SERIKALI YA MAPINDUZI ZANZIBAR

CARE TANZANIA AND DEPARTMENT OF COMMERCIAL CROPS, FRUITS AND FORESTRY

NGEZI – VUMAWIMBI FOREST RESERVES BIODIVERSITY INVENTORY REPORT

PREPARED BY

C. L. NAHONYO, L. B. MWASUMBI, C. A. MSUYA, C.A. MASAO, T. B. SUYA AND C. SHING'WENDA

DEPARTMENT OF ZOOLOGY AND MARINE BIOLOGY
UNIVERSITY OF DAR ES SALAAM
P. O. BOX 35064
DAR ES SALAAM, TANZANIA

nahonyo@uccmail.co.tz

JULY 2005

Table of Contents

Item **Page**

Title……..……... i
Table of Contents…….. ii
List of Tables……. iv
List of Figures…… v
List of Maps……... v
List of Appendices……. vi
Acknowledgements…… vii
Map showing position of Pemba relative to Tanzania mainland…….….. viii
Map of Zanzibar showing position of Ngezi –Vumawimbi Forest Reserves.……... ix
Executive Summary……... x
1.0 INTRODUCTION……... 1
1.1 Overview of Tanzania biodiversity…… 2
1.2 Brief history of Ngezi –Vumawimbi study area…… 3
1.2.1 History of Ngezi forest…… 3
2.0 THE SURVEY AREA……. 5
2.1 Location……. 5
2.2 Scope…….. 5
2.3 Accessibility……... 5
2.4 Topography…… 5
2.5 Geology and hydrology...…….. 6
2.6 Soils……... 6
2.7 Climate……... 6
2.8 Vegetation…….. 9
2.9 Fauna…… 9
2.10 Land tenure, land use and habitats……... 10
2.11 Human demography…… 10
3.0 METHODS…….…. 11
3.1 Vegetation Sampling…….. 11
3.2 Vegetation Mapping…….. 12
3.2.1 Interpretation and field verification…….. 12
3.2.2 Digitatization and rectifications…… 12
3.3 Fauna inventory……. 12
3.3.1 Reconnaissance survey……. 12
3.3.2 Fauna sampling……. 12
3.3.2.1Mammals…….. 16
3.3.2.2 Small mammals…… 16
3.3.2.3 Birds……. 18
3.3.2.4 Reptiles…… 18
3.3.2.5 Amphibians…….…. 18
3.3.2.6 Fish…….…. 18
3.3.2.7 Invertebrates……. 18
3.4 Socio economic survey…….. 19
3.5 Legend to threatened and endangered species of flora and fauna……. 20
4.0 RESULTS AND DISCUSSION……. 21
4.1 Vegetation…….. 21
4.1.1 Synopsis of the vegetation types……..…… 21
4.1.2 Description of vegetation types……..…….. 23
4.1.2.1 Natural moist forest…… 23
Item **Page**
4.1.2.2 Moist forest mixed with exotic species…….. 24
4.1.2.3 Microsites of open pools/ponds in moist forests…… 24
4.1.2.4 Coastal dry evergreen forest on coral rag……... 24
4.1.2.5 Coastal evergreen dry forest on sandy soils…… 25
4.1.2.6 Coastal evergreen thicket…… 25

4.1.2.7 Fresh water swamp forest……... 25
4.1.2.8 Fragmented Remnants…… 26
4.1.2.9 Erica Vegetation……. 27
4.1.2.10 Mangrove Thickets……... 27
4.1.2.11 Fresh water swamp in open land…….. 28
4.1.2.12 Rice field landscape and other crops fields…….. 28
4.1.3 Indicator species and criteria to diagnose ecological condition.. 28
4.1.4 Evaluation of plant biological resources……. 32
4.1.5 Plant species diversity……. 34
4.1.6 Medicinal Plants……. 34
4.1.7 Conservation values of the forest…… 36
4.1.8 Conservation Status of the forest…… 37
4.1.9 Endemic, endangered and introduced plant species……... 40
4.2 Fauna…….. 44
4.2.1 Mammal occurrence and distribution…… 44
4.2.2 Relative abundance of animals……... 52
4.2.3 Animal species richness and diversity…… 53
4.2.4 Important habitats for animals…… 53
4.2.5 Animal movement and migration……... 54
4.2.6 Birds…… 54
4.2 7 Reptiles……... 55
4.2.8 Amphibians……. 55
4.2.9 Endemic species of animals…… 56
4.2.10 Threatened and endangered animal species…….. 57
4.2.11 Introduced species of animals……... 58
4.2.12 Fish…… 59
4.2.12.1 Fisheries resources…… 59
4.2.12.2 Fish species occurrence, endemism and diversity in Ngezi……. 59
4.2.12.3 Fish movement and migration…….…. 60
4.2.12.4 Fish habitats and spawning areas…….…. 60
4.2.12.5 Threatened species of fish (IUCN threat categories)…… 61
4.2.12.6 Fishing and fish production…….. 62
4.2.12.7 Threats to fisheries resources…… 63
4.2.12.8 Fisheries conservation…….. 63
4.2.3 Invertebrates (Lepidopterans and Odonata)……... 63
4.4 Socio-economic Survey…….. 65
4.4.1 Demographic characteristics…….. 65
4.4.2 Crops grown……... 66
4.4.3 Livestock keeping…….. 67
Item **Page**
4.4.4 Resources utilization…….. 67
4.4.5 Threats to biodiversity……... 69
4.4.6 Future management of Ngezi Forest Reserve…… 70
4.4.7 Socio economic recommendations…… 72
6.0 EVALUATION OF BIOLOGICAL RESOURCES AND THEIR CONSERVATION VALUE……... 74
7.0 POTENTIAL THREATS TO BIODIVERSITY…….. 74
8.0 GENERAL RECOMMENDATIONS…….. 78
9.0 REFERENCES……. 83

Terms of reference……. 90
Appendices……. 91
Plates…….. 135

List of Tables

Item **Page**
Table 2.1: Human population distribution by Shehia in the study area, Pemba…… 11
Table 2.2: Human population in villages in the immediate vicinity of Ngezi forest, Pemba…….. 11
Table 3.1: Description of transects used to sample plants, small mammals, reptiles, amphibians and invertebrates in Ngezi - Vumawimbi Forest Reserves, Pemba……... 15
Table 4.1: Synopsis of main vegetation types in Ngezi – Vumawimbi Forest reserves, Pemba…….. 21
Table 4.2: Summary of tree data for the different vegetation types in Ngezi, Pemba…….. 22
Table 4.3: Land cover/Land use of Ngezi – Vumawimbi Forest Reserves and surrounding areas, Pemba…… 23
Table 4.4: Common herbaceous species occurring in seasonally water logged pools in Ericaceous bushland in Ngezi forest, Pemba……. 27
Table 4.5: Woody herbs and other herbaceous vegetation occurring in fresh water swamps in open land surrounding Ngezi forest, Pemba……. 28
Table 4.6: Trees used for commercial timber harvesting and other uses in Ngezi forest, Pemba…… 33
Table 4.7a: Some plant species with medicinal values in Ngezi forest reserve, Pemba……... 34
Table 4.7b: Records of medicinal plants also available in Ngezi forest used traditionally as primary source of health care…….. 35
Table 4.8a: List of new records of plant species from Ngezi forest, Pemba.. 37
Table 4.8b: List of new records of non-vascular (mushroom) plant species from Ngezi forest, Pemba……... 40
Table 4.9: Endemic species of the Zanzibar-Inhambane regional centre of endemism including Lowland and Eastern Arc Forests occurring in Ngezi forest and surroundings in Pemba……. 41
Table 4.10: Threatened plant species of Ngezi forest reserve, Pemba……... 43
Table 4.11: Animals and animal signs observed during foot count in Ngezi – Vumawimbi forest reserves, Pemba……. 45
Table 4.12: Total number of fauna specimens captured in traps (bucket pitfalls, snaps, Sherman's, cage) in Ngezi forest, Pemba……. 52
Table 4.13: Relative abundance of some vertebrate groups and species in Ngezi - Vumawimbi forest reserves, Pemba……. 53
Table 4.14: Distribution of different habitats in Ngezi - Vumawimbi forest reserves, Pemba…… 54
Table 4.15: Endemic and near endemic fauna species and sub species of Pemba… 56
Table 4.16: New record of fauna of Pemba……... 57
Table 4.17: Threatened and endangered animal species listed in IUCN redlist, and species listed in CITES Appendices found in Ngezi – Vumawimbi forest reserves and surrounding areas, Pemba…… 58
Table 4.18: Some animal species introduced to Pemba and Zanzibar……... 58
Table 4.19: Threatened fish species (IUCN) reported as occurring in Pemba and

Zanzibar…… 61
Table 4.20: The reported disadvantages experienced after the initiation of total protection programme at Ngezi forest…….. 70
Table 4.21: The declared suggestions/comments offered by the respondents regarding their views for future management of Ngezi forest…….. 71
Table 6.1: Summary of potential threats to biodiversity in Ngezi - Vumawimbi forest reserves, Pemba……... 77

List of Figures

Item **Page**
Figure 4.1: Tree density (trees ha^{-1}) shown against basal area (m^2 ha^{-1}) for the six sampled vegetation transects in Ngezi forest reserve, Pemba……. 30
Figure 4.2: dbh versus number of trees (stems) in each of the six sampled transects in Ngezi forest reserve, Pemba…….. 30
Figure 4.3: Height range (in metres) versus number of trees in six sampled transects in Ngezi forest reserve, Pemba…….. 31
Figure 4.4: Number of vervet monkeys observed on 6 foot count transects sampled in Ngezi – Vumawimbi forest reserves, Pemba……. 46
Figure 4.5: Total catch of various taxonomic groups of fauna using bucket pitfalls, snap and live traps in Ngezi forest, Pemba……. 52
Figure 4.6: The declared age classes of the 200 respondents from the study villages combined……. 66
Figure 4.7: Reported origins of the respondents in the studied villages……. 67
Figure 4.8: Reported activities/occupation of the respondents in the studied villages…….. 68
Figure 4.9: Declared uses of the forest products by the respondents from the studied villages……. 68

List of Maps

Item **Page**
Map 1: Tanzania mainland and Zanzibar Islands…….. viii
Map 2: Location of the study area……. ix
Map 3: Digital elevation model……. 7
Map 4: Ngezi – Vumawimbi Forest Reserve……..…… 8
Map 5: Ngezi – Vumawimbi Forest Reserve; vegetation Cover 13
Map 6: Sample points…… 14
Map 7: Animal foot count transects…….. 17

List of Appendices

Item **Page**
Appendix 1a: An annotated check-list of the Flora of Ngezi Forest, Reserve, NE, Pemba……. 91
Appendix 1b: Relative densities and relative frequency…….. 106
Appendix 1c: Reported plant species and their main uses in the studied villages around Ngezi forest, pemba……... 112
Appendix 2: Trap success from bucket pitfalls, snap traps and live traps (Sherman's and cage) in Ngezi forest reserve, Pemba……... 115

Appendix 3: A checklist of mammals recorded at Ngezi forest reserve and the surroundings, Pemba……. 118
Appendix 4: A checklist of birds recorded at Ngezi Forest Reserve and the surroundings, Pemba Island……... 119
Appendix 5: A checklist of reptiles recorded at Ngezi Forest Reserve and the surroundings, Pemba……. 125
Appendix 6: A checklist of amphibians recorded at Ngezi forest reserve and the surroundings, Pemba…….. 126
Appendix 7a: Marine fish recorded in nine villages around Ngezi forest….. 126
Appendix 7b: Freshwater fishes around Ngezi forest……. 128
Appendix 8a: Butterflies sampled in six transects in Ngezi forest, Pemba… 129
Appendix 8b: Moths sampled in six transects in Ngezi forest, Pemba……... 130
Appendix 8c: Odonata sampled in six transects in Ngezi forest, Pemba….. 131
Appendix 9a: Checklist of Lepidoptera (butterflies and Moths) from Ngezi Forest Reserve, Pemba…… 131
Appendic 9b: Checklist of Odonata (Dragonflies and Damselflies) sampled from Ngezi forest, Pemba…….. 132
Appendix 9c: Reported use of some animals and birds from Ngezi forest, Pemba ……..…… 133

Acknowledgements

We would like to thank CARE Tanzania for funding this biodiversity inventory. We are grateful for the time and commitment of CARE Zanzibar and Pemba staff Thabit Masoud who worked closely with Mr Amour, the Government CARE coordinator Mr. Mbarouk, and members of staff from Department of Commercial Crops, Fruits, and Forestry particularly the Ngezi Project manager Mr. Selemani, his assistant Mr Salim Saidand Ms. Fatma, Mr. Mussa Bakari, Mr. Salim Khamis and drivers Hamisi, Mohamed and Khalfan who devoted most of their time to ensure that this exercise becomes a success. The forest staff at Ngezi participated in the field excursions and the local communities around Ngezi forest were friendly and cheerfully participated in the fieldwork and during the questionnaire interviews. We sincerely thank Prof. Kim M. Howell who volunteered to help in the fieldwork and report writing at his own cost. We thank them all.

