z,P</i>	S/T		Not listed	Mkuyu	X			X				
	<i>Ficus</i>	<i>sur</i>	Forssk.	0-2300	<i>K1,3-7; T1-8,Z,P</i>	T		Not listed	Mkuyudume						X	X	
	<i>Milicia</i>	<i>excelsa</i>	(Welw.)	0-1350	<i>K4,5,7; T1-4,6-8,Z,P; Moz</i>	T		LR/nt	Mvule	X					X	X	X
MYRTACEAE	<i>Syzygium</i>	<i>cordatum</i>	Krauss.	900-2400	<i>K3-5; T1,4,6-8;</i>	T/S		PT	Mzambarau	X							
OCHNACEAE	<i>Ochna</i>	<i>holstii</i>	Engl.	900-2350	<i>K1,3-7; T2-8; Moz</i>	S/T		Not listed	Mnyale		X	X	X			X	X
OLEACEAE	<i>Schrebera</i>	<i>trichoclada</i>	Welw.	810-1350	<i>T1,4-6</i>	S/T											X
PITTOSPORACEAE	<i>Pittosporum</i>	<i>viridiflorum</i>	Sims	900-1200	<i>T3,8; Som</i>	S/T		Not listed		X					X		
POACEAE	<i>Arundinaria</i>	<i>alpina</i>	K. Schum.	2400-3000	<i>K1,3-6; T2,4,6,7</i>	B		Not listed	Mianzi					X			
POLYGALACEAE	<i>Securidaca</i>	<i>longipedunculata</i>	Fresen.	1500-2000	<i>K3,4,6; T4,5,7,8; Moz</i>	T		Not listed	Chiguruka			X				X	
RHIZOPHORACEAE	<i>Cassipourea</i>	<i>malosana</i>	(Baker) Alston	1100-2600	<i>K1,3-6; T2,3,7; Som</i>	T		Not listed					X				
RUBIACEAE	<i>Catunaregam</i>	<i>spinosa</i>	(Thunb) Tirvengadam	70-290	<i>K7; T6,7; Moz</i>	S/T		Not listed		X							X

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Crossopteryx</i>	<i>febrifuga</i>	(G.Don) Benth	0-1350	K7; T1-8	S/T		Not listed			X		X			X	
	<i>Keetia</i>	<i>gueinzii</i>	(Sond.) Bridson	90-2450	K2/3,3-5,7; T1-8,Z	C/S		Not listed					X	X			X
	<i>Pentas</i>	<i>longiflora</i>	Oliv.	1050-2450	K2-6,7; T2-4,7	H		Not listed			X	X					
	<i>Rothmannia</i>	<i>urcelliformis</i>	(Hiern) Robyns	850-2400	K3/5,4-6; T1-4,6,7; Moz	S/T		Not listed		X					X		
	<i>Rytigynia</i>	<i>decussata</i>	(K. Schum.) Robyns	75-1000	K7; T3,6,8; Moz	S	E	PT		X				X	X		
	<i>Rytigynia</i>	sp.	-	-	-	S	-	-						X			
	<i>Vangueria</i>	<i>infausta</i>	Burchell	500-2500	T4-7; Moz	S/T		Not listed				X					
	<i>Vangueria</i>	<i>madagascariensis</i>	Gmelin	0-2130	U1-4; K1,3,4,6; T1-8; Z; P; Gha; Nig; Cam; Zai; C Afr; Sud; Eth; Mal; S Afr	S/T		Not listed			X		X				
RUTACEAE	<i>Vepris</i>	<i>lanceolata</i>	(Lam.) G.Don	0-30	K7; T3,6; Moz	S		Not listed						X			
	<i>Zanthoxylum</i>	<i>chalybeum</i>	Engl.	5-1550	K1-5; T1-8; Som	S/T		Not listed	Namavwele					X			
SAPINDACEAE	<i>Allophylus</i>	<i>africanus</i>	P. Beauv.	30-2400	K3-6; T1-8;	T		Not listed						X			
SAPOTACEAE	<i>Bequaertiodendron</i>	<i>natalense</i>	S.Moore) Heine & J.H.Hemsl.	900-1700	K5	S		Not listed				X		X			
STERCULIACEAE	<i>Cola</i>	<i>greenwayi</i>	Brenan	1000-2000	K7; T3,4; Moz	T		Not listed						X			

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Dombeya</i>	<i>kirkii</i>	Mast.	1500	<i>K1-5,7; T2,3</i>	T		Not listed			X		X				
	<i>Octolobus</i>	<i>spectabilis</i>			<i>Not in LEAP</i>	T		Not listed		X					X		
	<i>Sterculia</i>	<i>appendiculata</i>	K. Schum ex Engl.	450	<i>K7; T7,8,Z</i>	T	E	Not listed	Mparatanyani		X		X				X
	<i>Sterculia</i>	sp.				T		Not listed	Mparatanyani								X
TILIACEAE	<i>Grewia</i>	<i>mollis</i>	Juss.	700-1550	<i>K5,6; T1,2,4; Som</i>	S/T		Not listed	Mbobo					X	X		
VELLOZIACEAE	<i>Xerophyta</i>	sp.	-	-	-	S		-									X
VERBENACEAE	<i>Vitex</i>	<i>mombassae</i>	Vatke	20-1580	<i>K7; T1-8; Moz</i>	S/T		Not listed		X							

X = presence/absence

T1 = Kagera, Mwanza, and Mara regions, T2 = Arusha and Manyara regions, T3 = Tanga and Kilimanjaro regions, T4 = Kigoma and Rukwa regions, T5 = Dodoma and Singida regions, T6 = Dar es Salaam, Coastal and Morogoro regions, T7 = Mbeya and Iringa regions, T8 = Lindi, Mtwara and Ruvuma regions, K7 = Kenya Coastal regions (Polhill, 1988); R = Rare species: plants present in less than two out of the eight FTEA vegetation regions of Tanzania (Knox, 2000)

T = Tree, S = Shrub, B = Bamboo, C = Climber, H = Herb/Grass/Sedge

E = Endemic – plant species with limited ranges in the Swahilian regional centre of endemism *sensu lato* (based on Clarke and Robertson, 2000)

PT= Potentially Threatened plants in the EACF Hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; LR cd = Lower risk, conservation dependent; LR nt = Lower risk, near threatened; LR lc = Lower risk, least concerned; DD = Data Deficient (IUCN, 2004)

b) List of plant species recorded in regeneration plots

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
ACANTHACEAE	<i>Hypoestes</i>	sp.				H		Not listed		X						X	
ALOEACEAE	<i>Aloe</i>	<i>macrosiphon</i>	Bak.	1125-1585	<i>K5,6; T1,4</i>	H		Not listed									X
	<i>Aloe</i>	<i>secundiflora</i>	Engl.	750-1980	<i>K1,3-7; T1-3,5</i>	H		Not listed									X
ANNONACEAE	<i>Annona</i>	<i>senegalensis</i>	Pers.	0-1800	<i>K5,7; T1-4,6,8,Z,P;</i>	S/T		Not listed	Mtopetope							X	
	<i>Monodora</i>	<i>grandidieri</i>	Baill.	0-900	<i>K7; T3,6, Z; Som; Moz</i>	S/T	E	Not listed					X				
	<i>Monodora</i>	<i>junodii</i>	Engl. & Diels	1-1590	<i>T3,5,6,8; Moz</i>	S		Not listed							X		
	<i>Uvaria</i>	sp.1	-	-	-	-	-	-			X						
	<i>Uvaria</i>	sp.2	-	-	-	-	-	-				X					
	<i>Uvaria</i>	sp.3	-	-	-	-	-	-					X				
APOCYNACEAE	<i>Landolphia</i>	<i>buchananii</i>	(Hallier f.) Stapf	450-2400	<i>K1,3-7; T1-5,7; Som; Moz</i>	C		Not listed	Msofu			X				X	
ASTERACEAE	<i>Aspilia</i>	<i>mossambicensis</i>	(Oliv.) Wild	45-2300	<i>K1-7; T1-8; Som</i>	H/S		Not listed		X							
	<i>Vernonia</i>	<i>chloropappa</i>	Baker					Not listed					X			X	
	<i>Vernonia</i>	<i>glabra</i>	(Steetz) Vatke		<i>K5; T1-8,Z</i>	H		Not listed					X				X
	<i>Vernonia</i>	sp.	-	-	-	H/S	-	-							X	X	

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
BIGNONIACEAE	<i>Markhamia</i>	<i>acuminata</i>	(Klotzsch) K.Schum.	70	T3,6,7; Moz	T		Not listed	Mtandavwala		X	X				X	
	<i>Markhamia</i>	<i>obtusifolia</i>	(Baker) Sprague	400	T1,3,5,6,7; Moz	T		Not listed	Mtandavwala				X				
BORAGINACEAE	<i>Ehretia</i>	sp.	-	-	-	S	-	-	Namapande							X	
CELASTRACEAE	<i>Salacia</i>	<i>madagascariensis</i>	(Lam.) DC.	600-1300	K7; T3,6-8,Z,P; Som; Moz	C/S		Not listed				X				X	
CHRYSOBALANACEAE	<i>Parinari</i>	<i>curatellifolia</i>	Blenh.	0-2070	K5; T1,4-7,Z,P	T		Not listed	Mbula			X					
CLUSIACEAE	<i>Garcinia</i>	<i>livingstonei</i>	T. Anderson	0-1650	K4-7; T1-8,Z; Som	S		Not listed		X			X	X			
COMBRETACEAE	<i>Combretum</i>	<i>hereroense</i>	Schinz		K3,4,7; T3,6,8; Moz	S		Not listed	Chinama			X					
	<i>Combretum</i>	<i>molle</i>	G. Don	30-2300	K1-7; T1-8	T		Not listed	Chinama			X				X	
	<i>Pteleopsis</i>	<i>myrtifolia</i>	(M. A. Lawson) Engl. & Di	0-1600	K; T2,3,6,8; Moz	T		Not listed	Mmalala			X					
	<i>Terminalia</i>	<i>brownii</i>	Fresen.	730-2000	K1-7; T2,5,6; Som	T		Not listed			X		X				
CONVOLVULACEAE	<i>Bonamia</i>	<i>mossambicensis</i>	(Klotzsch) Hall. f.	120-450	T6,8; Moz	C		Not listed		X							

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Ipomoea</i>	<i>crassipes</i>	Hook.	750-1230	K4-6; T1,2,4,6-8; Moz	H		Not listed				X					
DICHAPETALACEAE	<i>Dichapetalum</i>	<i>stuhlmannii</i>	Engl.	50-1600	T4,6,8; Moz	S/T		Not listed		X		X					
DILLENACEAE	<i>Tetracera</i>	<i>boiviniana</i>	Baill.	50-350	K7; T3,6,8; Moz	S/T	E	PT	Namachili	X						X	X
DIOSCOREACEAE	<i>Dioscorea</i>	<i>hirtiflora</i>	Benth.	770-1200	T4	C		Not listed				X	X				
DIPTEROCARPACEAE	<i>Monotes</i>	<i>elagans</i>	Gilg.	810-1740	T1,4-6	T		Not listed					X	X			
	<i>Monotes</i>	<i>africanus</i>	A. DC.	350-1800	T4-8; Moz	T		Not listed							X		
EUPHORBIACEAE	<i>Antidesma</i>	<i>membranaceum</i>	Müell. Arg.	10-1530	K4-7; T1,3,4,6-8,Z,P; Moz	T		Not listed		X				X	X	X	
	<i>Antidesma</i>	<i>venosum</i>	E. Mey. ex Tul.	0-1830	K4,5,7; T1-8,Z,P	T		Not listed				X		X	X	X	
	<i>Bridelia</i>	<i>cathartica</i>	Bertol. f.	0-2000	K7; T1-8,Z,P; Som	S		Not listed				X				X	
	<i>Cleistanthus</i>	<i>schlechteri</i>	(Pax) Hutch.	0-50	K7; T3,6,8; Moz	S/T	E	Not listed					X	X	X		
	<i>Croton</i>	<i>pseudopulchellus</i>	Pax	0-1800	K1,6,7; T3,6,Z; Som; Moz	S/T		Not listed	Mnyao			X				X	

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Drypetes</i>	<i>gerrardii</i>	Hutch.	1150-2300	<i>K1,4-7; T1-4,7</i>	S/T		Not listed	Mnyumbu			X	X	X			
	<i>Drypetes</i>	sp.				T		Not listed	Mnyumbumawe						X		
	<i>Drypetes</i>	<i>natalensis</i>	(Harv.) Hutch	125-1500	<i>K4; T2-6,8; Moz</i>	S/T		PT	Mnyumbu					X		X	
	<i>Spirostachys</i>	<i>africana</i>	Sond.	15-900	<i>K7; T2,3,6,8</i>	S/T		Not listed								X	
	<i>Suregada</i>	<i>zanzibarensis</i>	Baill.	0-1600	<i>K7; T3,6,8,Z,P; Som; Moz</i>	S		Not listed							X		
FABACEAE (CAES)	<i>Brachystegia</i>	<i>spiciformis</i>	Benth.	2350	<i>K7; T1-8; Moz</i>	T		Not listed	Mchenga			X					
	<i>Caesalpinia</i>	<i>decapetala</i>	(Roth) Alston	880-2130	<i>K4,5; T1-3,6,7</i>	S		Not listed			X						
	<i>Cassia</i>	<i>abbreviata</i>	Oliv.	220-1520	<i>T1,4,5,7,8; Moz</i>	T		PT	Mjohoro						X	X	
	<i>Cassia</i>	<i>alata</i>	L.	0-460	<i>T3,6,Z,P</i>	S		Not listed			X	X					
	<i>Scorodophloeus</i>	<i>fischeri</i>	(Taub.) J. Léon	200-1350	<i>T4-8; Moz</i>	T	E	PT					X				X
	<i>Tamarindus</i>	<i>indica</i>	L.	0-1520	<i>K1,2,-7; T1-8,Z</i>	T		Not listed	Mkwaju			X					
FABACEAE (MIM)	<i>Acacia</i>	<i>brevispica</i>	Harms	170-1830	<i>K1-7; T1-6; Som ; Moz</i>	T		Not listed		X	X	X					
	<i>Albizia</i>	<i>gummifera</i>	(J.F. Gmel.) C.A. Sm.	0-2440	<i>K3-7; T2-8,Z</i>	T		Not listed	Mtangadume			X				X	
FABACEAE (PAP)	<i>Craibia</i>	<i>brevicaudata</i>	(Vatke) Dunn	1500	<i>T4,7,8</i>	T		PT		X	X	X					

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Crotalaria</i>	sp.	-	-	-	S	-	-					X	X		X	
	<i>Dalbergia</i>	<i>melanoxydon</i>	Guill. & Perr.	0-1350	K4-7; T1-6,8	S		LR/nt	Mpingo		X		X				X
	<i>Dalbergia</i>	<i>nitidula</i>	Baker	350-1650	T1,3-8; Moz	T		Not listed	Mpingo				X			X	
	<i>Dalbergia</i>	<i>obovata</i>	E. Mey	0-1050	T3,5,6; Moz	T		Not listed	Mpingokamba			X					X
	<i>Indigofera</i>	sp.	-	-	-	S	-	-				X					
	<i>Indigofera</i>	<i>vohemarensis</i>	Baill.	0-1800	K1-7; T1-8,Z,P; Moz	H		Not listed			X		X				
	<i>Lonchocarpus</i>	<i>bussei</i>	Harms	0-1350	K1,7; T3,5-8; Moz	T		Not listed	Mlungulungu			X				X	
	<i>Millettia</i>	<i>impressa</i>	Harms	10-200	T6,8; Moz	C		PT	Mpangapanga		X	X	X				
	<i>Pterocarpus</i>	<i>angolensis</i>	DC.	300-1650	T1-8	T		Not listed	Mtumbati			X					
FLACOURTIACEAE	<i>Flacourtia</i>	<i>indica</i>	(Burm. f.) Merr	0-2400	K2-5,7; T1-8,Z	S		Not listed	Mkung'u								X
	<i>Xylothea</i>	<i>tettensis</i>	(Klotzsch) Gilg	200-600	T6-8; Moz	S	E	PT					X			X	
HYMENOCARDIACEAE	<i>Hymenocardia</i>	<i>ulmoides</i>	Oliv.	50-1550	T3,5,6,8	T		Not listed	Mhindi			X				X	
LOGANIACEAE	<i>Strychnos</i>	<i>madagascariensis</i>	Poir.	900-1500	T4-6,9; Moz	S		Not listed	Mkulung'uru								X
	<i>Strychnos</i>	<i>spinosa</i>	Lam.	400-2200	K2,4; T1,3-8	S		Not listed	Mkulung'uru			X					X

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Strychnos</i>	<i>usambarensis</i>	Gilg	75-2000	<i>K4,6; T3,5; Moz</i>	T		Not listed			X						
MALPIGHIACEAE	<i>Acridocarpus</i>	sp.	-	-	-	S	-	-	LC?								X
MALVACEAE	<i>Sida</i>	<i>acuta</i>	Burm. f.	1500-2100	<i>K2-4,6,7; T1-6,8</i>	H		Not listed		X							
MELASTOMATACEAE	<i>Memecylon</i>	sp.	-	-	-	S	-	-						X			
MORACEAE	<i>Ficus</i>	<i>sur</i>	Forssk.	0-2300	<i>K1,3-7; T1-8,Z,P</i>	T		Not listed	Mkuyumweupe		X		X				
	<i>Mesogyne</i>	<i>insignis</i>	Engl.	500-1300	<i>T3,6</i>	S/T		VUbl +2b					X	X	X	X	
OCHNACEAE	<i>Ochna</i>	<i>holstii</i>	Engl.	900-2350	<i>K1,3-7; T2-8; Moz</i>	S/T		Not listed	Mnyale		X		X	X		X	
POACEAE	<i>Arundinaria</i>	<i>alpina</i>	K. Schum.	2400-3000	<i>K1,3-6; T2,4,6,7</i>	B		Not listed	Mwanzi/mianzi								X
	<i>Heteropogon</i>	<i>contortus</i>	(L.) Roem. & Schult.	0-2100	<i>K1-7; T1-8,Z,P</i>	H		Not listed							X		
RHAMNACEAE	<i>Ziziphus</i>	<i>mucronata</i>	Willd.	Sea level to 2000	<i>K1-7; T1-7</i>	S/T		Not listed									X
RUBIACEAE	<i>Catunaregam</i>	<i>spinosa</i>	(Thunb) Tirvengadam	70-290	<i>K7; T6,7; Moz</i>	S/T		Not listed			X		X				
	<i>Gardenia</i>	<i>transvenulosa</i>	Verdc.	10-700m	<i>K7; T3,6,8 not elsewhere</i>	S/T	E	VUbl +2b				X					X

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Lamprothamnus</i>	<i>zanguebaricus</i>	Hiern	0-300	<i>K1,7; T3,6,8; Som</i>	S/T	E	PT			X		X				
	<i>Pentas</i>	<i>lanceolata</i>	(Forssk) Deflers	1440-3000	<i>K1-4,6; T2</i>	H		Not listed		X		X					
	<i>Rothmannia</i>	<i>engleriana</i>	(K. Schum) Keay	200-1850	<i>T1,2,4-8; Moz</i>	T		Not listed		X	X		X		X	X	
	<i>Rothmannia</i>	<i>urcelliformis</i>	(Hiern) Robyns	850-2400	<i>K3/5,4-6; T1-4,6,7; Moz</i>	S/T		Not listed			X		X			X	
	<i>Rytigynia</i>	<i>decussata</i>	(K. Schum.) Robyns	75-1000	<i>K7; T3,6,8; Moz</i>	S	E	PT			X		X				
	<i>Rytigynia</i>	sp.1	-	-	-	S	-	-						X			
	<i>Rytigynia</i>	sp.2	-	-	-	S	-	-							X		
	<i>Tricalysia</i>	sp.1	-	-	-	S	-	-							X		
	<i>Tricalysia</i>	sp.2	-	-	-	S	-	-					X				
	<i>Vangueria</i>	<i>infausta</i>	Burchell	500-2500	<i>T4-7; Moz</i>	S/T		Not listed								X	
	<i>Virectaria</i>	<i>major</i>	(K. Schum.) Verdc.	1100-2350	<i>T1,4,7</i>	H		Not listed		X							
RUTACEAE	<i>Zanthoxylum</i>	<i>chalybeum</i>	Engl.	5-1550	<i>K1-5; T1-8; Som</i>	S/T		Not listed	Namavwele	X				X	X		X
SAPINDACEAE	<i>Allophylus</i>	<i>abyssinicus</i>	(Hochst.) Radlk.	650-2550	<i>K1,3-5; T2,3,6,7; Moz</i>	T/S		Not listed						X			
	<i>Allophylus</i>	<i>africanus</i>	P. Beauv	30-2400	<i>K3-6; T1-8</i>	T		Not listed		X				X			
SAPOTACEAE	<i>Mimusops</i>	<i>schliebenii</i>	Mildbr. & G.M. Schulze	150-300	<i>K7; T3,8</i>	T	E	Not listed		X							

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
SIMAROUBACEAE	<i>Harrisonia</i>	<i>abyssinica</i>	Oliv.	0-1550	<i>K1-7; T1-8,Z,P; Som; Moz</i>	T/S		Not listed		X				X			X
STERCULIACEAE	<i>Cola</i>	<i>clavata</i>	Mast.	500	<i>K5,6; T3,6,8</i>	S/T	E	DD; PT						X	X		
	<i>Cola</i>	<i>greenwayi</i>	Brenan	1000-2000	<i>K7; T3,4; Moz</i>	T		Not listed						X			
TILIACEAE	<i>Grewia</i>	<i>bicolor</i>	Juss.	650-1650	<i>T1,2,4,5,7</i>	S/T		Not listed	Mbobomweupe				X				X
	<i>Grewia</i>	<i>forbesii</i>	Mast.	0-1250	<i>K4, 6,7; T2,3,6,8,Z,P; Moz</i>	S/T	E	Not listed				X					
	<i>Grewia</i>	<i>lepidopetala</i>	Garcke	50-700	<i>T3,6-8; Moz</i>	S/T	E	Not listed	Mbobo								X
	<i>Grewia</i>	<i>mollis</i>	Juss.	700-1550	<i>K5,6; T1,2,4; Som</i>	S		Not listed	Mbobo	X		X	X		X		
	<i>Grewia</i>	<i>similis</i>	K. Schum	600-2250	<i>K1-6,7; T1-3,5-7</i>	S/T		Not listed	Mbobo		X		X	X			
	<i>Triumfetta</i>	<i>rhomboidea</i>	Jacq.	0-2750	<i>K1-7; T1-8,Z</i>	H		Not listed		X							
UMBELLIFERAE	<i>Heteromorpha</i>	<i>trifoliata</i>	(Wendl.) Eckl. & Zeyh.	455-2730	<i>K1-6; T1-8</i>	H/S/T		Not listed		X		X					
	<i>Steganotaenia</i>	<i>araliacea</i>	Hochst.	150-2200	<i>K1-7; T1-8</i>	T		Not listed									X

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
VERBENACEAE	<i>Vitex</i>	<i>doniana</i>	Sweet	0-1950	K2,3-7; T1-8,Z,P; Moz	T		Not listed									X
	<i>Vitex</i>	<i>mombassae</i>	Vatke	20-1580	K7; T1-8; Moz	S/T		Not listed		X				X	X		X
	<i>Vitex</i>	<i>mossambicensis</i>	Gürke	400-800	T8; Moz	S/T	E	PT		X				X			X
VIOLACEAE	<i>Rinorea</i>	<i>angustifolia</i>	(Thouars) Baill.	100-2200	K7; T6-8; Moz	S/T		PT						X			
	<i>Rinorea</i>	<i>elliptica</i>	(Oliv.) Kuntze	50-600	K7; T2,3,6,8; Moz	S/T	E	Not listed						X			

X = presence/absence

T1 = Kagera, Mwanza, and Mara regions, T2 = Arusha and Manyara regions, T3 = Tanga and Kilimanjaro regions, T4 = Kigoma and Rukwa regions, T5 = Dodoma and Singida regions, T6 = Dar es Salaam, Coastal and Morogoro regions, T7 = Mbeya and Iringa regions, T8 = Lindi, Mtwara and Ruvuma regions, K7 = Kenya Coastal regions (Polhill, 1988); R = Rare species: plants present in less than two out of the eight FTEA vegetation regions of Tanzania (Knox, 2000)

T = Tree, S = Shrub, B = Bamboo, C = Climber, H = Herb/Grass/Sedge

E = Endemic – plant species with limited ranges in the Swahilian regional centre of endemism *sensu lato* (based on Clarke and Robertson, 2000)

PT= Potentially Threatened plants in the EACF Hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; LR cd = Lower risk, conservation dependent; LR nt = Lower risk, near threatened; LR lc = Lower risk, least concerned; DD = Data Deficient (IUCN, 2004)

c) List of species recorded opportunistically

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
ACANTHACEAE	<i>Barleria</i>	<i>holstii</i>	Lindau	900	T6	H	E	Not listed		X				X			
	<i>Blepharis</i>	<i>ciliaris</i>	(L.) B. L. Burt.	1000-1500	T3,6,7,8; Som, Arab, Eth	H		Not listed		X				X			
	<i>Hypoestes</i>	sp.				H		Not listed									X
	<i>Ruellia</i>	sp.	-	-	-	H	-	-					X				
ANACARDIACEAE	<i>Ozoroa</i>	sp.				S		Not listed			X	X		X			X
	<i>Ozoroa</i>	<i>obovata</i>	(Oliv.)	1-330	K7; T3,6,8,Z; Moz	S/T	E	Not listed		X							
	<i>Rhus</i>	sp.				S		Not listed		X				X			
	<i>Rhus</i>	<i>natalensis</i>	Krauss	1-3000	K1-7; T1-8,Z,P; Som	S		Not listed		X		X					
	<i>Sclerocarya</i>	<i>birrea</i>	(A. Rich.) Hochst	100-1600	K1-4,6,7; T1-4,6	T		Not listed	Mng'ongo								X
	<i>Sorindeia</i>	<i>madagascariensis</i>	DC., Prodr.	1-1830	K4,7; T2,3,5-8,P,Z; Moz	T		Not listed					X				
ANNONACEAE	<i>Monanthes</i>	<i>buchananii</i>	(Engl.) Verdc.	100-1290	K5,7; T1,3,6,8; Moz	C/S/T		Not listed		X	X		X	X			
	<i>Monanthes</i>	<i>fornicata</i>	(Baill.) Verdc.	0-450	K7; T3,6; Z	S	E	Not listed			X						
	<i>Monanthes</i>	<i>trichocarpa</i>	(Engl. & Diels) Verds.	30-1000	K7; T3,6,Z; Moz	C/S		PT			X						
	<i>Uvariadendron</i>	sp.	-	-	-	S	-	-								X	

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
APOCYNACEAE	<i>Tabernaemontana</i>	sp.				T		Not listed							X		
ARALIACEAE	<i>Cussonia</i>	<i>arborea</i>	A. Rich.	300-2470	<i>K2-5; T1,2,4-8</i>	T		Not listed			X					X	
	<i>Schefflera</i>	<i>barteri</i>	Harms	900-2000	<i>T2,3,6,8</i>	S/T		Not listed							X		X
ASPARAGACEAE	<i>Asparagus</i>	<i>africanus</i>	Lam.	450-2120	<i>K1-3,5,6; T7,8</i>	H		Not listed	<i>Lukan-galang'ope</i>		X		X			X	X
ASPENIACEAE	<i>Asplenium</i>	<i>nidus</i>	L.	40-1200	<i>T3,6,Z,P</i>			Not listed								X	
ASTERACEAE	<i>Bidens</i>	<i>pilosa</i>	L.	0-60; 750-2500	<i>K1-6; T1-8,Z,P</i>	H		Not listed								X	
	<i>Dicoma</i>	sp.				H		Not listed		X							
	<i>Dicoma</i>	<i>tomentosa</i>	Cass.	100-2250	<i>K1-4,6,7; T1-3;5-7</i>	H		Not listed		X				X		X	X
	<i>Vernonia</i>	sp.	-	-	-	H/S	-	-							X		
BIGNONIACEAE	<i>Kigelia</i>	<i>africana</i>	(Lam.) Benth.	1000-2600	<i>K1-3,5-7; T4-8</i>	T		Not listed		X				X			
	<i>Markhamia</i>	<i>acuminata</i>	(Klotzsch) K. Schum.	70	<i>T3,6,7; Moz</i>	T		Not listed	Mtandav-wala				X		X		
BURSERACEAE	<i>Commiphora</i>	<i>africana</i>	(A. Rich.) Engl.	5-1780	<i>K1,3,4,6,7; T2,3,6-8,Z,P; Som ; Moz</i>	S/T		Not listed	Mng'orola				X		X	X	
	<i>Commiphora</i>	<i>ugogensis</i>	Engl.	800-1400	<i>T1,2,4,5,7</i>	T		Not listed	Mng'orola				X				X
	<i>Commiphora</i>	<i>zanzibarica</i>	(Baill.) Engl.	2-510	<i>K7; T6,8,Z; Moz</i>	T	E	PT	<i>Mng'orola</i>		X		X				