Executive Summary

A biodiversity inventory of Ngezi – Vumawimbi Forest Reserves in Pemba was undertaken in January 2005. Ngezi forest together with the Eastern Arc Mountains and coastal forests are recognized as one of the global biodiversity hotspots. The inventory was preceded by a reconnaissance survey involving three members of the team from 17th to 19th December 2004, which allowed the team to see the study area and determine sampling plots. This was followed by fieldwork by 8 team members from 2nd to 12th of January 2005. The main goals of the inventory were to produce a vegetation map of the area and provide species lists of plants, mammals, reptiles, amphibians, fish and selected invertebrates (Lepidoptera and Odonata). The survey was also expected to provide an indication of the conservation status, endemism, distribution and relative abundance of the various species.

Vegetation sampling was conducted at selected sites in different habitat types using the Nested Quadrat Method. Opportunistic sampling of plants outside designated transects was also done. There was a total of 26 vegetation study plots surveyed on 6 strategically selected transects. For medium and large mammals foot counts on line transects and opportunistic sampling were employed. Vocalisation was the most useful method for identifying the prosimians (bushbabies). Small mammals were sampled along transects using bucket pitfalls, snap and Sherman traps at selected sites. Reptiles were also sampled opportunistically. Amphibians were sampled using bucket pitfalls and indirect methods such as vocalisation, while tree frogs were also collected opportunistically. Fish data was collected from artisanal fishermen and from office records. Invertebrates were collected using sweep nets, banana and light traps. For all taxonomic groups of flora and fauna additional information was obtained from previous surveys and literature. At least 355 vascular plant species belonging to 91 families were recorded in the survey area. There were a total of 73 new plant species recorded for Ngezi of which 60 were vascular and 14 were non vascular plants (mushrooms). Of the 73 new records 8 are new species to science and includes 1 vascular and 7 non-vascular species. A new vascular plant to science is *Uvaria* sp. nov. a liana observed at Chokaani coral rag and Mkia wa Ng'ombe areas. Flowers and fruits of the new plant species are needed for further identification and classification. Three plant species are new Flora of Tropical East Africa (FTEA) records for Pemba. These include *Uvaria lucida* (liana), which is seen in coastal forests on the mainland e.g. thickets near Ruvu area. Others are *Oncinotis tenuiloba* (climber), and *Cissus oliveri* (climber). The non vascular (mushrooms) new species to science are *Phellinus* sp., *Ganoderma* sp.1, *Ganoderma* sp.2, *Trametes cf. gibbosa*, *Microporus* sp.1, *Microporus* sp.2, and *Xylaria* sp. These are found in various places in the forest. The new non-vascular species need to be studied during rains by collecting spores from fresh mushrooms for microscopic identification. There are at least 8 strict endemic plants to Pemba

including *Connarus* sp.nov., *Chrysolidicarpus pembanus*, *Ensette proboscidium*, *Ananas comosus* var. (wild variety of *Ananas*), *Erica mafiensis* (found also in Mafia Island), *Vangueria* sp. nov.vel.gem.aff, and *Uvaria* sp.nov. The other 14 species are broad endemics found also in Zanzibar and some coastal forests on the mainland. At least 5 plant species are reported to be rare including *Quassia undulate*, *Erica mafiensis*, *Allophylus vestivus*, *Eugenia capensis*, ssp. *multiflora* and *Typhonodorum lindleyamum*. Within Ngezi and surrounding areas at least 22 plants have been introduced and some of which are naturalized. About 17 plant species are known to be threatened based on either IUCN or CITES red lists or both. There are 43 plants reported to have medicinal values some of which have scientifically proven potency. On the other hand 19 trees occurring in the forest are reported to be used for timber extraction. As observed in Zanzibar the *Acacia* genus is also missing on Pemba Island.

About 12 main vegetation types were recognized more than previously reported. These includes moist forest on soils with high humidity and organic humus, moist forest mixed with exotic species, microsite of pools, coastal evergreen dry forest on coral rags, coastal evergreen dry forest on sandy soils and coastal evergreen dry thickets on shallow soils overlying coral limestone. Others include fresh water swamp forest restricted to shallow soil valleys with very slow drainage, *Erica* bushland on the water-logged sites of former shallow lagoons, fragmented moist forest to the south with remnants of dry patches representing anthropic landscape, mangrove formation on saline swamp forest, fresh water swamps and Arable landscape. In some areas of the forest, the vegetation structure and composition resembles very closely with that of the Eastern Arc ranges on the mainland. Thus justifying the inclusion of Pemba as part of the eastern arc ranges as well as part of the biodiversity hotspot. Most of the remaining tropical moist forest in Ngezi maintains a thick forest (c.1,000 hectares) with large trees up to 30–40m high and some trees had quite large dbh e.g. *Bombax rhodognaphalon* (3m), *Adansonia digitata* (4-5m) and *Antiaris toxicaria* (2-3m). Such a prisitine forest with large trees is not found in Jozani Zanzibar because the great hurricane of 1892 seriously devastated Zanzibar Island and its vegetation and missed Pemba, hence left the island and its vegetation (trees) intact. Invasive plants, vegetation clearing, and over-exploitation are the major threats to plant biodiversity in the Ngezi area.

Mammals occur in most of the twelve vegetation types in the study area with vervet monkeys, bats, hyraxes, prosimians and rodents being ubiquitous. Few small mammals appeared to be relatively abundant and widely distributed, particularly rodents, hyraxes and bats. A total of 30 mammal, 131 birds, 25 reptiles 9 amphibians, 87 marine fishes, 5 freshwater fishes, 35 Lepidoptera and 10 Odonata species were recorded during the survey. In total there were 15 new records of fauna to Pemba including 1 mammal (Cape Clawless Otter – *Aonyx capensis*),

1 bird (Violet backed Starling – *Cinnyricinulus leugcogaster*) 1 lizard (*Panaspis* sp.) 2 amphibians (*Schoutedenella xenodactyloides* and *Hyperolius* sp.) and 11 butterflies. One amphibian species *Phrynobatrachus* was collected in Ngezi forest around Kwajoshi and Machopeni areas. According to previous reports the only member of this genus found on the island is *P. pakenhami,* which is endemic to Pemba. However, the taxonomic status of the collected specimen of *Phrynobatrachus parkenhami* is very uncertain due to the fact that the specimen does not fit well with the description of both *P. pakenhami* and *P. acridoides*. The snought-vent measurements and body texture of the three specimens collected during the survey suggest the specimens represent a new species. In this report the species is questionably been regarded as *P. pakenhami*?. Details of the new species including its ecology are being sought to be used in description and classification. There is potential of new amphibian discoveries in Ngezi if studies are done when it is raining. The study team in January 2005 was not lucky to have rains during the 10 days of sampling. There is high fauna endemism with at least 26 endemic or broad endemic species. These include 7 mammals (3 strict endemics), 8 birds (7 strict endemics), 7 reptiles (all strict endemics), and 4 butterfly species (3 strict endemics). At least 35 species are threatened or endangered including 8 mammals, 3 reptiles and 21 fish. There are 4 animal species all mammals introduced to Pemba and some became naturalized. Although their effects have not been determined species like House rat (*Rattus rattus*) are known pests and potential vectors of disease such as plague. The fauna is mostly threatened by hunting/exploitation, habitat loss and fragmentation, the small and declining populations' paradigms and pollution.

It is estimated that 20,138 people surrounding Ngezi and Vumawimbi forests of which 11,950 people live within the immediate vicinity of the forests. About 80% of these people are engaged in agriculture as their main source of income and 10% depended mostly on fishing. Almost all people interviewed said they depend on the forests in some way for various requirements including land, fuelwood, building materials, timber, medicinal plants, hunting and worship sites.

In summary the main threats to the forest and its biodiversity include habitat loss (small size and encroachment), fragmentation, resources overexploitation (of both flora and fauna resources), introduced species (both plants and animals) and disturbance. Immediate measures need to be taken to conserve the rare, endemic, threatened, endangered and other species occurring inside the forest reserves and surrounding areas. Control of biodiversity exploitation and habitat protection are immediate measures which are recommended to be taken to reduce, halt or reverse some negative trends of the affected populations while long term comprehensive management plans for the conservation of the habitats and species are being

prepared. Conservation programmes will need to be supported by monitoring programmes of biological and physical resources found inside and outside the forest reserves. In planning for future effective forest conservation strategies, community forest management should be taken into consideration.

1.0 INTRODUCTION

The introduction section has been adopted from Nahonyo *et al*., (2002). Biodiversity includes all organisms, species, and populations; the genetic variation among these; and all their complex assemblages of communities and ecosystems. It also refers to the interrelatedness of genes, species, and ecosystems and their interactions with the environment.

Maintaining a wide diversity of species in each ecosystem is necessary to preserve the web of life that sustains all living things. In his book "The Diversity of Life," Wilson (1992) said, "It is reckless to suppose that biodiversity can be diminished indefinitely without threatening humanity itself." Human activity has caused an alarming number of species to become extinct. When a large number of species perform various functions, an ecosystem is more stable. The fewer species there are filling certain niches, the more unstable the environment becomes. Humans have always depended on the Earth's biodiversity for food, shelter, and health. Biodiversity also supplies indirect services to humans, which include drinkable water, clean air, and fertile soils. The loss of populations, species, or groups of species from an ecosystem can upset its normal function and disrupt these ecological services.

The Earth's biodiversity contributes to the productivity of natural and agricultural systems. Insects, bats, birds, and other animals serve as pollinators. Parasites and predators can act as natural pest controls. Various organisms are responsible for recycling organic materials and maintaining the productivity of soil. Genetic diversity is also important in terms of evolution. The loss of individuals, populations, and species decreases the variety of genes (genetic diversity) the material needed for species and populations to adapt to changing conditions or for new species to evolve.

In recent years knowledge of biodiversity has increased, as has the realization that something must be done to counteract the loss of species, populations, and ecosystems. There is still much to be learned about biodiversity and its relationship to the functioning of our world. Ecologists conduct research to better understand biodiversity, quantify its loss, and develop strategies for conserving and using it. Much is still unknown as to what species exist, where they occur, and the relationships between them. By inventorying and monitoring biodiversity, ecologists study species abundance, functions, interactions, and importance to maintaining or enhancing the quality of human life.

Biodiversity hotspots are biologically rich areas that are under extreme threat. Together, they contain more than 60 percent of terrestrial biodiversity on just 1.4 percent of Earth's land surface. The hotspots contain concentrations of endemic species in areas, which are undergoing exceptional loss of habitat. As many as 44% of all species of vascular plants and 35% of all species in four vertebrate groups are confined to 25 hotspots already identified all over the world. The conservation effort priority in conserving the hotspots is based on their share of the world's species at risk. The threat to species diversity is reflected in the mounting loss of forests and other plant and animal habitat worldwide. Eighty-eight percent of the original hotspots are already destroyed. Some 12 percent of all mammal species and 11 percent of all bird species are currently threatened with extinction. Humankind is a successful breed.

His advance from hominid origins has brought mankind to near-dominance of the world as well as trying to understand it. Scientists now say we are in a new stage of the Earth's history, the Anthropocene Epoch, when human species has become the globe's principal force. In addition several eminent scientists are concerned that we have become too successful - that the unprecedented human pressure on the Earth's ecosystems threatens our future as a species. We now confront problems more intractable than any previous generation, some of them at the moment apparently insoluble.

As part of its strategy to conserve the biological diversity on the islands the Revolutionary Government of Zanzibar through the Department of Commercial Crops, Fruits, and Forestry in collaboration with CARE Zanzibar intends to enhance the protection of Ngezi –Vumawimbi forest reserves in Pemba in order to protect the habitat and species contained therein. This initiative is important due to potential threats facing the plant and animal species and the forest in general. However, this is only possible when species present in the area together with their conservation status is known. To provide sound biological data on which to base conservation activities the Revolutionary Government of Zanzibar and CARE Zanzibar initiated an inventory of the Ngezi - Vumawimbi Forest Reserves. The main areas of interest for the survey were on vegetation, mammals, reptiles, amphibians, fish and selected groups of invertebrates.

1.1 Overview of Tanzania biodiversity

Tanzania has a rich and diverse spectrum of animals and plants including a wide variety of endemic species and subspecies. The diversity and degree of endemism in Tanzania is fairly high, for example, of the 18 primate species, 5 are endemic, there are 30 antelope species and 2 are endemic, and 60 species of reptiles are endemic out of the 227 species present in the country. There are also many other species of fish, birds, amphibians and plants unique to our country (Wildlife Division 1998). There are over 600 endemic plant species in Tanzania most of them in the eastern arc forests/coastal forests. There are other species still unknown to science and are awaiting discovery particularly in the eastern arc mountains, Zanzibar and Pemba islands.

Within the coastal forests biodiversity hotspots in East Africa, the importance of Zanzibar and Pemba islands has long been recognised. Pemba has been separated from the mainland Tanzania for about 10 million years. During this time species have been evolving separately from their mainland counterparts. This has resulted in the presence of a number of new and endemic species and sub species of both flora and fauna. This inventory was an attempt to explore areas and taxa which may have been missed in previous studies (by various groups and individuals). Apparently very little research has been done in Pemba and there is not much documentation involving biological diversity aspects. This means little is known on the past status of flora and fauna of Pemba. The occurrence and conservation status of a number of already known species was assessed during the survey.