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
CAPPARIDACEAE	<i>Boscia</i>	<i>angustifolia</i>	A. Rich.	0-1850	K1,3,4,6,7; T1-5; Som	T		Not listed					X				X
	<i>Capparis</i>	<i>tomentosa</i>	Lam.	0-2500	K1-7; T1-8	S/T		Not listed								X	
CELASTRACEAE	<i>Maytenus</i>	<i>mossambicensis</i>	(Klotzsch) Blakelock	640-2900	K7; T2,3,6-8; Moz	S/T		PT							X		
	<i>Maytenus</i>	<i>undata</i>	(Thunb.) Blakelock	0-3150	K1-4,3/5,6,7; T1-4,6,Z; Som	S/T		Not listed		X				X			
CHRYSOBALANACEAE	<i>Parinari</i>	<i>curatellifolia</i>	Benth.	1700	K5; T1,4-7,Z,P; Moz	T		Not listed	Mbula			X					
COMBRETACEAE	<i>Combretum</i>	<i>hereroense</i>	Schinz		K3,4,7; T3,6,8; Moz	S		Not listed	Chinama						X	X	
	<i>Combretum</i>	<i>paniculatum</i>	Vent.	10-2000	K3-5,7; T1-8,Z; Moz	C		Not listed	Chinama							X	
COMMELINACEAE	<i>Commelina</i>	<i>benghalensis</i>	Wall.	100-2600	K1-7; T1-3,5-8	H		Not listed								X	
CUCURBITACEAE	<i>Momordica</i>	sp.	-	-	-	C/H	-	-								X	
CYPERACEAE	<i>Cyperus</i>	sp.	-	-	-	H	-	-								X	
	<i>Papyrus</i>	sp.	-	-	-	H	-	-							X		
	<i>Papyrus</i>	sp.	-	-	-	H	-	-									X
DICHAPETALACEAE	<i>Dichapetalum</i>	<i>stuhmannii</i>	Engl.	50-1600	T4,6,8; Moz	S/T		Not listed			X						
DILLENACEAE	<i>Tetracera</i>	<i>boviniana</i>	Baill.	50-350	K7; T3,6,8; Moz	S/T	E	PT	Namachili							X	
	<i>Monotes</i>	<i>africanus</i>	A. DC.	350-1800	T4-8; Moz	T		Not listed	Mnyatile							X	

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
DIPTEROCARPACEAE	<i>Monotes</i>	<i>elagans</i>	Gilg.	810-1740	<i>T1,4-6</i>	T		Not listed					X	X			
EUPHORBIACEAE	<i>Croton</i>	<i>pseudopulchellus</i>	Pax	0-1800	<i>K1,6,7; T3,6,Z; Som; Moz</i>	S/T		Not listed	Mnyao	X			X	X			
	<i>Euphorbia</i>	sp.				T		Not listed							X		
	<i>Cleistanthus</i>	<i>schlechteri</i>	(Pax) Hutch.	0-50	<i>K7; T3,6,8; Moz</i>	S	E	Not listed		X			X	X			
	<i>Margaritaria</i>	<i>discoidea</i>	(Baill.) Webster	850-1220	<i>T1</i>	S/T		Not listed		X				X			
	<i>Suregada</i>	<i>zanzibarensis</i>	Baill.	0-1600	<i>K7; T3,6,8,Z,P; Som; Moz</i>	S		Not listed			X		X				
FABACEAE (CAES)	<i>Afzelia</i>	<i>quanzensis</i>	Welw.	0-1350	<i>K7; T1-8,Z,P; Som, Moz</i>	T		Not listed	Mbambako fi	X				X	X		
	<i>Bauhinia</i>	<i>tomentosa</i>	L.	0-1520	<i>K1,3,4,7; T2,3,6,8</i>	T		Not listed	Mnyekechi							X	
	<i>Cassia</i>	<i>abbreviata</i>	Oliv.	220-1520	<i>T1,4,5,7,8; Moz</i>	T		PT	Mjohoro			X				X	X
	<i>Cassia</i>	<i>didymobotrya</i>	Fresen.	900-2440	<i>K3-7; T1-8; Moz</i>	S		Not listed	Mjohoro				X				
	<i>Cassia</i>	<i>singueana</i>	Delile	0-2130	<i>K1,3-5,7; T1-8</i>	T		Not listed	Mjohoro						X		
	<i>Julbernardia</i>	<i>globiflora</i>	(Benth.) Troupin	490-1830	<i>T1,3-8; Moz</i>	T		Not listed	Mchinji				X				
	<i>Scorodophloeus</i>	<i>fischeri</i>	(Taub.) J. Léon	200-1350	<i>T4-8; Moz</i>	T	E	PT					X			X	X

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Swartzia</i>	<i>madagascariensis</i>	Desv.	450-1260	<i>T1,4-8; Moz</i>	S		Not listed	Msekeseke	X				X	X		
FABACEAE (MIM)	<i>Acacia</i>	<i>brevispica</i>	Harms	170-1830	<i>K1-7; T1-6; Som; Moz</i>	T		Not listed								X	
	<i>Acacia</i>	<i>nilotica</i>	(L.) Willd. ex Delile		<i>T4,6,8; Moz</i>	T		PT							X		
	<i>Albizia</i>	<i>gummifera</i>	(J.F. Gmel.) C.A. Sm.	0-2440	<i>K3-7; T2-8,Z</i>	T		Not listed	Mtangadume						X		
	<i>Dichrostachys</i>	<i>cinerea</i>	(L.) Wight & Arn.	300-1625	<i>K4; T1,4-8</i>	S		Not listed							X		
FABACEAE (PAP)	<i>Baphia</i>	<i>punctulata</i>	Harms	250	<i>T8; Moz</i>	T		PT		X							
	<i>Craibia</i>	<i>brevicaudata</i>	(Vatke) Dunn	1500	<i>T4,7,8</i>	T		PT							X		
	<i>Crotalaria</i>	<i>retusa</i>	L.	0-150	<i>K7; T3,6,8,Z; Som, Moz</i>	S		Not listed		X				X			
	<i>Dalbergia</i>	<i>armata</i>	E. Mey.	240-660	<i>T8; Moz</i>	S		Not listed					X				
	<i>Dalbergia</i>	<i>melanoxylon</i>	Guill. & Perr.	0-1350	<i>K4-7; T1-6,8</i>	S		LR/nt	Mpingo						X		
	<i>Dalbergia</i>	<i>obovata</i>	E. Mey.	0-1050	<i>T3,5,6; Moz</i>	T		Not listed	Mpingokamba	X	X			X	X		
	<i>Erythrina</i>	<i>abyssinica</i>	DC.	200-2100	<i>K3-7; T1-8; Moz</i>	T		Not listed		X	X		X	X	X		
	<i>Erythrina</i>	<i>schliebenii</i>	Harms	240	<i>T8</i>	T	E	PT		X	X		X	X	X		
	<i>Lonchocarpus</i>	<i>capassa</i>	Rolfe	150-1650	<i>T1,4-8</i>	T		Not listed	Mlungulungu				X		X		
	<i>Pericopsis</i>	<i>angolensis</i>	(Baker) Meeuwen	900-1650	<i>T1,4-8; Moz</i>	T		Not listed	Muwanga				X				

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Pterocarpus</i>	<i>rotundifolius</i>	(Sond.) Druce	300-900	T6,8; Moz	T		Not listed	Mtumbatim aji	X		X		X			
	<i>Xeroderris</i>	<i>stuhmannii</i>	(Taub.) Mendonça & E.C.Sousa	100-1650	K7; T1-8	T		Not listed					X		X		
FLACOURTIACEAE	<i>Dovyalis</i>	<i>zenkeri</i>	Gilg	1500-1675	Not in LEAP	S		Not listed		X				X			
	<i>Flacourtia</i>	<i>indica</i>	(Burm. f.) Merr	0-2400	K2-5,7; T1-8,Z	S		Not listed	Mkung'u	X		X		X	X		
	<i>Oncoba</i>	<i>spinosa</i>	Forssk.	1800	K1-5,7; T1,2,4-7,Z	S		Not listed	Mdudung'orora						X		
ICACINACEAE	<i>Apodytes</i>	<i>dimidiata</i>	Arn.	1000-2500	K3-5; T1,2,4-8	S/T		Not listed					X				
LAMIACEAE	<i>Plectranthus</i>	sp.	-	-		H	-	-									X
LECYTHIDACEAE	<i>Barringtonia</i>	<i>racemosa</i>	(L.) Spreng.	0-450	K7; T3,6,8,Z,P; Som; Moz	T		Not listed									X
LOGANIACEAE	<i>Nuxia</i>	<i>congesta</i>	Fresen.	1800-2700	K1,3,4,6; T2-4,6,7	T		Not listed					X				
	<i>Strychnos</i>	<i>cocculoides</i>	Baker	400-2000	T1,4-8	S		Not listed		X	X		X	X	X		
	<i>Strychnos</i>	<i>madagascariensis</i>	Poir.	900-1500	T4-6,9; Moz	S		Not listed	Mkulung'uru								X
	<i>Strychnos</i>	sp.				S		Not listed	Mkulung'uru		X	X			X	X	
	<i>Strychnos</i>	<i>spinosa</i>	Lam.	400-2200	K2,4; T1,3-8	S		Not listed				X	X				
	<i>Strychnos</i>	<i>usambarensis</i>	Gilg	75-2000	K4,6; T3,5; Moz	T		Not listed		X				X	X		

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
MALVACEAE	<i>Hibiscus</i>	sp.	-	-	-	H	-	-					X		X		
	<i>Hibiscus</i>	<i>surattensis</i>	L.	0-1450	K3,7; T1,3,4,6,8; Moz	H		Not listed								X	
MELASTOMATACEAE	<i>Memecylon</i>	sp.1	-	-	-	S	-	-							X		
	<i>Memecylon</i>	sp.2	-	-	-	S	-	-							X		
MELIACEAE	<i>Khaya</i>	<i>anthotheca</i>	(Welw.)	120-1525	T3-8; Moz	T		VU A1cd								X	
	<i>Turraea</i>	<i>floribunda</i>	Hochst.	100-2150	K3,5-7; T2,3,6-8; Moz	S/T		Not listed		X		X					
MORACEAE	<i>Antiaris</i>	<i>toxicaria</i> (sub?)	Lschen.			S		Not listed								X	
	<i>Ficus</i>	<i>natalensis</i>	Hochst.	10-2200	K1,4-7; T1-3,5-8,Z,P	S/T		Not listed	Mkuyudume	X				X	X		X
	<i>Ficus</i>	<i>sur</i>	Forssk.	0-2300	K1,3-7; T1-8,Z,P	T		Not listed	Mkuyu								
	<i>Trilepsium</i>	<i>madagascariense</i>	DC.	1800	K3-5,7; T1-3,6-8,Z	T		Not listed					X				
OCHNACEAE	<i>Ochna</i>	<i>holstii</i>	Engl.	900-2350	K1,3-7; T2-8; Moz	S/T		Not listed	Mnyale						X		
ONAGRACEAE	<i>Jussiaea</i>	<i>repens</i>	L.	10-1830	K3,4,7; T1-8,P	H		Not listed		X				X			
PALMAE	<i>Hyphaene</i>	<i>compressa</i>	H. Wendl.	0-1400	K1,2,4,7; T2,3,6,8; Som; Moz	T		Not listed									X
POACEAE	<i>Cenchrus</i>	sp.														X	

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Heteropogon</i>	<i>contortus</i>	(L.) Roem. & Schult.	0-2100	<i>K1-7; T1-8,Z,P</i>	H		Not listed									X
	<i>Olyra</i>	<i>latifolia</i>	L.	300-1300	<i>K4,7; T1,3,4,6,7,Z,P</i>	S		Not listed									X
	<i>Panicum</i>	<i>trichocladum</i>	K. Schum	0-2300	<i>K1,4-7; T1-4,6-8,Z,P; Moz</i>	H		Not listed									X
	<i>Phragmites</i>	<i>mauritanus</i>	Kunth	0-1500	<i>K4-7; T1-7,Z</i>	H		Not listed									X
	<i>Themeda</i>	<i>triandra</i>	Forsk.	3200	<i>K1,3-7; T1-8,Z</i>	H		Not listed									X
POLYGALACEAE	<i>Securidaca</i>	<i>longipedunculata</i>	Fresen.	1500-2000	<i>K3,4,6; T4,5,7,8; Moz</i>	T		Not listed	Chiguruka	X				X			X
ROSACEAE	<i>Hagenia</i>	<i>abyssinica</i>	(Bruce) J.F. Gmel.	2400-3600	<i>K3-5; T2,3,7</i>	T		Not listed								X	
RUBIACEAE	<i>Catunaregam</i>	<i>spinosa</i>	(Thunb) Tirvengadam	70-290	<i>K7; T6,7; Moz</i>	S/T		Not listed			X					X	
	<i>Crossopteryx</i>	<i>febrifuga</i>	(G.Don) Benth	0-1350	<i>K7; T1-8</i>	S/T		Not listed	Mchengele						X		
	<i>Lamprothamnus</i>	<i>zanguebaricus</i>	Hiern	0-300	<i>K1,7; T3,6,8; Som</i>	S/T	E	PT			X						
	<i>Lasianthus</i>	<i>kilimandscharicus</i>	K. Schum.	1710-2400	<i>K1,3-5,7; T2,3,5-7; Moz</i>	S/T		PT							X	X	
	<i>Lasianthus</i>	sp.	-	-	-	S	-	-							X		
	<i>Leptactina</i>	sp.				S		Not listed			X						
	<i>Leptactina</i>	<i>platyphylla</i>	(Hiern) Wernham	45-1650	<i>K5,7; T3,4,6,7</i>	S		Not listed								X	

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Pentas</i>	<i>bussei</i>	K. Krause	0-1800	<i>K2,4,7; T1-8,Z; Som</i>	H/S		Not listed		X				X			
	<i>Pentas</i>	<i>longiflora</i>	Oliv.	1050-2450	<i>K2-6,7; T2-4,7</i>	H		Not listed		X				X			
	<i>Psychotria</i>	sp.1	-	-	-	S	-	-					X				
	<i>Psychotria</i>	sp.2	-	-	-	S	-	-							X		
	<i>Psychotria</i>	sp.3	-	-	-	S	-	-							X		
	<i>Rytigynia</i>	sp.1	-	-	-	S	-	-								X	
	<i>Rytigynia</i>	sp.2	-	-	-	S	-	-					X				
	<i>Tricalysia</i>	sp.	-	-	-	S	-	-					X				
	<i>Vangueria</i>	<i>infausta</i>	Burchell	500-2500	<i>T4-7; Moz</i>	S/T		Not listed		X		X					
RUTACEAE	<i>Vepris</i>	<i>lanceolata</i>	(Lam.) G.Don	0-30	<i>K7; T3,6; Moz</i>	S		Not listed					X				X
SAPINDACEAE	<i>Allophylus</i>	<i>abyssinicus</i>	(Hochst.) Radlk.	650-2550	<i>K1,3-5; T2,3,6,7; Moz</i>	T/S		Not listed		X			X	X	X		
	<i>Paullinia</i>	<i>pinnata</i>	L.	0-1600	<i>K3-7; T1-4,6-8,Z,P</i>	S		Not listed					X				
SAPOTACEAE	<i>Mimusops</i>	<i>schliebenii</i>	Mildbr. & G.M. Schulze	150-300	<i>K7; T3,8</i>	T	E	Not listed		X		X					
SIMAROUBACEAE	<i>Harrisonia</i>	<i>abyssinica</i>	Oliv.	0-1550	<i>K1-7; T1-8,Z,P; Som; Moz</i>	T/S		Not listed								X	
STERCULIACEAE	<i>Cola</i>	<i>greenwayi</i>	Brenan	1000-2000	<i>K7; T3,4; Moz</i>	T		Not listed	Mkolong'ombe								X