Tanzania has completed a country study on biodiversity as one its obligations under the Convention on Biological Diversity (CBD). On the other hand, a number of studies have been undertaken on the flora and fauna of Unguja and Pemba. While some studies were general surveys covering broad areas others were focused on Ngezi

forest in Pemba and Jozani Forest in Zanzibar the two main remaining sanctuaries for both plant and animal species on the islands. Moreau and Pakenham (1941) conducted a zoogeography study of Pemba and Zanzibar and Pakenham (1984) produced a checklist of mammals of Zanzibar and Pemba islands. Leskinen *et al*. (1997) conducted a wood biomass inventory of Zanzibar islands while Pikkarainen (1991) conducted an inventory of Jozani and Ngezi forests. Ruffo (1992) conducted a vegetation inventory of Jozani and Ngezi forests, while an inventory of Unguja and Pemba coral rag forests was undertaken by Leskinen and Silima (1993). Studies on individual animal species include those on the Zanzibar leopard by Marshall (1994), Goldman and Walsh (1997) and by Stuart (1999). Reports on the Zanzibar Red Colobus are available from Silkiluwasha (1981), Mturi (1991, 1993), Struhsaker and Siex (1998), Siex and Struhsaker (1999), Nowak (2000) and Masoud *et al*. (2001). Duikers have been studied by Swai (1983a, 1983b), Archer and Mwinyi (1995) and Williams *et al*. (1995).

1.2 Brief history of Ngezi - Vumawimbi study area

According to Abdullah, *et al*. (1996) the areas near Ngezi forest have been settled for quite a long time. The archeological evidences as supported by the remains of the ruins of the mosques with tombs date back the area to between 11^{th} –14^{th} centuries. This is supported by the archeological researches which included Mkia wa Ng'ombe, Tondooni and Msuka Mjini. To the side of the ruin of the Mosque of Mkia wa Ngombe is a mound of sand. This is believed to be the remains of one or more dwellings of people residing at this site so long ago. This area is believed to have a structure that was used as headquarters for either the Arabs or Persians who once lived here.

The present day Makangale village, earlier called Msuka Mjini was a human habitation centre as pointed out by ZCCFSP, (1995). Likewise, people from Kipange and Limani formally inhabited Tondooni and Mkia wa Ng'ombe, respectively. Apart from natives of Pemba, people form south of Mainland Tanzania particularly Makonde and Nyamwezi from Tabora migrated to this place and settled near Ngezi at around 20^{th} century. They cleared land for cultivation of agricultural crops and hunted for their food. In 1970s, during a period of food shortage, people from other areas of Pemba, as well as Mainland started moving to Makangale to cultivate in areas east of Ngezi that lead to a noticeable population increase. Abdullah *et al*. (1996), pointed out that this place may have had links to Makonde Cave situated at Shanzu at the boundary of the Ngezi Forest, less than a kilometer north of Mkia wa Ng'ombe village. The cave is accessible through the Mkia wa Ng'ombe/Tondooni path just in the west of the *Erica mafiensis* stand.

1.2.1 History of Ngezi forest

- During 1920's the importance of Ngezi Forest started to be realized by the colonial government. It was during this period when the first inventory and management plan was prepared. The management plan basically focused on commercial utilization of forest products rather than conservation activities.
- In the 1950's the forest was divided into 84 administrative units called compartments. This was done for easy management, extraction of timber and other activities deemed important by that time (Beentje 1990).

- During 1957, an Indian merchant called V.R.Joshi installed a sawmill in compartment 31 in the forest and started sawing timber, which was transported to outside Zanzibar, possibly to India and other parts of Asia.
- In 1959 Ngezi forest attained a status of being a forest reserve.
- In 1963 the first batch and planting of *Maesopsis eminii* was introduced to the forest from Usambara. This was aimed at filling gaps within the opened areas where timber extraction had been taking place.
- Parallel to planting of *Maesopsis eminii*, enrichment planting of indigenous tree species that were commercially harvested was done. This included such species as *Milicia excelsa, Antiaris toxicaria and exotic species such as Calophyllum innophyllum, Terminalia ivorensis, Cordia alliodora, Khaya nyasica and Tabebuia pentaphylla.*
- In January 1964 the colonial government was overthrown and so following that revolution, the Zanzibar government confiscated the sawmill in the forest. This had made the merchant to leave the country and the government started running the mill and the logging operations.
- In 1968 Vumawimbi was declared a forest reserve and became part of Ngezi management. However people continued to live in Vumawimbi forest as laws were not enforced to evacauate people from the reserve.
- During 1974 Kizimbani saw mill in Wete town was built and sawing of logs in the forest was stopped following the Chinese sawmill installation. The forest had to feed the sawmill in Wete with the raw materials.
- In late 1970s i.e. (1977/79) replanting of *Maesopsis eminii* in areas in which the government cleared for rubber plantation establishment, continued for the second time, after failure of the decision of planting of rubber in the forest where it was directed outside the forest reserve.
- During 1980's realization of colonization of invasive *Maesopsis eminii* to other species started to be noticed and different eradication means were launched. These included uprooting, use of chemicals, which was later discouraged and hence ring debarking along with uprooting had been done since then up to date. Due to its fast growth rate and tendency of colonizing the area, this species has become noxious species. Nevetheless, the Maeopsis eminii is currently playing a significant ecological role in the area as it has established an microenvironment which harbours a variaety of fauna species. Its eradication has to be undertaken with great care.
- Harvesting had to take place to feed the sawmill until, up to 1980's when the importance of conservation globally started to be known, and by 1988 commercial harvesting was officially stopped following FinniDA involvement in conservation activities. Enrichment planting continued parallel with other conservation activities, which included species such as *Afzelia quanzensis, Milicia excelsa, Calophyllum innophyllum, terminalia cattapa and Erythrophloeum suaveolens.* FinniDA continued funding conservation activities in Ngezi forest up to 1997 when they pulled out.
- During 1996 the first management plan after revolution was prepared to cover the five years period; 1996-2001.The preparation of this management plan involved the communities and local officers. It divided the forest into natural zone, which allowed minimal human interferences including scientific, tourism and recreation. The multiple use zones, allowed very low impact use of fuel wood, building poles, medicinal plants, collection of basketry materials, ropes, fruits and honey.

However implementation of this management plan was difficult due to lack of funds that were expected to come from donors who had pulled out one year of plan preparation.

- During 2000, funding of CARE TANZANIA came in as part of JCBW area, which included Kiwengwa and Ngezi forest. Different improvements in activities left by FinniDA were tackled giving priority in community participation in the conservation of the forest. Among the activities done were Tourist facilities improvement, Conservation education promotion, Social studies conduction and local communities' participation in forest related issues. Within this information center, nature trail and long hiking trails were periodically renovated along with well digging near information centre.
- From 2003/2007, CARE is expected to undertake capacity building activities to stakeholders around the forest. This will include assisting farmers, fishermen, and livestock keepers. Among activities in practice include, seminars, workshop and study visits; small scale nursery, woodlots, saving and credits and matching loan. Artificial Insemination, cattle deep and cattle spraying. This is expected to decrease pressures on the forest.
- Currently Ngezi – Vumawimbi forest reserves have a work force of 14 people including forest guards, 4 tour guides, manager and assistant manager.

The reserve is important for maintenance of water reservoirs feeding many streams, which flow throughout, and is part of historical, social and cultural inheritance to the people of Pemba Island. The indigenous forests are also important because they are sources of genetic diversity for adaptation to new environments for resistance against diseases and pests. They are as well reservoirs of other potentially useful species (Eldridge *et al.* 1993). Apart from trees for timber, they are also potential sources of food, building material, fuel wood, vegetables and medicines.

Introduction of alien species, especially the exotic timber trees to replenish over harvested species, has in many cases some how increased species diversity with no apparent danger to native species. Many native species maintain themselves successfully in mixed native/exotic ecosystems (Mueller – Dombois *et al*. 1986).

Before the forest was made a reserve, the local community used to enjoy these values of forest products including timber, building materials, medicines and food. Currently added values are going to include recreation for tourists; research facilities and training for schools. The reserve is of particular importance because it contains a diversity of vegetation communities having a variety of unique relic stands of plants and animals. These have established themselves as endemic to specific habitats over a long period of isolation enjoyed by Pemba Island.

2.0 THE SURVEY AREA

2.1 Location

The study area is located on the northern part of Pemba Island (Map 1, Map 2). Standing on the beaches of Chokaani peninsula, one would be approximately 50 km from the mainland Tanzania. The forest is located some 25 kilometers from Wete, and it is 55 km from Chakechake (using new tarmac road) or 38 km (using barabara kongwe). Ngezi is approximately 80 km from Mkoani and about 8 km from Konde village. The forest is situated between E 39° 34', S 6° 16' and 39° 45', S 6° 28'.

2.2 Scope

The area of Ngezi - Vumawimbi forest reserve is 20 sq. km. (1,975 ha.) (see Map 2 and Map 4). The forest falls within Kaskazini Pemba administrative Region in Micheweni District. The study area was within four Shehias of Makangale, Kifundi Konde and Msuka and covered ten villages of Kijijini, Jiwe Moja, Makangale Tondooni, Mkia wa Ng'ombe, Bandari Kuu, Kiuyu Kipangani, Mji Mpya, Kiuyu kwa Manda and Gombani Mtoni.

2.3 Accessibility

Ngezi - Vumawimbi forest can be reached by both road and sea. One can drive from Wete, Micheweni or Chakechake to Ngezi via tarmac road passing through Konde village to Kigomasha in northwest of Pemba. Konde is the main village boardering the forest. One can also reach the forest via various small ports and landing stations in places like Mkia wa Ng'ombe, Chokaani, Tondooni and Bandari Kuu.

2.4 Topography

Unlike Zanzibar Island, Pemba is hilly with undulating landscape occurring with valleys some quite steep and dry river beds. The terrain in the forest area is undulating with gentle slopes with few hillocks harbouring the moist forest. Altitude in Ngezi forest ranges from sea level to around 20 meters a.s.l. on a small hill at Tondooni along the way to Mkia wa Ng'ombe village. Most areas however, lie between 5 to 10 m a.s.l. (see the Digital Elevation Model Map 3).

2.5 Geology and hydrology

Zanzibar Island lies in continetal shelf surrounded with 35 - 50 meters deep water while Pemba Island is surrounded by comparatively deep water of strong currents as within few meters from the coast water depth change rapidly from 100 meters to 700 - 800 meters deep. This makes Pemba to fall into a class of "ancient continental islands" as described by Wallace (1892) quoted in (Moreau and Pakenham 1941). Towards the end of Miocene about 10 million years ago rift faulting occurred which separated Pemba from the mainland. On the other hand Zanzibar separation from the mainland is only recent during the Ice age that is under 500,000 years. This means Pemba island animals have been isolated from crossing with their continental congeners for at least 20 times as long as on Zanzibar.

Large part of Ngezi falls in Q2, charactersied by Quaternary coral line and reef limestone. The Q2 of Pemba is lithologically similar to the Q2 of Zanzibar, but differs in that the Pemba one is raised coral reef and unweathered to the extent of the Zanzibar rock. It is an equally hard cherty limestone, buff to grey in colour. The hydrogeology of Pemba's Q2 limestone is a coastal deposit occurring entirely within the tidal area of the east coast. It has no hydrological significance. The geohydrology of Pemba forms discontinuous perched aquifers, which fails seasonally. The water quality is characterised by high Ec values and seawater invasion.

2.6 Soils

According to Beentje (1990), soils in Ngezi Forest can be grouped into four types:

- **Clay soils**: These cover the waterlogged areas near the “ponds” on the northern border and along the streams within the sands
- Sandy loams and sand
    - Red sandy loams found along the eastern perimeter
    - Sand to very sandy loam that covers the greater part of the forest

- **Leached sands "Ndaamba**": Underlying by a clay pan on the southern part of the forest.
- **Coral rag**: Thin sand soil over the coral with many coral outcrops. This develops from Azania limestone and covers the western part (Tondooni Peninsula) and small area on the north of the forest.

2.7 Climate

The climate of Ngezi is typical as that of western Indian Ocean. The northern and southern trade winds dominate the area, which have marked effects on sea and air temperatures. The climate is hot and humid as in other parts of Pemba. The temperature of Ngezi ranges between 21° C at the coolest and 34°C at the warmest (Beentje 1990).

The rainfall in Ngezi is not different from that of the other parts of Pemba. Traditionally two rain seasons occur in Pemba. There is a seasonal variation in the climate with long rain (Masika) occurring between March and May and short rains (Vuli) occurring between November and December. However, rains are common throughout the year. The mean annual rainfall is 1,860 mm, the long rains average 363 mm per month and the short rains average 175 mm per month (Beentje 1990, Abdullah *et al*. 1996). The northwestern part of Pemba receives more rain from July to October than other areas of Pemba. This results in a cooler and more suitable climate, which maintains a better development of vegetation types and supports a health growth of trees, shrubs, lianas and other plant groups. There are few epiphytes in the moist forest especially those, which are indicators of moist conditions.
The relative humidity is high ranging from 87% during the long rains and 60% in the dry season (Abdullah *et. al.* 1996).

2.8 Vegetation

Biogeographically the flora of Zanzibar belongs to the Zanzibar-Inhambane regional centre of endemism (UNEP 2001), which extends from Somalia to Mozambique coast. Ngezi forest reserve in Pemba Islands has so many plant species and mushroom including timber trees. It belongs to lowland coastal forests highly disturbed with introduction of exotic species to replenish damaged sites in harvested compartments of indigenous timber trees. There are six main vegetation types with four subtle vegetation types. Ngezi forest is categorized as 'a high priority' conservation site because of rare or endemic species and a refuge to *T. lindleyanum* and *Quassia undulata*. Also present are some wild edible mushroom especially saprophytes.