Family	Genus	species	Author	Altitudinal range (m)	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Dombeya</i>	<i>kirkii</i>	Mast.	1500	K1-5,7; T2,3	T		Not listed				X	X		X	X	
	<i>Sterculia</i>	<i>appendiculata</i>	K. Schum ex Engl.	450	K7; T7,8,Z	T	E	Not listed	Mparatanyani							X	
TILIACEAE	<i>Grewia</i>	<i>bicolor</i>	Juss.	650-1650	T1,2,4,5,7;	S/T		Not listed	Mbobomweupe							X	
	<i>Grewia</i>	<i>lepidopetala</i>	Garcke	50-700	T3,6-8; Moz	S/T	E	Not listed	Mbobob	X		X		X	X	X	X
	<i>Grewia</i>	<i>mollis</i>	Juss.	780-2700	T1,2,4 Zai,Bur,Rwa	S		Not listed	Mbobob							X	
	<i>Grewia</i>	<i>similis</i>	K. Schum	600-2250	K1-6,7; T1-3,5-7	S/T		Not listed	Mbobob							X	
VERBENACEAE	<i>Vitex</i>	<i>mombassae</i>	Vatke	20-1580	T1,2,3,4,5,6,7,8; Zai,Bur,Moz, Zim, Ang	S		Not listed			X		X		X		
	<i>Vitex</i>	<i>zanzibarensis</i>	Vatke	0-10 & 360-600	K7; T3,6,8; Moz	S	E	VU B1+2c			X	X	X				
ZINGIBERACEAE	<i>Aframomum</i>	<i>orientale</i>	Lock	100-400	K7; T6; not known elsewhere	H	E	PT								X	

X = presence/absence

T1 = Kagera, Mwanza, and Mara regions, T2 = Arusha and Manyara regions, T3 = Tanga and Kilimanjaro regions, T4 = Kigoma and Rukwa regions, T5 = Dodoma and Singida regions, T6 = Dar es Salaam, Coastal and Morogoro regions, T7 = Mbeya and Iringa regions, T8 = Lindi, Mtwara and Ruvuma regions, K7 = Kenya Coastal regions (Polhill, 1988); R = Rare species: plants present in less than two out of the eight FTEA vegetation regions of Tanzania (Knox, 2000)

T = Tree, S = Shrub, B = Bamboo, C = Climber, H = Herb/Grass/Sedge

E = Endemic – plant species with limited ranges in the Swahilian regional centre of endemism *sensu lato* (based on Clarke and Robertson, 2000); PT= Potentially Threatened plants in the EACF Hotspot of Kenya and Tanzania (Gereau and Luke, 2006); CR = Critically Endangered; EN = Endangered; VU = Vulnerable; LR cd = Lower risk, conservation dependent; LR nt = Lower risk, near threatened; LR lc = Lower risk, least concerned; DD = Data Deficient (IUCN, 2004)

APPENDIX 10 - LIST OF ENDEMIC & THREATENED PLANT SPECIES FOUND IN THE SWAHILIAN REGIONAL CENTRE OF ENDEMISM *SENSU LATU* FOR ALL FOREST RESERVES

Family	Genus	species	Author	Altitudinal range	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
ACANTHACEAE	<i>Barleria</i>	<i>holstii</i>	Lindau	900	T6	H	E	Not listed		X				X			
ANACARDIACEAE	<i>Ozoroa</i>	<i>obovata</i>	(Oliv.)	1-330	K7; T3,6,8,Z; Moz	S/T	E	Not listed			X						
ANNONACEAE	<i>Monodora</i>	<i>grandidieri</i>	Baill.	0-900	K7; T3,6, Z; Som; Moz	S/T	E	Not listed				X		X			
ARALIACEAE	<i>Cussonia</i>	<i>zimmermannii</i>	Harms	0-400	K7; T3,6,8; Moz	T	E	PT								X	X
BOMBACACEAE	<i>Bombax</i>	<i>rhodognaphalon</i>	K. Schum.	20-700	K7; T3,6,8,P; Moz	T	E	PT	Msufipori					X		X	
BURSERACEAE	<i>Commiphora</i>	<i>zanzibarica</i>	(Baill.) Engl.	2-510	K7; T6,8,Z; Moz	T	E	PT	Mng'orola		X		X				X
CELASTRACEAE	<i>Maytenus</i>	<i>mossambicensis</i>	(Klotzsch) Blakelock	640-2900	K7; T2,3,6-8; Moz	S/T		PT							X		
DILLENIACEAE	<i>Tetracera</i>	<i>boiviniana</i>	Baill.	50-350	K7; T3,6,8; Moz	S/T	E	PT	Namachili	X		X		X	X	X	X
EUPHORBIACEAE	<i>Cleistanthus</i>	<i>schlechteri</i>	(Pax) Hutch.	0-50	K7 ; T3,6,8; Moz	S	E	Not listed		X			X	X	X		
	<i>Drypetes</i>	<i>natalensis</i>	(Harv.) Hutch	125-1500	K4; T2-6,8; Moz	S/T		PT	Mnyumbu	X	X		X	X		X	
FABACEAE (CAES)	<i>Cassia</i>	<i>abbreviata</i>	Oliv.	220-1520	T1,4,5,7,8; Moz	T		PT	Mjohoro			X			X	X	X
	<i>Cynometra</i>	<i>gillmanii</i>	J. Léon		T8	T	E	CR B1+2a bcde,c 2b					X				

Family	Genus	species	Author	Altitudinal range	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	<i>Scorodophloeus</i>	<i>fischeri</i>	(Taub.) J. Léon	200-1350	T4-8; Moz	T	E	PT					X			X	X
FABACEAE (MIM)	<i>Acacia</i>	<i>nilotica</i>	(L.) Willd. ex Delile		T4,6,8; Moz	T		PT							X		
	<i>Entada</i>	<i>stuhmannii</i>	(Taub.) Harms	15-1600	T6,8; Moz	C	E	PT									X
FABACEAE (PAP)	<i>Baphia</i>	<i>punctulata</i>	Harms	250	T8; Moz	T		PT		X							
	<i>Cleistanthus</i>	<i>schlechteri</i>	(Pax) Hutch.	0-50	K7; T3,6,8; Moz	S	E	Not listed		X			X	X			
	<i>Craibia</i>	<i>brevicaudata</i>	(Vatke) Dunn	1500	T4,7,8	T		PT		X		X		X	X		
	<i>Erythrina</i>	<i>schliebenii</i>	Harms	240	T8	T	E	PT		X	X		X	X	X		
	<i>Millettia</i>	<i>impressa</i>	Harms	10-200	T6,8; Moz	C		PT	Mpangapan ga		X	X	X				
FLACOURTIACEAE	<i>Xylothea</i>	<i>tettensis</i>	(Klotzsch) Gilg	200-600	T6-8; Moz	S	E	PT					X		X	X	
MYRTACEAE	<i>Syzygium</i>	<i>cordatum</i>	Krauss.	900-2400	K3-5; T1,4,6-8;	T/S		PT	Mzambarau	X							
RUBIACEAE	<i>Gardenia</i>	<i>transvenulosa</i>	Verdc.	10-700m	K7; T3,6,8 not elsewhere	S/T	E	VUb1 +2b				X					X
	<i>Lamprothamnus</i>	<i>zanguebaricus</i>	Hiern	0-300	K1,7; T3,6,8; Som	S/T	E	PT			X	X	X				
	<i>Lasianthus</i>	<i>kilimandscharicus</i>	K. Schum.	1710-2400	K1,3-5,7; T2,3,5-7; Moz	S/T		PT							X	X	
	<i>Rytigynia</i>	<i>decussata</i>	(K. Schum.) Robyns	75-1000	K7; T3,6,8; Moz	S	E	PT		X	X		X	X	X		
SAPOTACEAE	<i>Mimusops</i>	<i>schliebenii</i>	Mildbr. & G.M. Schulze	150-300	K7; T3,8	T	E	Not listed		X	X		X				

Family	Genus	species	Author	Altitudinal range	Dist. (FTEA) within the Swahilian region	Habit	Endemic Status	Conservation Status	Local names used in the Mtwara Region	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
STERCULIACEAE	<i>Cola</i>	<i>clavata</i>	Mast.	500	K5,6; T3,6,8	S/T	E	DD; PT						X	X		
	<i>Sterculia</i>	<i>appendiculata</i>	K. Schum ex Engl.	450	K7; T7,8,Z	T	E	Not listed	Mparatanyani		X		X			X	X
TILIACEAE	<i>Grewia</i>	<i>forbesii</i>	Mast.	0-1250	K4, 6,7; T2,3,6,8,Z,P; Moz	S/T	E	Not listed					X				
	<i>Grewia</i>	<i>lepidopetala</i>	Garcke	50-700	T3,6-8; Moz	S/T	E	Not listed	Mbobo	X		X		X	X	X	X
VERBENACEAE	<i>Vitex</i>	<i>mossambicensis</i>	Gürke	400-800	T8; Moz	S/T	E	PT			X			X			X
	<i>Vitex</i>	<i>zanzibarensis</i>	Vatke	0-10 & 360-600	K7; T3,6,8; Moz	S	E	VU B1+2c			X	X	X				
VIOLACEAE	<i>Rinorea</i>	<i>angustifolia</i>	(Thouars) Baill.	100-2200	K7; T6-8; Moz	S/T		PT						X			
	<i>Rinorea</i>	<i>elliptica</i>	(Oliv.) Kuntze	50-600	K7; T2,3,6,8; Moz	S/T	E	Not listed						X			
ZINGIBERACEAE	<i>Aframomum</i>	<i>orientale</i>	Lock	100-400	K7; T6; not known elsewhere	H	E	PT								X	

X = presence/absence

T1 = Kagera, Mwanza, and Mara regions, T2 = Arusha and Manyara regions, T3 = Tanga and Kilimanjaro regions, T4 = Kigoma and Rukwa regions, T5 = Dodoma and Singida regions, T6 = Dar es Salaam, Coastal and Morogoro regions, T7 = Mbeya and Iringa regions, T8 = Lindi, Mtwara and Ruvuma regions, K7 = Kenya Coastal regions (Polhill, 1988); R = Rare species: plants present in less than two out of the eight FTEA vegetation regions of Tanzania (Knox, 2000)

T = Tree, S = Shrub, B = Bamboo, C = Climber, H = Herb/Grass/Sedge

E = Endemic – plant species with limited ranges in the Swahilian regional centre of endemism *sensu lato* (based on Clarke and Robertson, 2000)

PT= Potentially Threatened plants in the EACF Hotspot of Kenya and Tanzania (Gereau and Luke, 2006)

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; LR cd = Lower risk, conservation dependent; LR nt = Lower risk, near threatened; LR lc = Lower risk, least concerned;

DD = Data Deficient (IUCN, 2004)

APPENDIX 11 - MEDICINAL PLANT SPECIES, THEIR GROWTH HABIT, THE AILMENTS THEY ARE USED TO CURE, THE PART OF THE PLANT THAT IS UTILISED AND THE STUDY AREA IN WHICH THEY WERE FOUND TO BE USED

Family	Species name	Habit	Ailments and part of the plant used	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
ALOACEAE	<i>Aloe macrosiphon</i>	H	Stomach, diarrhoea (sap from leaves)								X
ALOACEAE	<i>Aloe secundiflora</i>	H	Stomach, & chicken diseases (leaves)								X
ANACARDIACEAE	<i>Sclerocarya birrea</i>	T	Anti inflammatory (roots)	X	X	X	X		X		X
ANNONACEAE	<i>Annona senegalensis</i>	S/T	Stomach, (bark, roots)	X	X	X	X				
ARALIACEAE	<i>Cussonia arborea</i>	T	Urinary infection, headache (roots, leaves)				X				
ARALIACEAE	<i>Cussonia zimmermannii</i>	T	Urinary infection, headache (roots, leaves)	X	X						
DILLENACEAE	<i>Tetracera boiviniana</i>	S	Stomach, headache (roots)	X	X	X	X	X	X		X
EBENACEAE	<i>Diospyros kirkii</i>	T	Fever, headache (roots)	X	X	X	X	X			
FABACEAE (CAES)	<i>Azelia quanzensis</i>	S/T	Coughing, stomach headache (root, bark)	X	X	X	X	X	X		X
FABACEAE (CAES)	<i>Bauhinia petersiana</i>	T	Coughing, stomach, (leaves & seedpods)	X	X	X	X				
FABACEAE (CAES)	<i>Bauhinia tomentosa</i>	T	Stomach, headache (leaves, bark, pods)	X	X	X	X				
FABACEAE (CAES)	<i>Brachystegia spiciformis</i>	T	Stomach (roots and bark)								X
FABACEAE (CAES)	<i>Cassia abbreviata</i>	S	Urinary infection, headache (roots, leaves)			X	X	X			
FABACEAE (CAES)	<i>Cassia petersiana</i>	T	Stomach, Fever (root, bark)						X		
FABACEAE (CAES)	<i>Cassia singueana</i>	T	Urinary infection, headache (roots, leaves)				X				X
FABACEAE (MIM)	<i>Acacia brevispica</i>	T	Stomach, headache (bark, roots)			X	X				
FABACEAE (MIM)	<i>Acacia nigrescens</i>	T	Fever, diarrhoea, stomach (roots, bark)	X	X	X					X
FABACEAE (MIM)	<i>Acacia xanthophloea</i>	T	Fever, urinary infection (roots, bark)								X
FABACEAE (PAP)	<i>Dalbergia melanoxylon</i>	T	Fever (roots)								X
FABACEAE (PAP)	<i>Lonchocarpus bussei</i>	T	Stomach, headache (roots and leaves)	X	X	X	X		X		
FABACEAE (PAP)	<i>Lonchocarpus capassa</i>	T	Stomach, headache (roots & bark)	X	X	X	X	X			X
FABACEAE (PAP)	<i>Millettia stuhlmannii</i>	C	?	X							

Family	Species name	Habit	Ailments and part of the plant used	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
FABACEAE (PAP)	<i>Pterocarpus angolensis</i>	T	Teeth, ringworm (sap from the bark)	X	X	X	X		X		X
FLACOURTIACEAE	<i>Flacourtia indica</i>	T	Stomach, fever (leaves, roots)	X	X	X	X		X		
HYMENOCARDIACEAE	<i>Hymenocardia ulmoides</i>	T	Stomach (roots and bark)					X	X		X
LOGANIACEAE	<i>Strychnos cocculoides</i>	T	Stomach, diarrhoea (roots, leaves)	X	X	X	X	X	X		
LOGANIACEAE	<i>Strychnos madagascariensis</i>	S	Eyes problems, fever (leaves and roots)	X	X	X	X				
MORACEAE	<i>Milicia excelsa</i>	T	Stomach, headache (bark, roots)	X	X				X		X
OCHNACEAE	<i>Ochna holstii</i>	S	Stomach (roots and bark)	X	X	X	X				
POLYGALACEAE	<i>Securidaca longipedunculata</i>	T	Stomach, headache (roots)		X	X		X			
RUBIACEAE	<i>Crossopteryx febrifuga</i>	S/T	?				X				
RUBIACEAE	<i>Vangueria infausta</i>	S	Stomach (roots and bark)	X	X	X	X				
RUTACEAE	<i>Zanthoxylum chalybeum</i>	T	Urinary infection, stomach, headache (roots)	X	X	X	X	X	X		X
SAPOTACEAE	<i>Bequaertiodendron natalense</i>	T	Stomach, diarrhoea (roots)	X	X	X	X	X	X		
VERBENACEAE	<i>Vitex doniana</i>	T	Stomach (roots)						X		X