Ngezi Forest has some characteristics species, which are reminiscent of lowland coastal and mountain forests of the mainland. These include *Antiaris toxicaria, Milicia excelsa, Drypetes* spp. *Pouteria brevipes, Chrysophyllum lanceolatum, Barringtonia racemosa* and *Cassipourea lucida, Quassia undulata.* These species are absent in Jozani forest in Zanzibar.

Islands usually they have depauparate communities having fewer species per hectare compared with their counterparts on the mainland of the same area, reflecting a reduced range of resources offered by smaller area and a reduced level of saturation. This is because not all supportable species may have colonized the island (Begon *et al*. 1996). A species, which may have colonized an island, may respond well to the direct impact of external environment. *Erica mafiensis*, which probably has its

ancestors in the mountain heathland or some relatives on Madagascan coastal heath land, has the exclusive power of allowing only a few other individual species or none at all. This is known as “Competitive Exclusion Principle” *(or Gause’s Principle)*. That is why it is has very low species richness. Ngezi Forest Reserve is also centre of the endemic species of *Chrysalidocarpus pembanus, which* represents a remarkable outlier of a typical Madagascar palm genus (Dransfield 1986). Burgess *et al.* (2000) has categorized Ngezi Forest Reserve as a high priority site having over four plants and over six animal endemic species as a criterion for its conservation.

2.9 Fauna

Few mediums to large animals exist in Ngezi Vumawimbi forest. Among the mammals the vervet monkeys, hyraxes, bats, black rats are the most abundant/commonly seen animals. Ocassionally the Zanzibar red colobus may be sighted in part of the forest. Sightings of the Pemba Blue duiker are rare and the wild boar is rarely sighted. Many birds occur in the forest though not as reach as other comparable forests in the coastal belt. There are many snakes, lizards, geckos and skinks. A number of amphibians occur in the forest, marshes and swamps and possibility of discovering more species is high. Fish in the waters of Ngezi are common ones reported in other places on the islands. In all cases observations and reports suggest a decline in population numbers of animals including endemic or near endemic species and sub species of Pemba.

2.10 Land tenure, landuse, and habitats

The issue of land tenure on Zanzibar is complex. Though the land was nationalised soon after the Zanzibar revolution in 1964, several tenure systems exist within the islands. With nationalisation of land people had the right to own and sell only crops and structures located on a piece of land but could not sell land because it belongs to the State. In villages people may own land under customary law. There is also land; "*wakf*" which is dedicated specifically for religious use and no one including the Government could use it for a different purpose.

According to Abdullah *at al*. (1996), the whole northwestern tip of the peninsula was gazzetted as a reserve in 1968. However local people traditionally consider that the villagers own the land. The present situation is obviously due to the fact that local people did not accept the gazzetment and in the absence of law enforcement they continue living and utilizing the resources in the gazzetted area.

Most of the northwestern tip of the peninsula has been cleared of forest and turned into agricultural land, over the course of time. At present the only forest covered part of this large reserve is located immediately north of ngezi. This area called Vumawimbi forest is the main source of several forest products for the surrounding villages as well as an important grazing area for their cattle. The forest was exploited for timber until 1995 as well but commission of natural resources has prohibited that practice.

The other areas surrounding Ngezi are mostly under intensive cultivation. In fact the western side of the reserve, the Makangale area, is one of the most important food production areas on the whole of Pemba. The main crops are cassava, sweet potatoes and coconuts but also several species of fruits are grown. The farmers either own the

land themselves or have been given the right to use the land by the owner who usually in such cases lives far from Ngezi. The fact that people are not the owners of the land they cultivate seems to be the main reason for the lack of forest plantations in the area. Northwest of Ngezi is where there are 39 ha. of rubber plantation, which was established in 1977/78. The government of Zanzibar owns the plantation though it is under lease to private company.

2.11 Human demography

There are ten villages in the immediate vicinity of Ngezi. Some are located further from the forest but still depend on it for fuel wood, building poles, medicine and other forest products. According to URT (2002), the population size in the surrounding villages is about 20,138 peoples having 9,796 males and 10,342 females with 3,750 households. The annual growth rate is 5.4 % one of the highest in Tanzania and Africa.

The human population in the villages wchich are located in the immediate vicinity/ in contact with forest is provided in Table 2.1 and Table 2.2 below. This list excludes those village communities that are considered not to benefit directly from the forest and which are found further from the forest:

Table 2.1: Human population distribution by Shehia in the study area, Pemba

Shehia	Gender		Total	House Hold	
	Male	Female		Number	Average
Makangale	2,132	2,063	4,195	799	5.3
Konde	4,215	4,634	8,849	1,619	5.5
Msuka	3,449	3,645	7,094	1,332	5.1
Total	**9,796**	**10,342**	**20,138**	**3,750**	**5.4**

Source: (URT population Census 2002)

Table 2.2: Human population in villages in the immediate vicinity of Ngezi forest, Pemba

Ward (Shehia)	Village Name	Population	H/H estimate
Makangale	Kijijini	2,600	100
	Jiwe moja	1,000	200
	Makangale	2,000	136
	Tondooni	1,500	300
	Mkia wa Ngo'mbe	1,000	50
Kifundi	Bandari Kuu	350	70
	Kiuyu Kipangani	250	115
	Mji Mpya	50	16
Konde	Kiuyu kwa Manda	1,200	100
Msuka	Gombani Mtoni	2,000	100
	Total	**11,950**	**1187**

Source: Shehias' Offices, 2005

3.0 Methods

3.1 Vegetation sampling

Two days were spent during reconnaissance in order to familiarize with the Ngezi Forest Reserve and to identify and locate vegetation types in which transect lines were

to be established. Vegetation types were classified according to concepts of Greenway (1973) and White (1983), Herlocker (1999) and Beentje (1994). This classification combines physiognomic and floristic criterion including the dominant species in the community.

The vegetation communities were sampled from 26 plots each measuring 20x50m along six transects, at an interval of 50m apart in the beginning to100m interval later. The transects were randomly selected. Nested Quadrant Method (Stohlgren *et al*. 1995 and Crawley 1997) was employed to sample trees, shrubs, lianas and herbs as indicated below:

Life form	Fixed plot area	Length	Width	Definition
Herbs	$1.0m^2$	2.0m	0.5m	All herbs, grasses, sedges under 1.5m tall
Shrubs, lianas	$10.0m^2$	5.0m	2.0m	Woody plants >1.5m with dbh <10m
Trees	$1000.m^2$	50m	20m	Woody plants >5.0m and dbh >10cm

The mangrove formations, the fragmented *Albizia-Erythrophloeum* forest remnants and the *Erica* bushland (heathland) were not quantitatively sampled, but their species compositions were identified and recorded wherever they were considered to be new to the check-list. The species from fresh water swamps and ponds were also recorded but not quantitatively sampled.

Sampling in the nested subplots from the main plots involved counting and recording the herbs and shrubs of all individual species. All trees in the 50mx20m plot were recorded and their dbh measured together with their heights. Individual tree numbers in study plots provided basic information for calculating species abundance, basal area per $ha.^{-1}$ and ranges for dbh and heights. The distribution of diameters (dbh) and heights of tree species using classes of the respective attributes are provided in the results. Other attributes include density ($stems/ha^{-1}$ and basal area (m^2ha^-). The calculations show the demographic status of species over different communities.

3.2 Vegertation mapping

3.2.1 Interpretation and field verification

The main sources of information were aerial photographs at the scale of 1:10,000 and in some cases 1:50,000. The first stage was interpretation where major topographic features and the preliminary vegetation types were identified. The second stage involved final interpretation after field verification. Interpretations were made on transparent films. GPS readings were taken in different areas with their corresponding vegetation types. All vegetation types previously identified were covered.

3.2.2 Digitization and rectifications

The transparent films obtained from the thematic interpretation of different vegetation types were digitized using ArcInfo software. Further manipulation of digitally captured datasets e.g. area statement computation was done using ArcInfo, ArcView, and Microsoft Excel.

All digitized data sets underwent the following processes:

- Creation of raw digitized coverage
- Cleaning of the coverage (identifying errors)

- Editing of the coverage (correcting errors)
- Transformation of the coverage to UTM projection
- Checking for sliver polygons and editing-out
- Coding of polygons
- Clipping of the coverage (to allow edge-matching to adjacent sheets)
- Edge match editing
- Production of color plot and checking

Since the aerial photos were not rectified, rectification was done using control points appearing both on the existing topographic and aerial photographs. Map 5 presents the updated vegetation cover of Ngezi – Vumawimbi forests.

3.3 Fauna inventory

3.3.1 Recconnaissance survey

A scoping survey was undertaken from 17th to 19th December 2004 as a preliminary site visit. Three team members Dr. C. L. Nahonyo, Dr. C. A. Msuya and Mr. L. B. Mwasumbi participated in the survey. This visit enabled the team to familiarize with the area and identify areas to locate sampling transects. Logistical arrangements for the main field survey were also discussed during the visit.

3.3.2 Fauna sampling

Different techniques were used to sample different groups of animals in the study area. The techniques differed in accordance with the species concerned. The techniques enabled researchers to determine presence of species, their distribution and index of abundance. The sampling protocol was based on transects (Map 6) decided during the reconnaissance survey. Transects were located to cater for both habitat representation and spatial distribution. Little research has been done on the fauna of Ngezi as such the research effort concentrated on many taxonomic groups and species.

The vervet monkey density was calculated using estimator proposed by Gates (1969):

$$\Delta \equiv \frac{n}{2L\left(\frac{n\bar{y}}{n-1}\right)}$$

where:
Δ = density
n = number of animals seen
L = total transect length
$\bar{y}$ = mean of all values of y_1, y_2, ….y_i, the perpendicular sighting distances of the animals from the transect line.
Species diversity was calculated using the Shannon Weaver Index *H'*:
Where *k* = number of categories, f_i = number of observations in category i, *n* = sample size. The maximum diversity, which could be attained in the area, was calculated

$$H' = \frac{n\log n - \sum_{i=1}^{k} fi \log fi}{n}$$

using the expression:

$$H'_{max} = \log k$$

Where H'_{max} is the maximum possible diversity for a set of data consisting of k categories. H' tests abundance equality among k categories and is affected by the distribution of data and the number of categories. H'_{max} is the highest diversity which can be calculated from a set of data consisting of k categories (Zar, 1999).

Table 3.1: Description of transects used to sample plants, small mammals, reptiles, amphibians and invertebrates in Ngezi - Vumawimbi Forest Reserves, Pemba. GPS coordinates (using Garmin GPS 12x) for each transect were taken for future reference

Transect		**GPS**	**Description**
SN	**Name**		
1	Kwa Josh Trail (Evergreen moist forest)	S 04° 56.234' E 039° 42.549'	Natural moist forest close to Ngezi gate, tall trees up to 35-40 m high. Canopy cover c.60-100% in some areas with strata. Dry leaf litter cover 30-80%. No signs of harvesting. Soils fairly deep, gray sand
2	Makangare bwawani (grassland/forest)	S 04° 54.664' E 039° 41.670'	Grasses c.0.5 - 1m high. Grass cover 70% wood vegetation cover 10-15%. Soils sandy to dark clay soils fairly deep
3	Erica bushland (along Mkia wa Ng'ombe road)	S 04° 56.726' E 039° 41.294'	Dry bushland of 1.0 t0 3 m high sometimes pure stand. Canopy cover 50 - 90% and dry leaf litter cover is almost zero. Soils sandy and relatively deep
4	Chokaani (Coral rag forest)	S 04° 57.183' E 039° 40.587'	Coral rag forest close to the beach. Fairly tall trees up to 30 m high with many lianes and climbers. Vegetation cover range from 30 - 90%. Rock outcrops with shallow sandy soils.
Transect		**GPS**	**Description**
SN	**Name**		
5	*Maeopsis eminii* pure stand (near Sharif tomb)	S 04° 55.918' E 039° 41.723'	Tall trees some up to 40m high, dominated by *Maeopsis eminii*. Undergrowth of mixed vegetation including Pemba palm and ….Canopy cover 20-90% with layers. Leaf litter covers 30-100%. Deep sand loam soil.
6	Machopeni (moist forest)	S 04° 55.475' E 039° 42.666'	Evergreen moist forest with high canopy up to 40 m high, fairly thick with vegetation cover between 50 - 100%. Slopy area surrounded by marshes dominated by wild banana, ferns and *Cyperus*. Dry leaf litter cover c. 30 - 100%. Fairly deep brown loam

			soil. Signs of harvesting of building poles.

3.3.2.1 Mammals

Large mammals were censused using foot count on line transects selected from a baseline (Map 7). Animals encountered along the transects during censusing were counted and recorded. The perpendicular sighting distance distance from the transect line was estimated. Since Ngezi and Vumawimbi are basically forest habitats and animals were few or difficult to sight, animal signs e.g. pellet, footprint, vocalisation was recorded and used to identify species and for certain species determine their relative abundance (Davies, 2002). A variable visibility profile was used during the census to determine transect strip width. Opportunistic sampling was also used to record any large mammals encountered during the survey. Villagers were interviewed on local uses of wild animal species including large mammals and conflicts between wildlife and people.