T = Tree, S = Shrub, B = Bamboo, C = Climber, H = Herb/Grass/Sedge

APPENDIX 12 - LIST OF FAUNAL SPECIES REPORTED TO BE HUNTED IN THE FOREST RESERVES

Order	Family	Genus	species	Ecol. Type	End. Status	Conserv. Status (IUCN + CITES)	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
GALLIFORMES	NUMIDIDAE – Guineafowl	<i>Guttera</i>	<i>pucherani</i>	F	W	LC	X	X						
PASSERIFORMES	PLOCEIDAE – Weavers	<i>Quelea</i>	<i>erythrops</i>	O	W	LC; CITES III GH								X
STRIGIFORMES	TYTONIDAE – Barn owls	<i>Tyto</i>	<i>alba</i>	O	W	LC; CITES II	X	X						
PRIMATES – Primates	GALAGONIDAE – Bushbabies or galagos	<i>Otolemur</i>	<i>garnetti</i>	f	CF and a few other habitats in coastal E Africa	LR/lc; CITES II	X	X						
INSECTIVORA – Insectivores	SORICIDAE – Shrews	<i>Crocidura</i>	sp.	O	-	-	X	X						
MACROSCELIDEA – Elephant-shrews or Sengi	MACROSCELIDIDAE Rhynchocyoninae	<i>Rhynchocyon</i>	<i>cirnei</i>	f	W	VU B1+2c	X	X						
RODENTIA – Rodents	SCIURIDAE – Squirrels	<i>Paraxerus</i>	<i>flavovittis</i>	O	W	DD	X	X						
	THRYONOMYIDAE – Cane-rats	<i>Thryonomys</i>	<i>swinderianus</i>	O	W	LC			X			X		
CARNIVORA – Carnivores	VIVERRIDAE – Genets & Civets	<i>Civettictis</i>	<i>civetta</i>	f	W	LR/lc	X	X						
		<i>Genetta</i>	<i>genetta</i>	O	W	LR/lc	X	X						
HYRACOIDEA – Hyraxes	PROCAVIDAE	<i>Dendrohyrax</i>	sp.	-	-	-								X
ARTIODACTYLA – Even-toed ungulates	SUIDAE – Pigs	<i>Potamochoerus</i>	<i>larvatus</i>	f	W	LR/lc	X	X		X				X

Order	Family	Genus	species	Ecol. Type	End. Status	Conserv. Status (IUCN + CITES)	Kambona	Makonde I	Makonde II	Mkunya	Mtimiko	Mtuli Hinju	Makonde III	Ndechela
	BOVIDAE Antilopinae – Antilopes, Goats & sheep	<i>Cephalophus</i>	<i>monticola</i>	F	W	LR/lc; CITES II	X	X						
		<i>Cephalophus</i>	<i>natalensis</i>	F	W	LR/cd	X	X						
		<i>Hippotragus</i>	<i>niger</i>	O	W	LR/cd								X
TESTUDINES - Chelonians	TESTUDINIDAE – Land tortoises	<i>Geochelone</i>	<i>pardalis</i>	O	W	CITES II	X	X						
SAURIA - Lizards	VARANIDAE – Plated Lizards	<i>Varanus</i>	<i>albigularis</i>	O	W	CITES II	X	X						
	LACERTIDAE – Lacertid lizards or Typical lizards	<i>Latastia</i>	sp.	-	-	-	X	X						
SERPENTES - Snakes	BOIDAE – Boas & pythons	<i>Python</i>	<i>natalensis</i>	O	W	CITES II	X	X						

X = reported to be hunted

F = Forest dependent or specialist; f = Forest dwelling or generalist; O = Non-forest or forest visitor (Iverson, 1991b; Mlingwa *et al.*, 2000)

CF = species with limited ranges in the Coastal Forests alone; EACF = species with limited ranges in the Coastal Forests and Eastern Arc Mountains (Burgess *et al.*, 2000a); SE Tanzania = species with limited ranges in SE Tanzania; SE Africa = species with limited ranges in SE Africa; E Africa = species with limited ranges in E Africa

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; LR cd = Lower risk, conservation dependent; LR nt = Lower risk, near threatened; LR lc = Lower risk, least concerned (IUCN, 2004)

CITES I = Threatened with extinction and excluded from international trade; CITES II = Not yet threatened with extinction, but may be so if trade is not regulated, thus export permits are required (CITES, 2005)

APPENDIX 13 - MAMMAL SPECIES LIST FOR ALL FOREST RESERVES. TAXONOMY BASED ON KINGDON (2003)

Order	Family	Genus	species	Ecol. Type	End. Status	Cons. Status (IUCN + CITES)	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndehela	
PRIMATES	CERCOPITHECIDAE Papioninae – Baboons	<i>Papio</i>	<i>cynocephalus</i>	O	W	LR/lc	*			s				s	
	Cercopithecinae – Guenons & allies	<i>Cercopithecus</i>	<i>mitis</i> (sub sp.)	F	W	LR/lc; CITES II				s	s		s	s	
		<i>Cercopithecus</i>	<i>pygerythrus rufovidris</i>	f	W	Not listed	*	*	s	s	s		s	s	
	GALAGONIDAE – Bushbabies	<i>Otolemur</i>	<i>crassicaudatus</i>	f	W	LR/lc; CITES II		*	0	s				0	0
		<i>Otolemur</i>	<i>garnetti</i>	f	CF and a few other habitats in coastal E Africa	LR/lc; CITES II	0	0							
		<i>Galago</i>	<i>moholi</i>	f	Central S Africa (first record for the Coastal Forests of Tanzania)	LR/lc; CITES II		0			0	0			
CHIROPTERA	PTEROPODIDAE – Fruit bats	<i>Epomophorus</i>	<i>wahlbergi</i>	f	W	Not listed				X					
	NYCTERIDAE – Slit-faced bats	<i>Nycteris</i>	<i>grandis</i>	O	W	LC		X							
	RHINOLOPHIDAE Rhinolophinae – Horseshoe bats	<i>Rhinolophus</i>	<i>hildebrandti</i>	O	W	LC								X	
	VESPERTILIONIDAE – Vesper bats	<i>Scotoecus</i>	<i>hirundo</i>	O	W	DD				X					
		<i>Nycteris</i>	<i>hispidia</i>	O	W	LC									X

Order	Family	Genus	species	Ecol. Type	End. Status	Cons. Status (IUCN + CITES)	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
INSECTIVORA	SORICIDAE – Shrews	<i>Crocidura</i>	sp.1	-	-	-	X			X			X	X
		<i>Crocidura</i>	sp.2	-	-	-	X	X	X	X			X	0
MACROSCELIDEA	MACROSCELIDIDAE Rhynchocyoninae – Elephant-shrews or Sengi	<i>Rhynchocyon</i>	<i>cirnei</i>	f	W	VU B1+2c	s	*		s	s	s		s
LAGOMORPHA	LEPORIDAE – Hares	<i>Lepus</i>	<i>saxatilis</i>	O	W	LR/lc	0	*	0	s		0	0	0
		<i>Pronolagus</i>	<i>rupestris</i>	O	W	LR/lc								
RODENTIA	SCIURIDAE – Squirrels	<i>Heliosciurus</i>	<i>mutabilis</i>	f	W	LC		*		s		s		
		<i>Paraxerus</i>	<i>flavovittis</i>	O	W	DD			s			s		
		<i>Paraxerus</i>	<i>palliatus</i>	F	W	LC	s	*		s	s			
	HYSTRICIDAE – Porcupines	<i>Hystrix</i>	<i>cristata</i>	O	W	LC; CITES III GH	*	*	0	0				0
	MUROIDEA Gerbillinae – Gerbils	<i>Tatera</i>	<i>robusta</i>	f	O	LC; Not listed								X
	Cricetomyinae – Pouched rats & mice	<i>Beamys</i>	<i>hindei</i>	f	EACF and a few other forest types in Kenya and Tanzania	NT	X	X		X	X		X	
	MURIDAE – Murid rats & Mice	<i>Acomys</i>	<i>spinosissimus</i>	O	W	LC			X	X		X	X	X
		<i>Grammomys</i>	<i>dolichurus</i>	f	W	LC	X			X				X
		<i>Mastomys</i>	<i>natalensis</i>	O	W	LC	X	X	X	X		X	X	X
		<i>Mus</i>	<i>minutoides</i>	O	W	LC	X							
<i>Mus</i>		sp.	-	-	-			X						
<i>Praomys</i>		sp.	-	-	-				X					
THRIONOMYIDAE – Cane-rats	<i>Rattus</i>	<i>alexandrinus</i>	O	W	Not listed								X	
	<i>Thryonomys</i>	<i>swinderianus</i>	O	W	LC			0		*	0			

Order	Family	Genus	species	Ecolog. Type	End. Status	Cons. Status (IUCN + CITES)	Kambara	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	
CARNIVORA	CANIDAE – Wild dogs, Foxes & Jackals	<i>Canis</i>	<i>adustus</i>	O	W	LC	*	*	*	*					
	MUSTELIDAE Lutrinae – Otters	<i>Aonyx</i>	<i>capensis</i>	O	W	LC; CITES II		0						0	
	HERPESTIDAE – Mongoose	<i>Atelax</i>	<i>paludinosus</i>	O	W	LR/lc				0				0	0
		<i>Helogale</i>	<i>parvula</i>	O	W	LR/lc			0						
		<i>Herpestes</i>	<i>sanguinea</i>	O	W	Not listed									0
		<i>Mungos</i>	<i>mungo</i>	O	W	LR/lc									s
	HYAENIDAE – Hyenas	<i>Crocuta</i>	<i>crocuta</i>	O	W	LR/cd	*	*	0	0				0	0
	VIVERRIDAE – Genets & Civets	<i>Civettictis</i>	<i>civetta</i>	f	W	LR/lc; CITES III BW	*	*	0	0				0	0
		<i>Genetta</i>	<i>genetta</i>	O	W	LR/lc	*	*		0					
	FELIDAE – Cats	<i>Felis</i>	<i>caracal</i>	O	W	CITES II				0					
<i>Panthera</i>		<i>leo</i>	O	W	VU A2 abcd CITES II	*	*	*	*	*	*			0	
<i>Panthera</i>		<i>pardus</i> ssp. <i>panthera</i>	O	W	LC; CITES I	*	*	0	*					0	
PHOLIDOTA	MANIDAE – Pangolins	<i>Smutsia</i>	<i>temminckii</i>	O	W	Not listed		*						*	
TUBULIDENTATA	ORYCTEROPODIDAE – Aardvark	<i>Orycteropus</i>	<i>afer</i>	O	W	LC								s	
HYRACOIDEA	PROCAVIDAE – Hyraxes	<i>Heterohyrax</i>	sp.	-	-	-	*	*						0	
PROBOSCIDEA	ELEPHANTIDAE – Elephants	<i>Loxodonta</i>	<i>africana</i>	O	W	VU A2a, CITES I								0	
PERISSODACTYLA	EQUIDAE – Horses	<i>Equus</i>	<i>quagga</i>	O	W	Not listed								0	

Order	Family	Genus	species	Ecol. Type	End. Status	Cons. Status (IUCN + CITES)	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	
ARTIODACTYLA	HIPPOPOTAMIDAE – Hippopotamuses	<i>Hippopotamus</i>	<i>amphibius</i>	O	W	LR/lc; CITES II								*	
	SUIDAE – Pigs	<i>Phacochoerus</i>	<i>africanus</i>	O	W	LR/lc									0
		<i>Potamochoerus</i>	<i>larvatus</i>	f	W	LR/lc	*	*	*	0	0			0	0
	BOVIDAE Bovinae – Bovines	<i>Syncerus</i>	<i>caffer</i>	O	W	LR/cd									0
		<i>Tragelaphus</i>	<i>scriptus</i>	O	W	LR/lc						*			
		<i>Tragelaphus</i>	<i>strepsiceros</i>	f	W	LR/cd									s
	Antilopinae – Antilopes, Goats & sheep	<i>Cephalophus</i>	<i>monticola</i>	F	W	LR/lc; CITES II		0				*	0		0
		<i>Cephalophus</i>	<i>natalensis</i>	F	W	LR/cd		*	0	0					
		<i>Hippotragus</i>	<i>niger</i>	O	W	LR/cd									*
		<i>Madoqua</i>	<i>kirkii</i>	f	W	LR/lc						0	0		
		<i>Neotragus</i>	<i>moschatus</i>	F	W	LR/cd		0	0						
		<i>Oreotragus</i>	<i>oreotragus</i>	O	W	LR/cd				0					*

X = Confirmed by specimen (awaiting verification of some), s = sight records, 0 = calls or signs, * = reports of local people,

F = Forest dependent or specialist; f = Forest dwelling or generalist; O = Non-forest or forest visitor (Iverson, 1991b; Mlingwa *et al.*, 2000)

CF = species with limited ranges in the Coastal Forests alone; EACF = species with limited ranges in the Coastal Forests and Eastern Arc Mountains (Burgess *et al.*, 2000a); SE Tanzania = species with limited ranges in SE Tanzania; SE Africa = species with limited ranges in SE Africa; E Africa = species with limited ranges in E Africa

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; LR cd = Lower risk, conservation dependent; LR nt = Lower risk, near threatened; LR lc = Lower risk, least concerned; DD = Data Deficient (IUCN, 2004)

CITES I = Threatened with extinction and excluded from international trade; CITES II = Not yet threatened with extinction, but may be so if trade is not regulated, thus export permits are required (CITES, 2005)

APPENDIX 14 - BIRD SPECIES LIST FOR ALL FOREST RESERVES. TAXONOMY BASED ON SINCLAIR & RYAN (2003), STEVENSON AND FANSHAWE (2002) AND ZIMMERMAN *ET AL.* (1996)

Order	Family	Genus	species	Ecol. Type	Endemic Status	Conserv. Status (IUCN & CITES)	Kambona	Makonde I	Makonde II	Mkunya	Mtimiko	Mtuli Hinju	Makonde III	Ndechela
CICONIIFORMES	SCOPIIDAE – Hamerkop	<i>Scopus</i>	<i>umbretta</i>	O	W	LC				X		X		X
ANSERIFORMES	ANATIDAE – Ducks & Geese	<i>Dendrocygna</i>	<i>viduata</i>	O	W	LC; CITES III GH						X		
		<i>Nettapus</i>	<i>auritus</i>	O	W	LC; CITES III GH						X		
FALCONIFORMES	ACCIPITRIDAE – Eagles, Vultures, Kites, Hawks, Buzzards & Osprey	<i>Accipiter</i>	<i>tachiro</i>	f	W	LC; CITES II	X	X						
		<i>Aquila</i>	<i>verreauxii</i>	O	W	LC; CITES II				X				
		<i>Aviceda</i>	<i>cuculoides</i>	f	W	LC; CITES II		X						
		<i>Circaetus</i>	<i>cinereus</i>	O	W	LC; CITES II			X	X				
		<i>Circaetus</i>	<i>fasciolatus</i>	f	W	NT; CITES II	X		X		X			
		<i>Circaetus</i>	<i>pectoralis</i>	O	W	CITES II	X	X	X	X	X	X	X	X
		<i>Elanus</i>	<i>caeruleus</i>	O	W	LC; CITES II					X	X		
		<i>Gypohierax</i>	<i>angolensis</i>	f	W	LC; CITES II	X			X				
		<i>Hieraetus</i>	<i>spilogaster</i>	O	W	LC; CITES II								

Order	Family	Genus	species	Ecol. Type	Endemic Status	Conserv. Status (IUCN & CITES)	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
		<i>Kaupifalco</i>	<i>monogrammicus</i>	O	W	LC; CITES II	X	X	X	X	X	X	X	X
		<i>Lophaetus</i>	<i>occipitalis</i>	f	W	LC; CITES II				X				
		<i>Macheiramphus</i>	<i>alcinus</i>	f	W	LC; CITES II								X
		<i>Polyboroides</i>	<i>typus</i>	f	W	LC; CITES II	X	X		X				X
		<i>Stephanoaetus</i>	<i>coronatus</i>	F	W	LC; CITES II		X						
		<i>Terathopius</i>	<i>ecaudatus</i>	O	W	LC; CITES II	X	X	X	X	X	X	X	X
	FALCONIDAE – Falcons	<i>Falco</i>	<i>dickinsoni</i>	O	W	LC; CITES II								X
		<i>Falco</i>	<i>peregrinus</i>	O	W	LC; CITES I			X		X			
GALLIFORMES	PHASIANIDAE – Francolins (spurfowl) & Quail	<i>Pternistes (or Francolinus)</i>	<i>afer</i>	O	W	LC		X						
		<i>Pternistes (or Francolinus)</i>	<i>hildebrandti</i>	f	W	LC		X	X				X	X
	NUMIDIDAE – Guinea fowl	<i>Numida</i>	<i>meleagris</i>	O	W	LC		X			X			X
GRUIFORMES	RALLIDAE – Rails, Coots & Gallinules	<i>Amaurornis</i>	<i>flavivirostris</i>	O	W	LC						X		
CHARADRIIFORMES	JACANIDAE – Jacanas	<i>Actophilornis</i>	<i>africanus</i>	O	W	LC						X		
COLUMBIFORMES	COLUMBIDAE – Doves & Pigeons	<i>Streptopelia</i>	<i>capicola</i>	O	W	LC	X	X	X	X	X	X	X	X

Order	Family	Genus	species	Ecol. Type	Endemic Status	Conserv. Status (IUCN & CITES)	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
		<i>Streptopelia</i>	<i>semitorquata</i>	f	W	LC; CITES III GH	X	X	X	X	X	X	X	X
		<i>Streptopelia</i>	<i>senegalensis</i>	O	W	LC; CITES III GH								X
		<i>Treron</i>	<i>calva</i>	f	W	LC; CITES III GH	X	X		X				X
		<i>Turtur</i>	<i>chalcospilos</i>	f	W	LC; Not listed	X	X	X	X	X	X	X	X
		<i>Turtur</i>	<i>tympanistria</i>	f	W	LC; CITES III GH	X	X			X	X		X
PSITTACIFORMES	PSITTACIDAE – Parrots & Lovebirds	<i>Agapornis</i>	<i>liliana</i>	O	W	NT; CITES II								X
		<i>Poicephalus</i>	<i>cryptoxanthus</i>	f	SE Africa	LC; CITES II		X		X	X	X		X
MUSOPHAGIFORMES	MUSOPHAGIDAE – Turacos	<i>Tauraco</i>	<i>porphyreolophus</i>	f	W	LC								X
CUCULIFORMES	CUCULIDAE – Cuckoos & Coucals	<i>Centropus</i>	<i>burchellii</i>	f	W	Not listed	X	X	X	X	X	X	X	X
		<i>Ceuthmochares</i>	<i>australis</i>	f	W	Not listed			X	X				
		<i>Chrysococcyx</i>	<i>cupreus</i>	f	W	LC		X						X
		<i>Chrysococcyx</i>	<i>klass</i>	f	W	LC				X				X
STRIGIFORMES	STRIGIDAE – Owls	<i>Bubo</i>	<i>africanus</i>	O	W	LC; CITES II			X	X				X
		<i>Glaucidium</i>	<i>capense</i>	f	W	LC; CITES II				X				

Order	Family	Genus	species	Ecol. Type	Endemic Status	Conserv. Status (IUCN & CITES)	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	
		<i>Strix</i>	<i>woodfordii</i>	f	W	LC; CITES II		X		X	X	X	X		
CAPRIMULGI FORMES	CAPRIMULGIDAE – Nightjars	<i>Caprimulgus</i>	<i>pectoralis</i>	f	W	LC	X	X	X	X	X	X	X	X	
APODIFORMES	APODIDAE – Swifts & Spinetails	<i>Apus</i>	<i>affinis</i>	O	W	LC				X			X		
		<i>Apus</i>	<i>caffer</i>	O	W	LC			X			X	X		
		<i>Cypiurus</i>	<i>parvus</i>	f	W	Not listed	X								
		<i>Neafrapus</i>	<i>boehmi</i>	f	W	LC				X					X
TROGONIORMES	TROGONIDAE – Trogons	<i>Apaloderma</i>	<i>narina</i>	f	W	LC	X				X	X			
CORACIIFORMES	ALCEDINIDAE – Kingfishers	<i>Halcyon</i>	<i>albiventris</i>	f	W	LC	X	X	X	X	X	X	X	X	
		<i>Halcyon</i>	<i>chelicuti</i>	O	W	LC	X		X	X				X	
		<i>Ispidina</i>	<i>picta</i>	f	W	Not listed	X	X		X		X			
		<i>Megaceryle</i>	<i>maxima</i>	O	W	LC				X					
	MEROPIIDAE – Bee-eaters	<i>Merops</i>	<i>boehmi</i>	f	W	LC				X	X	X			
		<i>Merops</i>	<i>pusillus</i>	O	W	LC	X	X	X	X	X	X	X	X	
	CORACIIDAE – Rollers	<i>Coracias</i>	<i>caudata</i>	O	W	LC								X	
		<i>Coracias</i>	<i>spatulata</i>	O	W	LC			X						
	PHOENICULIDAE – Woodhoopoes & Scimitarbills	<i>Phoeniculus</i>	<i>purpureus</i>	f	W	LC			X	X	X				X
		<i>Rhinopomastus</i>	<i>cyanomelas</i>	O	W	LC			X	X					X
	BUCEROTIDAE – Hornbills	<i>Bucorvus</i>	<i>leadbeateri</i>	O	W	Not listed	X			X				X	X
		<i>Bycanistes</i>	<i>bucinator</i>	f	W	LC									X
		<i>Tockus</i>	<i>alboterminatus</i>	f	W	LC		X		X	X	X			X
<i>Tockus</i>		<i>nasutus</i>	O	W	LC									X	

Order	Family	Genus	species	Ecol. Type	Endemic Status	Conserv. Status (IUCN & CITES)	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	
PICIFORMES	CAPITONIDAE – Barbets & Tinkerbirds	<i>Lybius</i>	<i>melanopterus</i>	f	E Africa	LC			X	X					
		<i>Pogoniulus</i>	<i>bilineatus</i>	f	W	LC	X	X	X	X	X	X	X	X	
	INDICATORIDAE – Honeyguides	<i>Indicator</i>	<i>indicator</i>	O	W	LC		X		X					X
		PICIDAE – Wrynecks & Woodpeckers	<i>Campethera</i>	<i>abingoni</i>	f	W	LC			X	X	X			
			<i>Dendropicos</i>	<i>fuscescens</i>	f	W	LC			X	X				X
	<i>Dendropicos</i>	<i>namaquus</i>	f	W	Not listed				X					X	
PASSERIFORMES	EURLAIMIDAE – Broadbills	<i>Smithornis</i>	<i>capensis</i>	F	W	LC		X		X	X	X	X		
	MOTACILLIDAE – Wagtails, Longclaws & Pipits	<i>Anthus</i>	<i>cinnamomeus</i>	O	W	Not listed			X						
		<i>Motacilla</i>	<i>aguimp</i>	O	W	LC				X					
	HIRUNDINIDAE – Swallows & Martins	<i>Hirundo</i>	<i>abyssinica</i>	O	W	LC			X			X		X	
		<i>Hirundo</i>	<i>smithii</i>	O	W	LC	X		X	X				X	
		<i>Psalidoprocne</i>	<i>holomelas</i>	f	W	Not listed	X	X	X	X		X			
		<i>Psalidoprocne</i>	<i>orientalis</i>	O	W	Not listed								X	
	PYCNONOTIDAE – Nicators & Greenbuls	<i>Andropadus</i>	<i>importunus</i>	f	W	LC	X	X	X	X	X				X
		<i>Chlorocichla</i>	<i>flaviventris</i>	f	W	LC		X	X	X	X	X	X	X	
		<i>Nicator</i>	<i>gularis</i>	f	SE Africa	LC	X	X		X	X	X	X	X	
		<i>Phyllastrephus</i>	<i>flavostriatus</i>	F	SE Africa	LC					X				
		<i>Phyllastrephus</i>	<i>fischeri</i>	F	W	LC					X				
		<i>Pycnonotus</i>	<i>barbatus</i>	O	W	LC	X	X	X	X	X	X	X	X	
	TIMALIIDAE – Babblers, Chatterers & Illadopses	<i>Turdoides</i>	<i>jardinei</i>	O	W	LC				X				X	
	TURDIDAE – Thrushes, Robins, Chats & relatives	<i>Cercomela</i>	<i>familiaris</i>	O	W	LC				X					
<i>Cercotrichas</i>		<i>quadrivirgata</i>	f	W	Not listed	X	X	X	X	X	X	X	X		
<i>Cossypha</i>		<i>heuglini</i>	O	W	LC		X	X	X				X		

Order	Family	Genus	species	Ecol. Type	Endemic Status	Conserv. Status (IUCN & CITES)	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	
		<i>Cossypha</i>	<i>natalensis</i>	f	W	LC	X	X							
		<i>Myrmecocichla</i>	<i>cinnamomeiventris</i>	O	W	LC				X					X
		<i>Sheppardia</i>	<i>gunningi</i>	F	CF and a few other forest types in Tanzania, Kenya, Malawi and Coastal Mozambique	VU B2ab (i,ii,iii,v)						X			
		<i>Turdus</i>	<i>libonyanus</i>	O	W	LC		X		X					
	MUSCICAPIDAE – Flycatchers	<i>Bias</i>	<i>musicus</i>	f	W	LC					X				
		<i>Erythrocerus</i>	<i>livingstonei</i>	f	SE Africa	Not listed		X	X	X	X	X	X	X	X
		<i>Muscicapa</i>	<i>caerulescens</i>	f	W	LC		X		X	X	X			X
		<i>Muscicapa</i>	<i>striata</i>	O	W	LC									X
		<i>Terpsiphone</i>	<i>viridis</i>	f	W	LC	X	X	X	X	X	X	X	X	X
		<i>Trochocercus</i>	<i>cyanomelas</i>	F	W	LC	X			X	X	X	X		
	SYLVIIDAE – Warblers	<i>Apalis</i>	<i>flavida</i>	f	W	LC		X	X	X				X	X
		<i>Camaroptera</i>	<i>brachyura</i>	f	W	LC	X	X	X	X	X	X	X	X	X
		<i>Cisticola</i>	<i>erythropros</i>	O	W	LC		X							X
		<i>Heliolais</i>	<i>erythroptera</i>	O	W	LC									X
		<i>Prinia</i>	<i>subflava</i>	O	W	LC	X	X	X	X	X	X	X	X	X
		<i>Sylvietta</i>	<i>whytii</i>	f	W	LC	X	X		X					
	ZOSTEROPIDAE – White-eyes	<i>Zosterops</i>	<i>senegalensis</i>	f	W	LC							X		X

Order	Family	Genus	species	Ecol. Type	Endemic Status	Conserv. Status (IUCN & CITES)	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	
	PLATYSTEIRIDAE – Batises & Wattle-eyes	<i>Batis</i>	<i>reichenowi</i>	F	CF	Not listed					X				
		<i>Batis</i>	<i>soror</i>	f	SE Africa	LC	X	X	X	X			X	X	
		<i>Platysteira</i>	<i>peltata</i>	f	W	LC	X	X	X	X	X	X	X	X	
	PRIONOPIDAE – Helmet-shrikes	<i>Prionops</i>	<i>poliophilus</i>	O	Previously restricted to SW Kenya and N Tanzania (first record for S Tanzania)	NT				X					X
		<i>Prionops</i>	<i>retzii</i>	f	W	LC	X	X		X			X	X	
	MALACONOTIDAE – Bush-shrikes	<i>Dryoscopus</i>	<i>cubla</i>	f	W	LC	X	X	X	X	X	X	X	X	
		<i>Laniarius</i>	<i>aethiopicus</i>	f	W	LC	X	X	X	X	X	X	X	X	
		<i>Malaconotus</i>	<i>blanchoti</i>	f	W	LC	X							X	
		<i>Malaconotus</i>	<i>quadricolor</i>	f	W	Not listed			X		X		X		
		<i>Malaconotus</i>	<i>sulfureopectus</i>	f	W	LC		X	X		X	X	X		
		<i>Tchagra</i>	<i>australis</i>	f	W	LC	X	X	X	X	X	X	X	X	
		<i>Tchagra</i>	<i>senegala</i>	O	W	LC	X	X		X				X	
	CAMPEPHAGIDAE – Cuckoo-shrikes	<i>Campephaga</i>	<i>flava</i>	f	W	LC	X	X		X			X	X	
		<i>Coracina</i>	<i>pectoralis</i>	O	W	Not listed		X		X				X	
	DICRURIDAE – Drongos	<i>Dicrurus</i>	<i>adsimilis</i>	O	W	LC	X	X	X	X	X	X	X	X	
		<i>Dicrurus</i>	<i>ludwigii</i>	f	W	LC		X		X		X		X	
	ORIOOLIDAE – Orioles	<i>Oriolus</i>	<i>auratus</i>	f	W	LC	X	X	X	X				X	
		<i>Oriolus</i>	<i>larvatus</i>	f	W	LC	X	X		X		X	X		