A total of 6 transects totaling 14.566 km were surveyed as follows:

Transect		GPS start	GPS Finish	km	General description
No.	**Name**				
1	Vumawimbi → Machopeni	S04°54.412' E039°42.076'	S04°54.978' E039°42.043'	1.732	Coastal thicket, moist forest with open wooded grassland on coastal floodplain
2	Makangare Kisimani → Machopeni (Kisiwani)	S04°55.212' E039°41.436'	S04°55.812' E039°42.721'	3.307	Moist tropical forest, potential area of sighting Zanzibar red colobus
3	Tondooni → Ngezi	S04°55.778' E039°41.340'	S04°56.278' E039°42.610'	2.695	Moist forest
4	Ngezi → Tondooni	S04°56.319' E039°42.583'	S04°56.030' E039°41.325'	2.784	Moist forest
5	Mkia wa Ng'ombe → Tondooni	S04°57.128' E039°41.310'	S04°56.159' E039°41.078'	1.909	Mixed vegetation types including moist forest, Fillipia bushland, mangroves and farmland
6	Chokaani → Tondooni (Verani)	S04°57.183' E039°40.539'	S04°56.098' E039°40.472'	2.139	Coral rag forest

from Vumawimbi, Makangare Kisimani, Tondooni. Night drives were also used to record presence of nocturnal animals which are difficult to sight during daytime.

3.3.2.2 Small mammals

The trapping of small mammals was done in 6 transects (Table 3.1) described above. Specimen collection was done using three types of traps: bucket pitfalls, snap traps and live traps (Sherman traps, and cage traps). On each transect 11 buckets of 18litres capacity were buried in the ground such that the bucket rim was level with the ground and the buckets were spaced 5m apart making a total transect length of 55m. A drift fence using polythene sheeting of 0.5m high (see plates later) was erected with the support of wooden stakes to run above ground across the middle of the buckets. Part of the drift fence was buried in the ground to prevent animals going under the fence. Beside each bucket trapline 25 snap traps and 5 Sherman traps were laid in order to trap other species not easily caught in the bucket pitfalls. Fried coconut mixed with peanut butter was used as bait in the snap and Sherman's traps. Baits were replaced

each day during trap inspection. Traps were inspected every morning during sampling time from around 7.00am to around 11.00am since traplines were far spaced; all specimens found in the traps were identified and recorded. Specimens not identified immediately were collected for later identification. The traps were also used to collect certain reptile species (see section 3.3.2.4) and amphibians (see section 3.3.2.5). Bats were sampled using mist netting and opportunistically. Mistnetting was done early evening and at dawn at three selected sites of Machopeni, Makangare Bwawani and Kwa Josh Trail. Collected specimens were preserved in 70% alcohol, 10% formalin. Specimens found alive during trap inspection and which could be readily identified were released near the place they were captured.

3.3.2.3 Birds

Mist netting meter-net-hours (12m x 4m x hours) was conducted in three different habitats of Machopeni, Makangare bwawani and Chokaani. The capture success was very poor hence most bird records reported here come from direct observation (bird watching) of birds in different parts of the forest both in daytime and and night. The checklist also includes previously reported species occurring in Ngezi and Pemba Island as a whole.

3.3.2.4 Reptiles

Opportunistic sampling and pitfalls (see section 3.3.2.2 above) were used to obtain information of reptile species available in Ngezi. All sightings of the reptiles were recorded to give clues of their occurrence and distribution in the area.

3.3.2.5 Amphibians

Most amphibian specimens were collected using bucket pitfall traps (see section 3.3.2.2 above). However for tree frogs and other amphibian groups, which are not easily trapped in buckets opportunistic sampling was used, and those were collected whenever they were encountered. Vocalisation especially at night was also used to establish presence of some of the species and also detrmine their relative abundance. Photographs of some specimens were taken for identification.

3.3.2.6 Fish

Fish specimens from artisan fishermen were identified on sight using identification keys and knowledge of the local fishermen. Useful information on fish and fisheries resources and exploitation were obtained from office records in Wete. Some fishermen were interviewed and provided valuable information on fish, fishing gear, fish spawning areas and fish marketing.

3.3.2.7 Invertebrates

Sampling of invertebrates (Butterflies, Moths, Dragonflies and Damselflies) was carried at six transects (hereafter T1, T2, T3, T4, T5 and T6 see table above). Collection methods used included the following:

(i) Sweeping using a sweep-net (for Odonata and Lepidoptera) was carried out for one hour during late morning hours

(ii) A baited Butterfly trap (“banana trap”) was set in the morning and emptied in the late afternoon or evening

(iii) An 11W fluorescent tube light trap was run for one hour during the night to catch moths.

Sweeping during daylight and collecting at night were timed (5 minutes per sample for general sweeping, and 60 minutes per sample for butterflies and Odonata. Collecting at night took 60 minutes per sample). Night collections were done between 7.00pm and 10.00pm. There was no moonlight during the survey time. Banana traps were set in the morning and checked in the evening.

Six specific sites were selected within the study area to give a representation of the various sub-habitats of the area. The sites, with their co-ordinates, were as follows: (1) Kwa Josh trail, S 04° 56.234', E 039° 42.549' (2) Makangare Bwawani S 04° 54.664', E 039° 41.670' (3) Erica bushland S 04° 56.726', E 039° 41.294' (4) Chokaani coral rag S 04° 57.183', E 039° 40.587' (5) Maeopsis pure stand S 04° 55.918', E 039° 41.723' and (6) Machopeni moist forest S 04° 55.475', E 039° 42.666'. At each site a 50m x 50m square plot was marked and all the sampling took place inside the plot. Most of the specimens were identified using Kieland (1990), Migdoll (1987) Pinhey (1961), Pinhey (1965) and Scholtz (1985).

3.4 Socio economic survey of local communities around Ngezi forest

A study was undertaken in ten villages around Ngezi Forest Reserve to obtain a social feel of the reserve and further to determine how important the forest is to them, their suggestions for future management and general look at the threat this forest is facing from the surrounding community. Open-ended conversations and interview-administered questionnaires were used to gather information from the locals (Kikula and Nelson 1993, Martin 1995, Bernard 1994 & 2002). Two pre-trained personnel were used to administer the questionnaires. A random sampling (Nahonyo *et al*. 1997), was used in questionnaire administration where the heads of the house holds were targeted, but when these were not around, any member aged above 18 years old from that household was interviewed. This was due to time limit, since some heads went to farm or were attending their everyday prayers. Data were summarised and analysed using the SPSS 11.5 and excel programmes, where descriptive statistics (frequencies, and cross tabulations) were used (Dytham 2003). Existing land use types of areas under crop, forestry, settlements, roads and river systems were updated during the survey and are shown on Map 4 and Map 5.

3.5 Legend to threatened and endangered species of flora and fauna

The IUCN redlist updated in 2002 of endangered species and CITES Appendices were used to estalish the conservation status of plants and animals:

Legend to the IUCN status of Threatened Species of Flora and Fauna (for details see http://www.redlist.org**)**

Critically Endangered (CR): A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the **immediate** future (These are defined under criteria A-E)

Endangered (EN): A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the **near** future (These are defined under criteria A-E)

Vulnerable (VU): A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the **medium-term** (These are defined by criteria A-E)

Lower Risk (LR): A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk cane be separated into three sub-categories:

1. **Conservation Dependent (cd)**
2. **Near Threatened (nt)**
3. **Least Concern (lc)**

Data Deficient (DD): A taxon is data deficient when there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status.

Not Evaluated (NE): A taxon is Not Evaluated when it has not yet been assessed against the criteria.

Explanation of CITES Appendices

CITES works by subjecting international trade in specimens of selected species to certain controls. These require that all import, export, re-export and introduction from the sea of species covered by the Convention has to be authorized through a licensing system.

The species covered by CITES are listed in three Appendices, according to the degree of protection they need. (for additional information see CITES Species or http://www.cites.org)

- **Appendix I** includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances
- **Appendix II** includes species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival
- **Appendix III** contains species that are protected in at least one country, which has asked other CITES Parties for assistance in controlling the trade

4.0 RESULTS AND DISCUSSION

4.1 Vegetation

4.1.1 Synopsis of the vegetation types

Ngezi forest is characteristically part of the lowland coastal forests, which belong to the Zanzibar-Inhambane regional mosaic. The islands of Zanzibar and Pemba receive an appreciably high rainfall, for example Wete receives 1964-2000mm of rainfall. This amount of rainfall is sufficient to support rain forest (White 1983). The forest reserve is rich in species, but changes rapidly in floristic composition and physiognomy over short distances making it difficult to classify the different vegetation types. The main vegetation types are represented in Table 4.1 below:

Table 4.1: Synopsis of main vegetation types in Ngezi – Vumawimbi game reserves, Pemba (Source: This survey, January 2005)

SN	Vegetation types and their edaphic features	Specifications and definitions	Notes
1.	Moist forest on soils with high humidity and high organic humus content from decaying litter	Main canopy cover of dominant tree species, evergreen over 20m tall with emergent trees to over 40m. It accommodates many lianas and epiphytes	There are also several micro-habitats of pools/ponds in the openings which are wet in rain season and dry out in dry season, usually surrounded by *Barringtonia racemosa*
2.	Moist forest mixed with exotic species	Indigenous timber trees over-harvested. Exotic trees planted to replenish timber supplies in damaged sites	Some of the exotic trees are aggressive invaders and suppress regeneration of indigenous species
3.	Microsite of pools	Open depressions in moist forest, black sandy, silt soil, weedy herbs invading soil cover	Several scattered pools, edges with *Anthostata, Barringtonia*
4.	Coastal evergreen dry forest on coral rags which is an equivalent of Zanzibar-Inhambane undifferentiated forest (White 1983). Shallow soils on coral rocks	*Afzelia-Haplocoelum* stunted trees open canopy which is tolerant to stress condition including succulent herbs and lianas and cacti-like plants – *Sanseviaria calanthe, Lissus, Aloe*	Low species density Disturbed areas bushland
5.	Coastal evergreen dry forest on sandy soils	*Manilkara-Diospyros-Afzelia* association. Many induced exotic trees of *Casuarina* and *Terminalia cattapa* in the seaward	Contains some patches of *Erica* bush land and scattered *Dodonaea viscose*
6.	Coastal evergreen dry thickets on shallow soils	This forms a narrow zone extending above the mangrove to the moist	The boundary of this zone and the moist forest is rather indistinct

	overlying coral limestone	forest boundary. It is characterized by bush forming shrubs, lianas and climbers with few trees and associated emergent. There are clustered populations of *Sorindeia-madagascariensis*	
7.	Fresh water swamp forest restricted to shallow soil valleys with very slow drainage. These are located in moist forest with exception for a small one in open land	Plants which can tolerate water soaked muddy soils. In Ngezi this is referred to as *Raphia* palm. Other swamp populations include *Typhonodorum lindleyanum* and *Quassia indica* (all introduced species)	*Raphia* palm dies after fruition. In the two *Raphia* palm swamps *Barringtonia racemosa* was absent contrary to White (1983) statement
8.	*Erica* bush-land on the water-logged sites of former shallow lagoons (Greenway 1973). There are a few micro-sites of pools in bush-land openings	*Erica* bush-land forms a loose canopy 5m high. Few associate trees are emergent 8m tall. Few scattered shrubs and generally low species diversity	Apart from the main bush-land a narrow strip was encountered in the coastal evergreen dry forest to the north
9.	Fragmented moist forest to the south with remnants of dry patches representing anthropic landscape	Forest remnants-moist and dry openings. Dominated by *Albizia-Erythrophloeum* association	Engulfed area between conservation and human interactions (Grazing, cultivation and human settlements)
10	Mangrove formation on saline swamp forest	The mangrove formation occurs as open stands, rarely close on shore between low and high water mark. Most have pneumatophores or are viviparous. Smaller patches occur around the bay of Tondooni peninsula	Mangrove species are important source of building materials especially poles Only four species are represented
11	Two fresh water swamps, one permanently wet. Overflows to the sea in rain season. Other seasonal wet pools in moist forest	*Nymphaea*, Sedges and *Acrostichum*. Thickets of *Harungana, Syzygium* and *Parinari* separate the two swamps	Fishing activities
12	Arable landscape	Rice and cassava cultivations	Annexed to Ngezi Forest Reserve

There were a total of 26 study plots spread over 6 transects, representing different vegetation types selected for sampling. These study plots had a total of 733 tree individuals, which were measured. However, transects varied considerably due to variation in physical environments determining the extent of each vegetation type. These formations are unequal in sizes of the areas, which they occupy, and in the degree of physiognomic distinctness including floristic and environmental characteristics. Moist forests, including enrichment plantations of exotic trees, occupies the largest coverage and is represented by transects one (8 study plots) and transect No. 2 (exotic tree plantations). The analyzed data on Table 4.2 show the structural differences among the different vegetation types.