Order	Family	Genus	species	Ecol. Type	Endemic Status	Conserv. Status (IUCN & CITES)	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	
	CORVIDAE – Crows, Ravens & Piapiac	<i>Corvus</i>	<i>albicollis</i>	O	W	LC			X					X	
		<i>Corvus</i>	<i>albus</i>	O	W	LC	X	X	X	X	X	X	X	X	
	STURNIDAE – Starlings & Oxpeckers	<i>Cinnyricinclus</i>	<i>leucogaster</i>	O	W	LC									X
		<i>Lamprotornis</i>	<i>elisabeth</i>	f	W	LC		X							X
		<i>Onychognathus</i>	<i>morio</i>	O	W	LC				X					X
	NECTARINIDAE – Sunbirds	<i>Chalcomitra</i>	<i>amethystina</i>	f	W	Not listed	X	X		X					
		<i>Chalcomitra</i>	<i>senegalensis</i>	O	W	Not listed									X
		<i>Cinnyris</i>	<i>talatala</i>	f	W	Not listed			X	X					
		<i>Cyanomitra</i>	<i>olivacea</i>	f	W	Not listed	X	X	X	X	X	X	X	X	X
		<i>Hedydipna</i>	<i>collaris</i>	f	W	Not listed	X	X	X	X	X	X	X	X	X
	PASSERIDAE – Sparrows & Petronias	<i>Petronia</i>	<i>superciliaris</i>	O	W	LC		X		X					X
		<i>Plocepasser</i>	<i>mahali</i>	O	W	LC									X
	PLOCEIDAE – Weavers	<i>Amblyospiza</i>	<i>albifrons</i>	f	W	LC; CITES III GH				X					
		<i>Anaplectes</i>	<i>rubriceps</i>	O	W	LC; CITES III GH				X					X
		<i>Euplectes</i>	<i>afer</i>	O	W	LC; CITES III GH				X					
		<i>Euplectes</i>	<i>hordeaceus</i>	O	W	LC; CITES III GH		X		X					
		<i>Euplectes</i>	<i>orix</i>	O	W	LC		X							
		<i>Ploceus</i>	<i>bicolor</i>	f	W	LC				X	X	X	X	X	X

Order	Family	Genus	species	Ecol. Type	Endemic Status	Conserv. Status (IUCN & CITES)	Kambona	Makonde I	Makonde II	Mkunya	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
		<i>Ploceus</i>	<i>cucullatus</i>	O	W	LC; CITES III GH		X						
		<i>Ploceus</i>	<i>intermedius</i>	O	W	LC		X					X	
		<i>Ploceus</i>	<i>ocularis</i>	f	W	LC				X				X
		<i>Ploceus</i>	<i>subaureus</i>	O	SE Africa	LC				X				
		<i>Quelea</i>	<i>erythrops</i>	O	W	LC; CITES III GH								X
	ESTRILDIDAE	<i>Estrilda</i>	<i>astrild</i>	O	W	LC	X	X						
		<i>Hypargos</i>	<i>niveoguttatus</i>	f	W	LC	X	X	X	X	X	X	X	X
		<i>Lagonosticta</i>	<i>rubricata</i>	O	W	LC	X	X	X	X	X	X	X	X
		<i>Mandingoa</i>	<i>nitidula</i>	f	W	LC		X		X	X	X		
		<i>Pyrenestes</i>	<i>minor</i>	f	W	LC				X				
		<i>Pytilia</i>	<i>afra</i>	O	W	LC			X	X			X	
		<i>Pytilia</i>	<i>melba</i>	O	W	LC	X	X	X	X	X	X	X	X
		<i>Spermestes</i>	<i>bicolor</i>	O	W	Not listed	X			X			X	X
		<i>Spermestes</i>	<i>cucullata</i>	O	W	Not listed	X	X	X	X				
		<i>Spermophaga</i>	<i>ruficapilla</i>	f	Previously restricted to W Kenya and N Tanzania (first record for S Tanzania)	LC				X				
		<i>Uraeginthus</i>	<i>angolensis</i>	O	W	LC		X	X	X				X
		<i>Vidua</i>	<i>chalybeata</i>	O	W	LC			X					

Order	Family	Genus	species	Ecol. Type	Endemic Status	Conserv. Status (IUCN & CITES)	Kambona	Makonde I	Makonde II	Mkunya	Mtimiko	Mtuli Hinju	Makonde III	Ndechela
		<i>Vidua</i>	<i>obtusa</i>	O	W	LC		X		X				X
	FRINGILLIDAE – Canaries & Seedeaters	<i>Serinus</i>	<i>mozambicus</i>	O	W	LC; CITES III GH	X	X	X	X	X	X	X	X
		<i>Serinus</i>	<i>reichardi</i>	f	W	LC			X	X				
	EMBERIZIDAE – Old-world buntings, Waxbills, Whydahs & Indigobirds	<i>Emberiza</i>	<i>cabanisi</i>	O	W	LC			X					X
		<i>Emberiza</i>	<i>tahapisi</i>	O	W	LC		X	X	X				

X = species identified by sight

F = Forest dependent or specialist; f = Forest dwelling or generalist; O = Non-forest or forest visitor (Iverson, 1991b; Mlingwa *et al.*, 2000)

CF = species with limited ranges in the Coastal Forests alone; EACF = species with limited ranges in the Coastal Forests and Eastern Arc Mountains Africa (Burgess *et al.*, 2000a); SE

Tanzania = species with limited ranges in SE Tanzania; SE Africa = species with limited ranges in SE Africa; E Africa = species with limited ranges in E

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; LR cd = Lower risk, conservation dependent; LR nt = Lower risk, near threatened; LR lc = Lower risk, least concerned;

DD = Data Deficient (IUCN, 2004)

CITES I = Threatened with extinction and excluded from international trade; CITES II = Not yet threatened with extinction, but may be so if trade is not regulated, thus export permits are required (CITES, 2005)

APPENDIX 15 – REPTILE SPECIES LIST FOR ALL FOREST RESERVES. TAXONOMY BASED ON SPAWLS *ET AL.* (2002)

Order/ sub-order	Family	Genus	species	Ecol Type	Endemic Status	Cons. Status (IUCN & CITES)	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
TESTUDINES - Chelonians	TESTUDINIDAE – Land tortoises	<i>Geochelone</i>	<i>pardalis</i>	O	W	CITES II	0							0 ?
	PELOMEDUSIDAE – African side-necked terrapins	<i>Pelomedusa</i>	<i>subrufa</i>	O	W	CITES III GH								X
SAURIA – Lizards	GEKKONIDAE – Geckoes	<i>Hemidactylus</i>	<i>mabouia</i>	O	W	Not listed		X						
	AGAMIDAE – Agamas	<i>Agama</i>	<i>agama</i>	O	W	Not listed				X				
		<i>Agama</i>	<i>mossambica</i>	O	W	Not listed			X	X	X		X	X
	VARANIDAE – Monitor lizards	<i>Varanus</i>	<i>albigularis</i>	O	W	CITES II	0							*
		<i>Varanus</i>	<i>niloticus</i>	O	W	CITES II				s		s		
	SCINCIDAE – Skinks	<i>Panaspis</i>	sp.	-	-	Not listed		X						
		<i>Trachylepis</i>	<i>maculilabris</i>	O	W	Not listed					X			
		<i>Trachylepis</i>	<i>megalura</i>	O	W	Not listed			X	X				
		<i>Trachylepis</i>	sp. 1	-	-	Not listed			s	s			s	s
		<i>Trachylepis</i>	<i>striata</i>	O	W	Not listed								X
		<i>Trachylepis</i>	<i>varia</i>	O	W	Not listed				X				
	LACERTIDAE – Lacertid Lizards	<i>Ichnotropis</i>	<i>squamulosa</i>	O	W	Not listed		X						
	GERRHOSAURIDAE	<i>Gerrhosaurus</i>	<i>nigrolineatus</i>	O	W	Not listed		X	X					
	CORDYLIDAE – Girdled lizards & relatives	<i>Cordylus</i>	<i>tropidosternum</i>	f	W	CITES II	X							
<i>Platysaurus</i>		<i>maculatus</i>	O	N Mozambique and Masasi district in SE Tanzania	Not listed								X	

Order/ sub-order	Family	Genus	species	Ecol Type	Endemic Status	Cons. Status (IUCN & CITES)	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	
SERPENTES – Snakes	BOIDAE – Boas & Pythons	<i>Python</i>	<i>natalensis</i>	O	W	CITES II	0			*					
	COLUBRIDAE – Typical snakes	<i>Crotaphopeltis</i>	<i>hotamboeia</i>	O	W	Not listed			X						
		<i>Dasypeltis</i>	<i>medici</i>	f	W	Not listed		X							
		<i>Lamprophis</i>	<i>capensis</i>	O	W	Not listed		X		X					
		<i>Lycophidion</i>	<i>capense</i>	O	W			X							
		<i>Mehelya</i>	<i>nyassae</i> (juv.)	O	W	Not listed			X						
		<i>Philothamnus</i>	<i>semivariiegatus</i>	O	W	Not listed				X					
		<i>Psammophis</i>	<i>mossambicus</i>	O	W	Not listed								s	
		<i>Psammophis</i>	<i>orientalis</i>	O	W	Not listed				X			X	s	
	<i>Thelotornis</i>	<i>capensis oatesi</i>	O	W (first record for Tanzania; awaiting ID confirmation)	Not listed			X							
	<i>Thelotornis</i>	<i>mossambicanus</i>	O	W	Not listed		X		X				s		
VIPERIDAE – Vipers	<i>Bitis</i>	<i>arietans</i>	O	W	Not listed		X								
	<i>Causus</i>	<i>defilippii</i>	O	W	Not listed				X					X	

X = Confirmed by specimen (awaiting verification of some), s = sight records, 0 = calls or signs, * = reports of local people,

F = Forest dependent or specialist; f = Forest dwelling or generalist; O = Non-forest or forest visitor (Iverson, 1991b; Mlingwa *et al.*, 2000)

CF = species with limited ranges in the Coastal Forests alone; EACF = species with limited ranges in the Coastal Forests and Eastern Arc Mountains (Burgess *et al.*, 2000a); SE Tanzania = species with limited ranges in SE Tanzania; SE Africa = species with limited ranges in SE Africa; E Africa = species with limited ranges in E Africa

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; LR cd = Lower risk, conservation dependent; LR nt = Lower risk, near threatened; LR lc = Lower risk, least concerned; DD = Data Deficient (IUCN, 2004)

CITES I = Threatened with extinction and excluded from international trade; CITES II = Not yet threatened with extinction, but may be so if trade is not regulated, thus export permits are required (CITES, 2005)

APPENDIX 16 – AMPHIBIAN SPECIES LIST FOR ALL FOREST RESERVES. TAXONOMY BASED ON CHANNING (2001) AND PASSMORE & CARRUTHERS (1995)

Order	Family	Genus	species	Ecol. Type	End. Status	Cons. Status (IUCN & CITES)	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela	
ANURA – Amphibians	ARTHROLEPTIDAE – Squeakers	<i>Arthroleptis</i>	<i>stenodactylus</i>	f	W	LC	X	X	X	X			X	X	
		<i>Arthroleptis</i>	<i>xenodactyloides</i>	f	W	VU B1ab(iii)	X	X		X			X		
	BUFONIDAE – 'True' Toads	<i>Bufo</i>	<i>maculatus</i>	O	W	Not listed								X	
		<i>Bufo</i>	sp.	-	-	-	X								
		<i>Mertensophryne</i>	<i>micranotis</i>	f	EAC lowland	LC			X						
	HEMISOTIDAE – Shovel-nosed frogs or Snout-burrowers	<i>Hemisis</i>	<i>marmoratus</i>	O	W	LC				X					
	HYPEROLIIDAE – Tree, Leaf-folding, Reed, Lily, and Rattling Frogs & Kassinas	<i>Afrivalus</i>	<i>fornasinii</i>	O	W	LC		X		X		X			
		<i>Afrivalus</i>	sp.	-	-	-				X					
		<i>Hyperolius</i>	<i>punctulatus</i>	f	EA	DD	X					X			
		<i>Hyperolius</i>	sp.	-	-	-						X			
		<i>Kassina</i>	sp.	-	-	-									X
		<i>Leptopelis</i>	<i>flavomaculatus (juv)</i>	f	W	LC				X		X			
	MICROHYLIDAE – Rain frogs & Rubber frogs	<i>Breviceps</i>	<i>mossambicus</i>	O	W	LC		X							

Order	Family	Genus	species	Ecol. Type	End. Status	Cons. Status (IUCN & CITES)	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
	PIPIDAE – Platannas	<i>Xenopus</i>	<i>muelleri</i>	O	W	LC	X			X		X		
	RHACOPHORIDAE – Foam-nest frogs	<i>Chiromantis</i>	<i>xerampelina</i>	O	W	LC					X			X
	RANIDAE – Common or ‘True’ frogs	<i>Ptychadena</i>	<i>anchietae</i>	O	W	LC				X				
		<i>Ptychadena</i>	<i>mossambica</i>	O	W	LC						X		X
		<i>Ptychadena</i>	<i>oxyrhynchus</i>	O	W	Not listed								X
		<i>Phrynobatrachus</i>	<i>mababiensis</i>	O	W	LC								X
		<i>Phrynobatrachus</i>	<i>natalensis</i>	O	W	LC		X						X
		<i>Phrynobatrachus</i>	sp.		-	-	-							

X = Confirmed by specimen (awaiting verification of some)

F = Forest dependent or specialist; f = Forest dwelling or generalist; O = Non-forest or forest visitor (Iverson, 1991b; Mlingwa *et al.*, 2000)

CF = species with limited ranges in the Coastal Forests alone; EACF = species with limited ranges in the Coastal Forests and Eastern Arc Mountains (Burgess *et al.*, 2000a); SE Tanzania = species with limited ranges in SE Tanzania; SE Africa = species with limited ranges in SE Africa; E Africa = species with limited ranges in E Africa

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; LR cd = Lower risk, conservation dependent; LR nt = Lower risk, near threatened; LR lc = Lower risk, least concerned; DD = Data Deficient (IUCN, 2004)

CITES I = Threatened with extinction and excluded from international trade; CITES II = Not yet threatened with extinction, but may be so if trade is not regulated, thus export permits are required (CITES, 2005)

APPENDIX 17 - BUTTERFLY SPECIES LIST FOR ALL FOREST RESERVES. TAXONOMY BASED ON DAVENPORT (2001), LARSEN (1996) AND KIELLAND (1990)

Order	Family	Genus	species	Ecol. Type	End. Status	IUCN	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela		
PAPILIONOIDEA	PAPILIONIDAE – Swallowtails	<i>Papilio</i>	<i>constantinus</i>	f	W - first record for Mtwara Region	Not listed					X					
		<i>Papilio</i>	<i>demodocus</i>	O	W	Not listed						s				
		<i>Papilio</i>	<i>ophidicephalus</i>	O	W	Not listed					s			s		
	PIERIDAE – Yellows & Whites	<i>Belenois</i>	<i>thysa thysa</i>	f	W	Not listed				X				X		
		<i>Catopsilia</i>	<i>florella</i>	O	W	Not listed									X	
		<i>Colotis</i>	<i>amata calais</i>	O	W	Not listed				X						
		<i>Colotis</i>	<i>euipe omphale</i>	O	W	Not listed	X	X		X			X		X	
		<i>Colotis</i>	<i>ione</i>	O	W	Not listed								X		
		<i>Eurema</i>	<i>desjardinsi marshalli</i>	O	W	Not listed	X	X								
		<i>Eurema</i>	<i>hapale</i>	O	W	Not listed	X									
		<i>Eurema</i>	<i>hecabe solifera</i>	O	W	Not listed	X	X		X						
		<i>Eurema</i>	<i>regularis</i>	O	W	Not listed									X	
		<i>Leptosia</i>	<i>alcesta inalcesta</i>	f	W	Not listed		X		X	X				X	
		<i>Nepheronia</i>	<i>thalassina</i>	f	W - first record for Mtwara Region	Not listed										X
		<i>Alaena</i>	sp.	-	-	-			X							
		<i>Anthene</i>	<i>lumulata</i>	O	W	Not listed			X						X	