Table 4.2: Summary of tree data for the different vegetation types in Ngezi, Pemba

Transects	**1**	**2**	**3**	**4**	**5**	**6**	**Area**
Attributes							
Density (trees.ha^{-1})	40	34	21	21	22	24	
Basal area (m^2.ha^{-1})	59.5	8.33	17.2	7.3	6.45	2.36	
Height ranges - Distribution of trees according to the height class ranges in each transect							
5 – 10m	152	31	51	29	44	32	
11 – 20m	127	46	43	26	35	22	
21 – 30m	41	17	11	7	6	1	
31 – 40m	8	3	2	2	0	0	
DBH Ranges (m) – Distribution of trees according to the dbh class ranges in each transect							
0.10 – 0.20	161	62	90	22	43	31	
0.21 – 0.30	67	17	19	23	27	11	
0.31 – 0.40	27	3	8	5	3	2	
Transects	**1**	**2**	**3**	**4**	**5**	**6**	*Area*
0.41 – 0.50	19	3	5	6	2	1	
> 0.51	41	10	7	6	3	1	
Sum of stems. per transect	**315**	**107**	**124**	**65**	**85**	**48**	
Sampled area in ha^{-1}	**8**	**3**	**6**	**3**	**4**	**2**	
Total area sampled							**26 ha.**

4.1.2 Description of vegetation types

Table 4.3: Land cover/Land use of Ngezi – Vumawimbi Forest Reserves and surrounding areas, Pemba

SN	**Land cover**	**Area (hectares)**
1	Pond	2.7458

2	Coastal evergreen Dry forest on sandy soils	196.3000
3	Mangroves	303.9660
4	Moist forest	906.7000
5	*Erica* bushland	207.7000
6	Coastal Dry evergreen forest on coral rag	59.3000
7	Coastal evergreen thicket	113.3000
8	*Raphia* stand	41.0070
9	Rice field landscape	59.4500
10	Rubber plantation	47.8300
11	Cultivated area	73.1400
12	Swamp forest	109.3000
13	*Quassia indica* stand	1.0770
14	*Typhonodorum*	14.7300
15	*Maeopsis* mixed moist forest	92.1800
16	*Terminalia ivorensis*	10.5360
	Total cover	**2,239.2618**

Source: This survey, January 2005

4.1.2.1 Natural Moist forest

This includes both natural undisturbed and disturbed forests. Appreciably high amount of precipitation is experienced on the Pemba Island (Wete - 1964mm). Thus this amount is sufficient to drain the soils adequate moisture for supporting a rain forest. The forest is rich in species composition of up to 40 trees per ha. (Table 4.2). The moist forest compares to the Zanzibar – Inhambane undifferentiated forest (White 1983) that occurs in the lowland coastal forests. They form main canopy at 15-20m, and from its emergent rise to heights of 30-40m (Table 4.2). Very few trees are taller than 40-50m. Lianas and climbers are plentiful, but vascular epiphytes (6 orchid species mainly on *Baringtonia* on river and swamp banks and fens, *Vittaria* and *Asplenium ridus* are most widespread.

The larger trees include *Albizia adianthifolia* (20-30m), *Antiaris toxicaria* (30m high, dbh 0.5 – 1.50m), *Quassia* (30-40m high, dbh 0.5 – 1.45m), *Bombax* (40m high, dbh 2.74m), *Milicia excelsa* (30-35m but all timber trees have been exhausted), *Erythrophloeum suaveolens* (25-49m tall, dbh 0.35 – 45m), *Inhambanella henriquesii* (25m), *Manilkara sansibarensis* (25m), *Macaranga capensis* (25m), *Pouteria brevipes* (25m), *Bombax rhodognaphalon* (35m, *Uapaca guineensis* (25m high, 0.73m dbh).

In the lower tree canopy class group 5-10m tree density is highest containing 162 trees. The middle class layers include few trees 11-20m high (about 127 trees from 8 plot samples). They include *Chrysalidocarpus (*15-18m high, dbh 0.20-0.35m), *Alangium salicifolia* (15 high, 0.7 dbh), *Elaeis guineensis* (10-15m), *and Pouteria brevipes* (10-20m high). There are more trees in the 5-10m class (162) distribution compared to other vegetation types in the same class distribution group.

The *Barringtonia racemosa* areas were encountered in transect 1 between plots 3 and 4. *Barringtonia racemosa* has very dominant tree stands representing 90% of all trees in the plot. Other species are *Lannea schweinfurthii* (2%), *Elaeis guineensis* (3%), *and Garcinia livingstonei* (5%). The trees are 5-10m tall, with plenty of epiphytic orchids on *Barringtonia*. There are no lianas and canopy cover is over 90%. Two seasonal

flooded ponds or pools around *Barringtonia racemosa* occupy open locations containing aquatic herbs and other annual weeds.

4.1.2.2 Moist forest mixed with exotic species

This sample study is represented in Transect 2. It was the area where harvesting of indigenous timber supplies was concentrated. Timber tree species included *Milicia excelsa* (25m, few 20m) and *Bombax rhodognaphalon*, while less important timber trees include *Quassia undulata* (25-35m high, dbh >0.5m). Exotic species include C*ordia alliodora, Mangifera indica, Tabebuia pentaphylla* (20m), *Tectona grandis* (10-20 high, 027-0.47m dbh), *Terminalia catappa, Cedrella mexicana, Terminalia ivorensis* and *Maesopsis eminii.* Trees >5m high were not encountered. There were many dead logs of *Maesopsis eminii* that were cut down to eliminate it. The dead logs support populations of saprophytic mushrooms. Other indigenous species in the middle layer include *Chrysalidocarpus* (10m high), *Pouteria brevipes* (10m high), *Alangium salvicifolia* (10m high), *Croton sylvaticus, and Polyscias fulva* (20m high).

4.1.2.3 Microsites of open pools/ponds in moist forests

These are depressions, which are seasonally wet in rain season, dry out in summer. The edges are surrounded by *Anthoclesta* and *Barringtonia* tees. They contain silty mud dry dry black sandy soils that crack as the habitat dries out. Invasive aliens cover the microsites. These include *Ludwigia abyssinica, L.jussioaeoides, L.stolonifer, Melastomastrum segregatum, Tristemma mauriatum, Khautia* sp., *Pentodon pentandrous, Cyperus erectus, C. polystachyus, Fimbristylis longiculmis, Stachytaphytta urticifolia, Vitex doniana, Agathisanthemum bojeri, Scoparia dulcis, Mimosa pudica, Triumfetta rhomboide, Desmodium adscendens, Borreria scabra, Achyranthes aspera.*

4.1.2.4 Coastal dry evergreen forest on coral rag

This is an equivalent to what Birch (1963) calls an evergreen thicket representing the climax on shallow soils overlying coral limestones (rags). Characteristic species includes *Afzelia quanzensis* (20-25) which forms clustered patterns on coral rag pavements, *Haplocoelum inoploeum* which has stunted growth form (5-8m) in coral rag pavements. Others include *Pandanus kirkii, Bridelia micrantha* (8m) and *Calophyllum inophyllum* (12m, high, 0.4 dbh). Where coastal coral rag forest is disturbed it forms impenetratable dense bushland with many lianas and climbers including *Saba comorensis, Ancylobotrys petesiana, Uvaria* ssp.nov. *Voacanga africana* found on raised beach is not in FTEA for Pemba. Species tolerant of coral rag stress conditions include *Sansevieria, Calanthe* and *Cissus* which are characteristically succulent.

4.1.2.5 Coastal evergreen dry forest on sandy soils

This is found on the north of the reserve. A peculiar *Erica* zone 10-20 wide and 50 – 100m from the sea runs parallel to the seacoast. *Dodonaea viscosa* is also scattered in a narrow band 10-20m deep into the forest from the sand beach. The vegetation community contains many characteristic species of an evergreen dry forest. They include *Manilkara sansibarensis* (10-25m), *Haplocoelum inophylum* (7m), *Brexia madagascariensis* (5m), *Terminalia boivinii* (20m), *Afzelia quanzensis* (5-25m), *Diospyros consolatae* (12m), *Lannea schweinfurthii* (7-15m), *Olea woodiana* (15m),

Drypetes natalensis (5m), *Rauvolfia mombasiana* (5m, usually on forest margins), *Chrysophyllum lanceolatum* (10m), *Syzygium cardatum* (10-30m, but usually a riverine forest species), *Sorindeia madagascariensis* (7m, rare), *Casaeria gladiiformis* (15m), *Pandanus kirkii* (15m), *Vitex ferruginea* (12m), *Vitex domiana* (10m on forest edge) and scattered *Chrysalidocarpus, Salacia senegalensis* (5m).

4.1.2.6 Coastal evergreen thicket

This community occupies a narrow zone on the southwest and gradually fades into moist forest. Its transition to moist forest is indistinct, however the damaged or undisturbed stands of bushes composed of lianas, climbers, branched shrubs and scandent shrubs create thick envelope, which is normally impenetrable. Tree species are small in stature ranging from 3-6m tall, with a discontinuous stratum of emergent trees e.g. *Adansonia digitata, Boureria petiolaris* (10m), *Voacanga Africana* (12m), *Manilkara sansibarensis* (15-20m), *Diospyros consolatae* (12m) and rare species of *Manilkara sulcata.* This is a very useful species for building poles, charcoal and fuel wood. *Haplocoelum inoploeum* is an important plant for its wide clustered distribution usually 7-10m tall. *Terminalia boivinii, Pandanus kirkii* and *Psychotria* sp. are rare species.

.

In some areas *Sorindeia madagascariensis* forms distributions of isolated population clusters with height range of 10-15m. Distribution of dbh ranges of many species in this community is mostly10-20m (28), 21-30 (12 trees), 31- 40m (3trees). Only 2 species *Adansonia digitata* and rarely *Sorindeia madagascariensis* measure above 0.41m dbh. Such vegetation type may be too localized. Birch (1963) says it may be a climax of local significance. Common shrubs and lianas forming impenetrable bushes include *Rhoicissus tridentata* (liana), *Rhoicissus revoilii* (liana), *Acridocarpus zanzibaricus* (shrub/climber), *Mystroxylon aethiopicum* (liana/shrub), *Uvaria* sp. (undecided species), *Cissus quadrangularis* (climber), *Cissus rotundifolia*, *Suregada zanzibarensis* and *Allophylus pervillea* (all lianas/scandent shrubs).

Shrubs include *Cassipourea gummiflua* (usually a mountain tree species 5-20m in moist forest), *Vernonia sansibarensis* (associated with *Erica* bushland) S*ynaptolepis kirkii* (drier forest indicator), *Pyrostria bibracteata, Antidesma venosum* (generalist). Lianas and woody climbers are *Salacia madagascariensis, Rhoicissus revoilii, Flagellaria guineensis, Mystroxylum aethiopicum, Ochna* sp., *Chrysophyllum lanceolatum, Rawsonia Lucida.* Lianas and woody climbers are *Salacia madagascariensis, Rhoicissus revoilii, flagellaria quineensis, and Mystroxylum aethiopicum.*

4.1.2.7 Fresh water swamp forest

Fresh water swamp forests are all similar in the coastal of East Africa with the Ngezi forest swamps except for the exotic *Quassia indica* and T*ynophodorum*). They about 22 true species in all Burgess *et al*. (2000). In Ngezi *Raphia* swamps 7 tree species were recorded.

The vegetation type is a variant of moist forest occurring in isolated locations. This made planning of quantitative sampling difficult, because they are small in extents. Beentje (1990), mentions that they follow a narrow belt up to 30m wide. We did not

make a follow up to support this statement. The following forest swamp areas were visited:

a) Raphia swamp forest

In Ngezi Forest Reserve *Raphia* swamp occurs in shallow valleys with very slow drainage. One small patch was encountered along transect one Plot 8 across a small stream. The key species include *Raphia farinifera* (6-7m), *Syzygium cordatum* (10-25m high, dbh 0.14-055m), *Vitex domiana* (12-18m, dbh 0.14-0.45m), *Erythrophloeum suaveolens* (15-40m, dbh 0.20-0.45m), *Uapaca guineensis* (18-20m, dbh 0.20-0.35m), *Pouteria brevipes* (12m, dbh 0.12), *Parinari curattelifolia* (20m, dbh 0.50). In a big *Raphia* palm forest on the stream to the north was qualitatively sampled. The common tree species were counted in two plot sites of 20 x 50m as follows:

Elaeis guineensis 24 trees (8m high), it dies after fruiting. *Anthocleista grandiflora* 10 trees (25m dbh 0.18m), on the margin of the swamp *Syzygium cardatum* 10 trees (15-25m, dbh. 17-0.50), this species is not known in FTEA for Pemba Island although ssp. *cordatum* is well known as a swamp forest indicator from 0-24.00m elsewhere, *Tabernaemontana ventricosa* (10m). There were no lianas or shrubs. *Barringtonia racemosa* was missing altogether. The monocotyledons species of *Raphia, Elais* species are usually the most dominants of these microsites and Ngezi forest is an important isolated site for establishing rare species facing extinction in their sites of origin.

b) Swamp forest

Swamp forest includes also small open depressions or pools with herbs and aquatic species. These usually contain grasses, sedges, and herbs. Permanent swamps contain *Nymphaea nouchali* and *Nymphoides*. *Utricularia* sp. may be present and the big swamp in the open land is important for fishing.

c) Quassia indica stand

This occupies an enclave and restricted area along the river stream. The river course running through this population to the mangrove was dry during the survey, but the *Quassia indica* habitat was wet with black muddy soils. There are few lianas including *Combretum, Entada, Mucuna, Uncaria, Scutia* and *Adenia* species. *Quassia indica* is exclusively dominant.

d) Typhonodorum lindleyanum swamps

Open pools/swamps

There are also unique micro-sites of open swamps occupied by *Typhonodorum lindleyanum* (Plate 3a and 3b). This was not surveyed, though it is expected to host some weedy herb species. *T. lindleyanum* is the only known species in the genus (monotypic) observed in the NE side of Ngezi Forest Reserve as pure stands. There are also many open swamps of *Typhonodorum lindleyanum* in moist forest.

4.1.2.8 Fragmented Remnants

Landscape which has been altered through settlements and other human activities

a) Albizia-Erythrophloeum mosaic

This one is a relict or remnant of a moist forest variant. It contains the following:

Albizia adiantifolia (25m), *Erythrophloeum suaveolens* (20-25m), *Vitex doniana* (20m), *Lannea schweinfurthii* (15m), *Phoenix reclinata* (5m), *Syzygium cordatum, Apodytes dimidiata* and *Garcinia livingstonei.*A bushland has developed at the forest margins. The bushland cover is impenetrable. The main lianas forming the dense cover include *Salacia madagascariencis, Landolfia kirkii, and Uvaria* sp. Herbs includes *Phyllanthus, Hibiscus* and *Zammioculcas* species.

b) Evergreen dry forest remnants in forest gaps

These dry forest remnants are of limited extent. The patches are poor in plant species because grazing and other human interactions retard their vegetation development. Main trees are *Parinari curattelifolia, Vitex domiana, Adansonia digitata, Phoenix, Haplocoelum, Terminalia boivinii, Pouteria.* Shrubs include *Antidesma, Pyrostria, Chassalia, Xylotheca and Deinbollia* species.

4.1.2.9 Erica Vegetation

a) Erica Bushland

The ericaceous bushland occurs on the waterlogged habitat of former shallow lagoons (Greenway 1973). On Ngezi Forest Reserve, the ericaceous bush-land forms a unique habitat with a loose open canopy at a height of 5-8m (White 1983). Associated species include *Syzygium cardatum* and *Phoenix reclinata* at the margins of shallow pools and scattered in the bushland.

b) Seasonal waterlogged pools

There are several shallow ponds or pools in Erica bushland, which are waterlogged in the rainy season and become dry when the season ends. They are surrounded by scattered trees of *Syzygium cordatum, Harungana madagascariensis*, stunted *Lannea schweinfurthii, Phoenix guineensis* and *Erica* bushland. They are herbaceous habitats dominated by *Xyris* sp. and sedges at Locations 576277, 9453295 and 576371, 9453271.

Table 4.4: Common herbaceous species occurring in seasonally water logged pools in Ericaceous bushland in Ngezi forest, Pemba

Species name	Notes
Xyris anceps	Very common, 30-40cm tall
Xyris sp.	Small herb restricted distribution
Cyperus tenax	Densely tufted perennial
Cyperus erectus	Tufted perennial
Cyperus laceoulatus	Tufted perennial
Dissotis rotundifolia	Prostrate herb
Tristemma mauritianum	Shrub forming bush at the marshy edges
Fimbristylis dichotoma	Tufted perennial
Fimbristylis longiculmis	Tufted perennial
Panicum brevifolium	
Phymatodes scolopendria	

In pools with permanent standing water, floating aquatic plants include *Nymphaea nouchali, Nymphoides* sp. *Ultricularia gibba* and *Cyperus prolifer* (rooted in muddy soil). *Xyria anceps* is prevalent in slow moving streams in the heathland.

4.1.2.10 Mangrove Thickets

The mangrove formations are constituted by trees and shrubs or bushes which tolerate stress conditions on shores periodically flooded by sea water. The mangrove flora is the same for the rest of East African coasts. Any community in these habitats contains species including *Avicennia marina, Bruguiera gymnorrhiza, Ceriops tagal, Lumnitzera racemosa, Sonneratia alba, Heritiera littoralis, Xylocarpus granatum* and *Xylocarpus mollucensis.* Mangrove communities were not sampled, but two sites were observed. A large mangrove area lies to the north of the reserve (Plate 7). Smaller populations were seen to the west of the reserve in Tondooni peninsular. The occurrence of 5 species including *Bruguiera, Ceriops, Heritiera, Rhizophora* and *Xylocarpus granatum* was confirmed during the study. Mangrove ecosystem is very important as a sanctuary for marine life and biodiversity, source of building materials, they protect coastal areas from soil erosion and they support salt production (the latter is however, a destructive practice because it involves clearance of salt production sites).

4.1.2.11 Fresh water swamp in open land

These are two small swamps at Makangare bwawani. These swamps are surrounded by abandoned cultivation and forest remnants dominated by *Harungana madagascariensis, Syzgygium cordatum, Vitex doniana* and *Bridelia micrantha*:

Location: 0577345, 9456953 Site No. 1, dry	Permanent swamp by abandoned cultivation Site No. 2

Pools inside moist forest were surrounded by *Barringtonia racemosa* scattered *Anthocleista grandiflora.* There is also the semi-aquatic swamp that dries out in dry season, while its muddy soils form cracks when drying

Table 4.5: Woody herbs and other herbaceous vegetation occurring in fresh water swamps in open land surrounding Ngezi forest, Pemba

Species name	**Notes**
Cyperus erectus	Perennial with densely set culms
Cyperus prolifer	Robust perennial in swamp edges
Desmodium adscendens	Spreading herb
Fuirena ochreata	Perennial, woody rhizome
Ludwigia abyssinica	Perennial herb edge of swamp, scattered
Ludwigia jussiaeoidess	Woody herb scattered
Ludwigia stolonifera	Herb with prostrate stems, plenty
Melastomastrum segregatum	Shrub forming dense bush at edges of swamps/ pools
Melochia corcholifolia	A weed, edge of swamp
Mimosa pudica	Straggling herb
Pentodon pentandrus	Succulent branched herb, spreading
Scoparia dulcis	Woody herb, weed
Stachytaphytta urticifolia	A weed edge of swamp
Triestemma mauritianum	Shrubby herb forming bush

4.1.2.12 Rice field landscape and other crops fields

This vegetation type represents public land, which has been annexed to the Ngezi Forest Reserve. This area was not botanically assessed, but it is likely to contain a rich diversity of annual and perennial weeds.

4.1.3 Indicator species and criteria to diagnose ecological condition/integrity

Biological indicator species predict the environmental quality of the community ecosystem. A forest is sound if it is able to sustain its structure when faced with regular and incidental natural perturbations. The main criterion for forest integrity is the occurrence of all species and age classes in a particular proportion of social organization (Herlocker 1999). The loss of any one species is an indication of poor forest condition. The change in the relative abundance of various species forms the basis of community indicators, which can be detected by establishment of long term monitoring programmes (Spellerberg 1991).

Plants and animal populations exist in community ecosystems under different regimes of environmental conditions including climate, soil and moisture content. Not only loss of a particular species that counts for community (forest) integrity, but fluctuating climatic conditions also affect the ecological conditions which inflict vegetation change. Indicator species have been used in mineral prospecting or as soil pH indicators. Heathland community is found on oligotrophic acid soils and the indicators are low growing, dwarf ericoid shrubs e.g. *Erica mafiensis* whose population forms over 90%. It has very low species diversity. This is a unique habitat, which is very fragile.

Some tree species are declining or disappearing through over-harvesting for timber and other forest products (medicines, building material, edible fruits). *Croton sylvaticus* is over used as medicinal plant. Indigenous timber trees include *Milicia excelsa, Bombax rhodognaphalon, and Afzelia quanzensis*. Abandoned logs, cut stumps and planks on the market, foot-trails to harvested sites are good indicators of the decline of timber trees. There are also reports that big companies carried tree harvesting of these species. Between 1957 and 1964 an Indian, V.R. Joshi used Ngezi Forest to harvest timber; the Zanzibar Government was also involved in timber harvesting from 1964 to 1966, while the Chinese did the same from 1975-1979. Although timber harvesting has been suspended there were many indications of illegal harvesting, these included fresh cut logs and trails to harvesting sites.

The Government replenished the forest by introducing exotic timber trees of *Calophyllum inophyllum, Cordia alliodora, Grevillea robusta, Khaya anthotheca, Terminalia ivorensis, Maesopsis eminii, Tabebuia triphylla, Tectona grandis* and *Cedrella mexicana.* Some of these are aggressive invaders on the regeneration of the indigenous species. The main aggressors are *Cedrella mexicana, Maesopsis eminii, Cordia alliodora* and *Terminalia ivorensis* (H. Selemani pers.comm. 2005).

I. Structural indicators

Natural vegetation is considered stable when it is undisturbed. Where a forest is disturbed through man-made interactions the likes of fire, land clearance, collection of fuel wood and medicines, building materials and timber harvesting, the ecological ecosystem (forest integrity) is also affected (Budowski 1965). Forest structural indicators, therefore, can define the ecological integrity of the habitat.

a) Basal area

The number of counted trees and their basal areas are presented in Table 4.2 It is demonstrated that the moist forest has the highest number of 59.5m^2.ha^{-1} coming from the larger dbh size class trees. This is followed by17.2m^2.ha^{-1} from coastal forest on coral rag. See Figure 4.1 below in which there is a characteristic inverted **J** shape in the resulting graph.

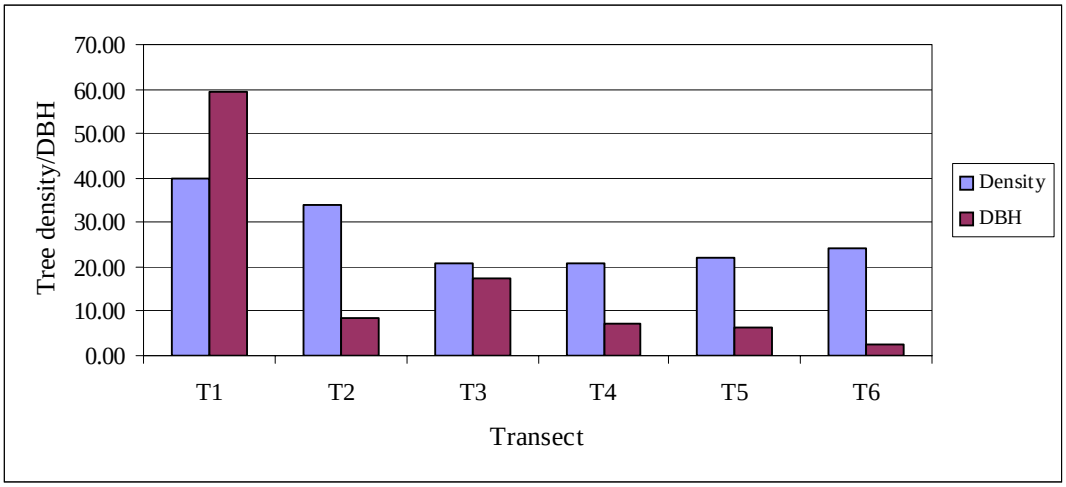

Figure 4.1: Tree density (trees ha^{-1}) shown against basal area (m^2 ha^{-1}) for the six sampled vegetation transects in Ngezi forest reserve, Pemba

b) Tree diameter

The presence of large trees is an indication of mature forest. In Ngezi Forest Reserve measured trees with a diameter >0.4m were considered as relatively large. For instance there were 41 trees with dbh over 0.50m in the moist forest, while in the 0.41- 0.50 dbh class ranges there were less trees than in the preceding dbh class range. Similar results indicate that dbh class range over 0.50 has more trees than dbh class range 40-50 in the rest of the transects representing different vegetation types. Most trees in almost all vegetation types were recorded in dbh class range 0.10-020m. The moist forest contains more trees than other types. For instance, there are 161 trees compared with 90 trees in the next vegetation types in the order of importance. Smiet (1989) categorized as big trees if their dbh exceed 5m. This is relevant for the moist forest, which also contains some timber trees, which need to be, protected e.g. *Milicia*, *Bombax*, *Afzelia* and the exotic tree species. Figure 4.2 shows the dbh range distribution in sampled transects which exhibit a more or less inverted J characteristic shape.

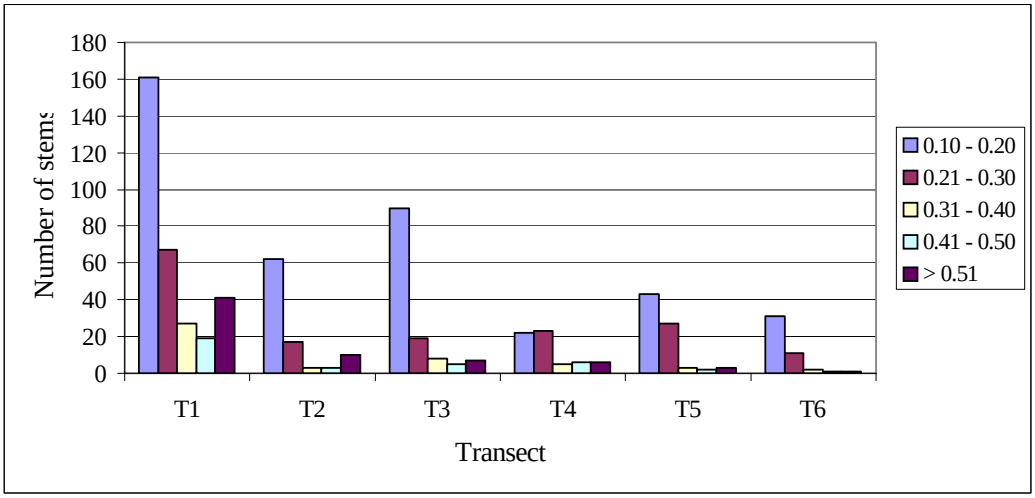

Figure 4.2: dbh versus number of trees (stems) in each of the six sampled transects in Ngezi forest reserve, Pemba.