Order	Family	Genus	species	Ecol. Type	End. Status	IUCN	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
		<i>Baliochila</i>	<i>lipara</i>	O	W	Not listed			X					
		<i>Euchrysops</i>	<i>malathana</i>	O	W	Not listed				X				
		<i>Hypolycaena</i>	<i>pachalica</i>	O	W - first record for Mtwara Region	Not listed		X		X				
		<i>Pentila</i>	<i>pauli nyassana</i>	f	W	Not listed	X						X	
		<i>Zizeeria</i>	<i>knysna</i>	O	W	Not listed			X					
NYMPHALOIDEA	DANAIDAE – Milkweed butterflies	<i>Amauris</i>	<i>ochlea ochlea</i>	O	W - first record for Mtwara Region	Not listed	X							
	SATYRIDAE – Browns & Ringlets	<i>Bicyclus</i>	<i>safitza</i>	O	W	Not listed	X	X		X		X	X	X
		<i>Coenyropsis</i>	<i>carcassoni</i>	O	W - first record for Mtwara Region	Not listed		X						
		<i>Gnophodes</i>	<i>betsimena diversa</i>	F	W	Not listed							X	
		<i>Melanitis</i>	<i>leda</i>	f	W	Not listed				X			X	
		<i>Ypthima</i>	<i>asterope</i>	O	W	Not listed				X				
		<i>Byblia</i>	<i>anvatara acheloia</i>	O	W	Not listed			X	X				X
	NYMPHALIDAE – Brush-footed butterflies	<i>Charaxes</i>	<i>achaemenes achaemenes</i>	O	W	Not listed								X
		<i>Charaxes</i>	<i>bohemani</i>	f	W	Not listed			X					
		<i>Charaxes</i>	<i>brutus alcyone</i>	f	W	Not listed	X							
		<i>Charaxes</i>	<i>castor flavifasciatus</i>	f	W	Not listed		X						
		<i>Charaxes</i>	<i>citherion kennethi</i>	f	W	Not listed	X	X	X	X	X	X	X	

Order	Family	Genus	species	Ecol. Type	End. Status	IUCN	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
		<i>Charaxes</i>	<i>etesipe</i>	f	W - first record for Mtwara Region	Not listed			X					
		<i>Charaxes</i>	<i>ethalion</i>	O	W	Not listed			X					
		<i>Charaxes</i>	<i>guderiana</i>	f	W	Not listed	X	X		X				X
		<i>Charaxes</i>	<i>howartha</i>	f	W	Not listed		X		X	X		X	X
		<i>Charaxes</i>	<i>jasius saturnus</i>	O	W	Not listed								X
		<i>Charaxes</i>	<i>lasti lasti</i>	F	EACF - first record for Mtwara Region	Not listed				X	X	X	X	
		<i>Charaxes</i>	<i>macclounii</i>	O	W	Not listed	X	X						
		<i>Charaxes</i>	<i>protoclea azota</i>	F	W	Not listed	X			X			X	
		<i>Charaxes</i>	sp.1	-	-	-				X	X	X		X
		<i>Charaxes</i>	sp.2	-	-	-				X				X
		<i>Charaxes</i>	sp.3	-	-	-	X				X			
		<i>Charaxes</i>	sp.4	-	-	-		X						
		<i>Charaxes</i>	<i>varanes vologeses</i>	O	W	Not listed		X		X	X	X	X	
		<i>Cymothoe</i>	<i>herminia</i>	F	W - first record for Mtwara Region	Not listed							s	
		<i>Danaus</i>	<i>chrysippus chrysippus</i>	O	W	Not listed	X							

Order	Family	Genus	species	Ecol. Type	End. Status	IUCN	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
		<i>Euphaedra</i>	<i>neophron littoralis</i>	F	W - first record for Mtwara Region	Not listed				s	s		s	s
		<i>Eurytela</i>	<i>dryope angulata</i>	f	W - first record for Mtwara Region	Not listed			X		X	X		
		<i>Euxanthe</i>	<i>wakefieldi</i>	F	W	Not listed		X					X	
		<i>Hamanumida</i>	<i>daedalus</i>	O	W	Not listed	s			s	s	s	s	s
		<i>Harma</i>	<i>theobene blassi</i>	F	W	Not listed					X		X	
		<i>Junonia</i>	<i>hierta cebrene</i>	O	W	Not listed								X
		<i>Junonia</i>	<i>natalica</i>	f	W	Not listed	X							
		<i>Junonia</i>	<i>oenone oenone</i>	O	W	Not listed				X			X	
		<i>Junonia</i>	<i>orithya madagascariensis</i>	O	W	Not listed								X
		<i>Junonia</i>	<i>terea elgiva</i>	f	W	Not listed	X						X	
		<i>Neptidopsis</i>	<i>fulgurata platyptera</i>	f	W - first record for Mtwara Region	Not listed					X			
		<i>Neptis</i>	<i>alta</i>	F	W	Not listed						X	X	
		<i>Neptis</i>	<i>jordani</i>	O	W	Not listed					X		X	X
		<i>Precis</i>	<i>antilope</i>	O	W	Not listed								X
		<i>Salamis</i>	<i>parhassus</i>	f	W	Not listed					s			

Order	Family	Genus	species	Ecol. Type	End. Status	IUCN	Kambona	Makonde I	Makonde II	Mkunya River	Mtiniko	Mtuli Hinju	Makonde III	Ndechela
		<i>Sallya</i>	<i>amulia rosa</i>	f	W - first record for Mtwara Region	Not listed	X	X						X
		<i>Acraea</i>	<i>anacreon bomba</i>	f	W	Not listed				X				
HESPEROIDEA	HESPERIIDAE – Skippers	<i>Kedestes</i>	sp.	-	-	-		X						

X = Confirmed by specimen, s = sight records, 0 = calls or signs, * = reports of local people,

F = Forest dependent or specialist; f = Forest dwelling or generalist; O = Non-forest or forest visitor (Iverson, 1991b; Mlingwa *et al.*, 2000)

CF = species with limited ranges in the Coastal Forests alone; EACF = species with limited ranges in the Coastal Forests and Eastern Arc Mountains; SE Tanzania = species with limited ranges in SE Tanzania; SE Africa = species with limited ranges in SE Africa; E Africa = species with limited ranges in E Africa (Burgess *et al.*, 2000a)

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; LR cd = Lower risk, conservation dependent; LR nt = Lower risk, near threatened; LR lc = Lower risk, least concerned; DD = Data Deficient (IUCN, 2004)

CITES I = Threatened with extinction and excluded from international trade; CITES II = Not yet threatened with extinction, but may be so if trade is not regulated, thus export permits are required (CITES, 2005)

APPENDIX 18 - NUMBER OF CAPTURES AND RECAPTURES AND SPECIMEN RECORD NUMBERS OF SMALL MAMMALS, AMPHIBIANS AND REPTILES FOR ALL FOREST RESERVES

Forest Reserve	Location	Order	Family	Genus	Species	Sherman traps (bucket pitfalls)	No. recaptured	Record no. (KMH)
Kambona	Zoo site 1	INSECTIVORA	SORICIDAE	<i>Crocidura</i>	sp.	1(2)	0	26662 (26663)
		RODENTIA	CRICETOMYINAE	<i>Beamys</i>	<i>hindei</i>	7(1)	3	26793 (26792)
			MURIDAE	<i>Grammomys</i>	<i>dolichurus</i>	1	0	26794
			MURIDAE	<i>Mastomys</i>	<i>natalensis</i>	1	0	26796
			MURIDAE	<i>Mus</i>	<i>minutoides</i>	(1)	0	(26797)
		ANURA	ARTHROLEPTIDAE	<i>Arthroleptis</i>	<i>stenodactylus</i>	(13)	0	26856, 26855
			BUFONIDAE	<i>Bufo</i>	sp.	(6)	0	26858
		Makonde I	Zoo site 2	INSECTIVORA	SORICIDAE	<i>Crocidura</i>	sp.	2
RODENTIA	CRICETOMYINAE			<i>Beamys</i>	<i>hindei</i>	2	4	
	MURIDAE			<i>Mastomys</i>	<i>natalensis</i>	2	4	
SAURIA	LACERTIDAE			<i>Ichnotropis</i>	<i>squamulosa</i>	(1)	0	26737
ANURA	ARTHROLEPTIDAE			<i>Arthroleptis</i>	<i>xenodactyloides</i>	(36)	0	26868
	ARTHROLEPTIDAE			<i>Arthroleptis</i>	<i>stenodactylus</i>	(4)	0	26869, 26870
	MICROHYLIDAE			<i>Breviceps</i>	<i>mossambicus</i>	(2)	0	26867

Forest Reserve	Location	Taxon	Family	Genus	Species	Sherman traps (bucket pitfalls)	No. recaptured	Record no. (KMH)
Makonde II	Zoo site 3/1	INSECTIVORA	SORICIDAE	<i>Crocidura</i>	sp.	(1)	0	26668
	Zoo site 3/2	RODENTIA	MURIDAE	<i>Mastomys</i>	<i>natalensis</i>	3	1	26795
			MURIDAE	<i>Acomys</i>	<i>spinosissimus</i>	2	0	26799
			MURIDAE	<i>Mus</i>	sp.	(1)	0	26798
			SORICADAE	<i>Crocidura</i>	sp.	2(1)	0	26665, 26666, 26667
Mkunya River	Zoo site 4	INSECTIVORA	SORICIDAE	<i>Crocidura</i>	sp.	(2)	0	26669, 26670
		RODENTIA	CRICETOMYINAE	<i>Beamys</i>	<i>hindei</i>	1 (1)	0	26801
			MURIDAE	<i>Grammomys</i>	<i>dolichurus</i>	1	0	26802
			MURIDAE	<i>Mastomys</i>	<i>natalensis</i>	1	0	
		SERPENTES	VIPERIDAE	<i>Causus</i>	<i>defilippii</i>	(1)	0	26742
		ANURA	ARTHROLEPTIDAE	<i>Arthroleptis</i>	<i>stenodactylus</i>	(5)	0	26875
			ARTHROLEPTIDAE	<i>Arthroleptis</i>	<i>xenodactyloides</i>	(1)	0	26880
			HEMISOTIDAE	<i>Hemisus</i>	<i>marmoratus</i>	(3)		26873
Mkunya River	Zoo site 5	INSECTIVORA	SORICIDAE	<i>Crocidura</i>	sp.	1(1)	0	26671, 26672
			MURIDAE	<i>Acomys</i>	<i>spinosissimus</i>	3	0	26804
			MURIDAE	<i>Mastomys</i>	<i>natalensis</i>	3	1	26803

Forest Reserve	Location	Taxon	Family	Genus	Species	Sherman traps (bucket pitfalls)	No. recaptured	Record no. (KMH)
Mtiniko	Zoo site 6	RODENTIA	SCIURIDAE	<i>Paraxerus</i>	<i>palliatus</i>	1 (0)	0	
			CRICETOMYINAE	<i>Beamys</i>	<i>hindei</i>	5 (0)	4	
		SAURIA	SCINCIDAE	<i>Trachylepis</i>	<i>maculilabris</i>	0 (1)	0	26745
Mtuli Hinju	Zoo site 7	RODENTIA	SCIURIDAE	<i>Paraxerus</i>	<i>flavovittis</i>	1 (0)	0	
		RODENTIA	MURIDAE	<i>Acomys</i>	<i>spinosissimus</i>	7(0)	4	26805
			MURIDAE	<i>Mastomys</i>	<i>natalensis</i>	1 (0)	0	26806
Makonde III	Zoo site 8	INSECTIVORA	SORICIDAE	<i>Crocidura</i>	sp.	2(3)	0	26673, 26674, 26675
		RODENTIA	MURIDAE	<i>Acomys</i>	<i>spinosissimus</i>	16	10	26807
			MURIDAE	<i>Mastomys</i>	<i>natalensis</i>	3		26808
			CRICETOMYINAE	<i>Beamys</i>	<i>hindei</i>	3	0	
		ANURA	ARTHROLEPTIDAE	<i>Arthroleptis</i>	<i>stenodactylus</i>	(3)	0	
			ARTHROLEPTIDAE	<i>Arthroleptis</i>	<i>xenodactyloides</i>	(16)	0	
Ndechela	Zoo site 9	INSECTIVORA	SORICIDAE	<i>Crocidura</i>	sp.	1	0	26676
		MUROIDEA	GERBILLINAE	<i>Tatera</i>	<i>robusta</i>	1	0	26811
		RODENTIA	MURIDAE	<i>Acomys</i>	<i>spinosissimus</i>	1	2	
			MURIDAE	<i>Grammomys</i>	<i>dolichurus</i>	1	0	26812
			MURIDAE	<i>Mastomys</i>	<i>natalensis</i>	8	1	26810, 26809

Forest Reserve	Location	Taxon	Family	Genus	Species	Sherman traps (bucket pitfalls)	No. recaptured	Record no. (KMH)
		SAURIA	SCINCIDAE	<i>Trachylepis</i>	<i>megalura</i>	1	0	
Ndechela	Zoo site 10	MUROIDEA	GERBILLINAE	<i>Tatera</i>	<i>robusta</i>	1	0	26815
		RODENTIA	MURIDAE	<i>Acomys</i>	<i>spinosissimus</i>	1	1	
			MURIDAE	<i>Grammomys</i>	<i>dolichurus</i>	1	0	26814
		SAURIA	SCINCIDAE	<i>Trachylepis</i>	<i>varia</i>	(1)	0	

APPENDIX 19 - STRUCTURED INTERVIEW SHEET

DATE

NAME OF INTERVIEWEE

VILLAGE & STUDY SITE

TRIBE

RELIGION

SOURCE OF INCOME

WATER SUPPLY

FUEL SOURCE

SOURCE/SPECIES/QUANTITY

BUILDING POLES / FURNITURE

SOURCE/SPECIES/QUANTITY

VILLAGE WOOD LOT / PLANTATION

MEDICINAL PLANTS

SOURCE/SPECIES/QUANTITY

FOREST PRODUCTS EXPORTED

SOURCE/SPECIES/QUANTITY

- BY WHOM

- WHEN

- WHERE SOLD

OTHER FOREST PRODUCTS

(MUSHROOMS/GUM/HONEY etc.)

- GATHERING METHODS

ANIMALS HUNTED

- HUNTING METHOD

ATTITUDE TO FOREST

HISTORICAL EXTENT OF FOREST

LARGE FOREST MAMMALS FOUND

OTHER NOTES

RELIABILITY OF ANSWERS

COMPLETED BY