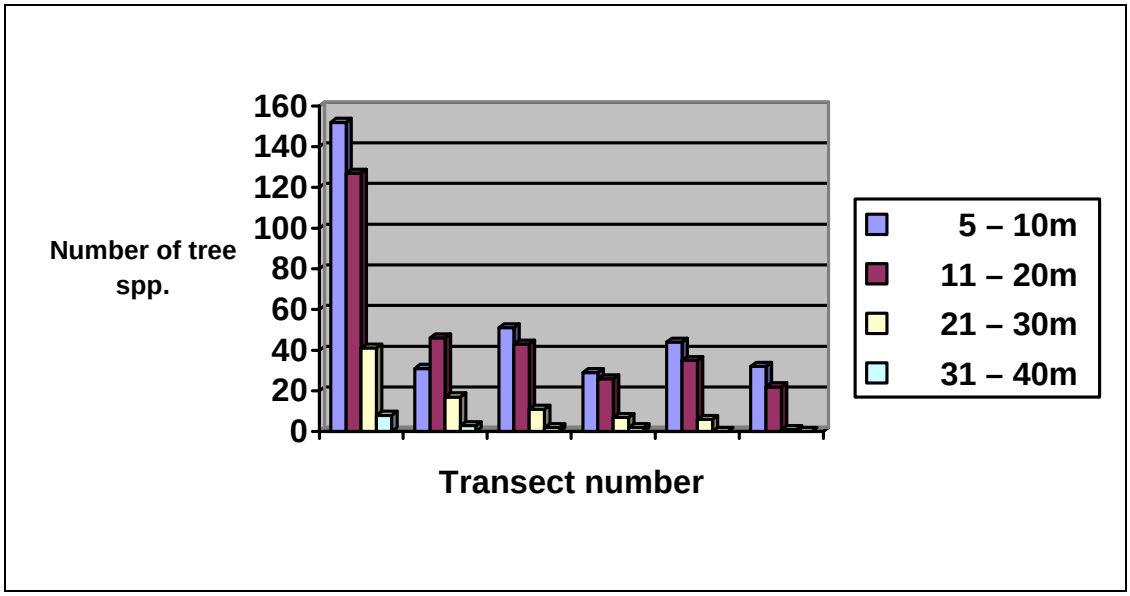

Figure 4.3: Height range (in metres) versus number of trees in six sampled transects in Ngezi forest reserve, Pemba

c) Tree height

Tree heights were estimated 5-10m class, the rest in 10m classes. The maximum height in 5-10m class contained the largest number of trees followed by coastal forest on coral rag. There were no trees in the 31-40 class tree heights**.** Figure 4.3 above supports the observation made with a characteristic inverted J shape of the graph.

d) Forest Layers

Young and old secondary forests have a single or double layer, while late successional stages have a more multi-layered structure (Budowski 1965, Jacobs 1988). In Ngezi Forest Reserve *Quassia indica, Barringtonia racemosa* and the *Raphia* swamp forests have single layers. Exotic tree forest plantations are successional stages with amore multi-layered structure.

e) Characteristic diameter distributions
The diameter distribution patterns tend to display a reverse J-shaped curve shown by the undisturbed forest. In Ngezi Forest Reserve the relationship of overall density of dbh follows the L-shaped curve whereby the lowest dbh class has the highest number of species.

II. Light indicator species
Light indicator species show reduced ecological integrity. The occurrence of such indicators is a sign of secondary forest or disturbed habitat (Budowski 1965).

a) Indicator Groups of Pioneer species in the gap formation
These include *Trema guineensis, Macaranga capensis, Ageratum conyzyides* and many weedy annuals in seasonally inundated ponds/pools (Table 4.1)

b) Light demanding indicators
These include *Olyra latifolia, Aframomum angustifoliam* (Ginger group), *Costus tomentosus,* the ferns of *Stenochlaena tenuifolia, Nephrolepis, biserrata, Phymatodes scolopendria.*

III. Atmospheric moisture indicators
This indicator group refers to families of species indicating high atmosphere humidity. These indicators in Ngezi Reserve Forest include epiphytic ferns and orchid family. The orchids include *Aerangis hologlotis, A. kirkii, Bulbophyllum* sp.; the fern epiphytes include *Asplenium nidus, Vittaria elongata* and *Microsorium punctatum.* Other direct ecological indicators include associated perturbations.

These are cut stumps of timber trees and building poles, presence of footpaths leading to areas of destruction (fresh stumps of *Milicia* and fallen logs of *Bombax*). Some species serve as ecological indicators for certain habitat conditions such as *Erica mafiensis,* for heathland ecosystem. *Acrosticm aureum* population is an indicator of saline condition associated with salt-marsh. *Nymphaea nouchali* and *Nymphoides kirkii* are floating aquatic herbs.

IV. Indicator species
This refers to species which by their presence or absence shows the type of environmental conditions that prevail. They have been used for instance in mineral prospecting and soil acidity studies. Biological indicator predicts the environmental quality of community ecosystems. They have been used for detection of pollution and specific pollutants.

The presence of every plant and animal (and its condition) is a measure of the conditions under which it exists. Animal and plant populations occur in communities. Heathlands are found on oligotropic acidific soils and the indicator heath-land plants are low- growing, dwarf ericoid shrubs e.g. *Erica mafiensis*. If moist forest trees, which abound with epiphytic ferns and orchids are cut down the populations of ferns and orchids will decline or disappear altogether.

Ferns and orchids usually grow on epiphytic cover on trees, where the height of tree at 1.5m, which is also the standard height for population studies of tree diameter, is used as the starting point in studies of tree epiphytes. The change in the relative abundance

of various species forms the basis of community indicator. Such changes can be determined by initiating reliable long-term monitoring programs (Spellerberg 1991).

V. Community indicators

Populations of animals and plants occur in communities and different soils support indicator plant communities. Thus *Erica* heathland is found on oligotrophic acid soils and the indicator heathland species are the low-growing, dwarf ericoid shrubs and for other species of *Syzygium cardatum, Venonia sansibarensis, Psydrax* and *Elaeis* spp. (Spellerberg 1991).

VI. Plant and animal indictors

The presence of every plant and animal (and its condition) is a measure of the conditions under which it is existing or existed previously.

4.1.4 Evaluation of plant biological resources

Ngezi forest is a storehouse of biodiversity with a few endemic or near endemic species and other threatened or endangered. Apart from maintaining biological diversity plant resources at community level, Ngezi forest has been supporting ecosystems, climate control, ecological processes and wildlife habitats.

Food crop relatives such as rice were not encountered at least from this study. However, there are many keystone tree species which did not show much regeneration in the ground layer apart from *Chrysalidocarpus pembanus* which regenerates vigorously in the moist forest, coastal dry evergreen forest and coral rag forest. The endemic species of *Ensette proboscoides* on the contrary, is very restricted to a small population in the moist forest. These two species are both of local and global importance. *C. Pembanus* is listed in the category of endangered species in the world IUCN red data book but not for *Ensette* spp. Other species of both local and global significance include *Erica mafiensis* which is confined to the heathland only, *Typhonodorus lindleyanum* confined to the swamps (monotypic), and rare species of *Allophylus vestives* (confined to the coral rag and coastal evergreen dry forest), as well as *Quassia undulata*. Other species including *Barringtonia racemosa, Haplocoelum inophylum*, and *Sorindeia madagascariensis* form clustered population where they occur, although *Haplocoelum* occur as scattered individuals. Timber trees are becoming rare due to unsustainable harvesting, which cause loss of species density in keystone tree species. Bryce (1965) includes some of these keystone tree species, which occur in Ngezi Forest Reserve.

Table 4.6: Trees used for commercial timber harvesting and other uses in Ngezi forest, Pemba (Source: Bryce 1967, Nahonyo *et al*. 2002, Burgess 2000, Beentje 1994)

S/N	Species name	Remarks
1	*Antiaris toxicaria*	For dug-out canoes, weak verniers and plywood
2	*Afzelia quanzensis*	Rare in moist forest but common in coral rag forest and evergreen coastal forest
3	*Bombax rhodognaphalon*	The weakest among hardwoods
4	*Ceurella mexicana*	Exotic species
5	*Milicia excelsa*	Best timber tree which is rare due to over-harvesting
6	*Dalbergia melanoxylon*	Absent in moist forest and rare in other forest communities

7	*Entandophragma* sp.	Reported but not encountered in study plots
8	*Erythrophloeum suaveolens*	same relative density as Bombax rhodognaphalon
9	*Grevillea robusta*	Among the exotic species, rare
10	*Khaya anthotheca*	Reported as introduced but not encountered in the study plots
11	*Maesopsis eminii*	Exotic, vigorous invader and spread fast
12	*Mangroves*	For building poles mainly but may soon be used for charcoal production
13	*Manilkara sansibarensis*	Timber tree, resistant to water and tear, thus for dhow-building according to Beentje 1994
14	*Quassia undulata*	Perishable wood
15	*Oxystigma* sp.	Said to occur in Pemba coast near Ngezi and Rau in Moshi for plywood and canoe
16	*Pterocarpus indicus*	Boundary marker, may be a timber tree
17	*Syzygium guineense*	Not widely used except for shuttering boxes
18	*Tamarindus indica*	Charcoal, boat-building, turnery and furniture
19	*Vitex doniana*	Low grade timber, locally for boxes, oats and cheap furniture

Mushrooms

There are no collections of mushrooms from Pemba Island. The only records of mushroom collections are from Zanzibar Island (Pergler 1977). The collectors quoted by Pergler include Berkeley (1974), Wheeler (1955) and Faulkner (1962). Even these collections do not indicate whether or not came from forests.

Apart from the edible mushrooms like *Pleurotus* spp. in general they also play an important role in forest ecology. Where forest tree would not survive without fungi in conjunction with other soil microorganisms fungi decompose forest tree litter, tree trunks and fallen logs facilitating the accumulated nutrients to be released and become available as plant food. These fungi are saprophytes. Fungi are also important mycorrhizal partners with trees where they are useful for water and mineral uptake; an association very essential especially in forest areas with poor laterite soils. This is true where trees are felled and the fungi stays alive; so helping stump roots to draw mineral food and water from the surroundings. Such partinership is called symbiosis.

The association is quite common in Miombo woodland. Some fungi grow as parasites on trees. The fungus *Armillaria mellea* causes disease to forest trees. There are many others, which cause harm to several parts of plants; some however plays part in the ripening of fruits. List of mushroom species collected in Ngezi forest is shown in Table 4.7b below (Plates 11 – 21).

4.1.5 Plant species diversity

Variables used in the ecological evaluation are many. Some of these include the number of species, species composition and the proportional abundance of species. In Appendix 1b relative densities and relative frequencies are used to predict the abundance and rarities of individual species. Many natural exploited species are being pushed towards the brink of extinction. Many of the endangered species are rare (though not all the rare species are endangered). Abundance refers to the high

intensity within an inhabitated area. In trees in Appendix 1b *Chrysalidocarpus pendanus* is very dominant (intensive) and widespread (frequent) with relative density 23.03%, and relative frequency 5.26%. This is followed by *Quassia undulata, Antiaris toxicaria* and *Pouteria brevipes.* Two species *Pouteria brevipes* and *Elaeis quineensis* are most widespread (RF 7.89% each). The two species *Pouteria brevipes* and *Elaeis quineensis* are broad riched (generalists) with wide range in moist forests. Rare species have a narrow range of relative density and frequency, and also their local populations are small (low intensity). Some conservationists support the protection of rare species. However, protection of this nature may lead to fragmentation of the reserve.

4.1.6 Medicinal Plants

Medicinal plants have been used to cure diseases traditionally because medical services could not be afforded in rural areas. Collection of medicinal plants is destructive because it involves, bark stripping of both stems and roots apart from leaves. This results in the deaths of the intended trees thus disturbing the ecosystem. Some plant species occurring in Ngezi Forest Reserve have been chemically investigated and contain biologically active compounds as it is shown in Table 4.7a and 7b below:

Table 4.7a: Some plant species with medicinal values in Ngezi forest reserve, Pemba (Sources: Chhabra *et al*. 1987; Nkunya *et al*. 1990a, 1990b)

Species	**Active agents/actions**	**Information source**
Annona senegalensis	Bark and root bark contain deterpenes. Extracts show antimicrobial and antitumour actions *in vitro*	Chhabra *et al*. (1987
Antiaris toxicaria	Small doses of dried latex may be stimulant to heart. Very toxic in large quantities	Oliver Bever (1986)
Dracaena deremensis	Show antimicrobial activity	Chhabra and Uiso (1991)
Lannea schweinfurthii	Antibacterial activity	Chhabra *et al*. (1987
Maytenus senegalensis	Extract show antimicrobial activity	Chhabra and Uiso (1991)
Rauvolfia mombasiana	Reserpine and desrpidine root extracts produce hypotension and counteracts effects of adrenaline also remedy for malaria (Beentje 1994)	Chhabra *et al*. (1987)
Scadoxus multiflorus	Bulb contains alkaloid lycorine, chlidanthine, haemonthidine, hyppeastrine and haemultine	Chhabra *et al*. (1987
Schizozygia coffaeoides	Contain alkaloids. Roots to treat skin disease	Beentje (1994)
Species	**Active agents/actions**	**Information source**
Uvaria acuminata	Uvaricin and desacytluvaricin shupantitumour and antibacterial actions	Chhabra *et al*. (1987)

Uvaria lucida	Extracts show *in vitro* activity against multidrug resistant strains of *falciparum* malaria parastites	Nkunya *et al*. (1990a)
Vernonia zanzibarensis	Contains vernonin, a hypotensive	Oliver Bever (1986)

Table 4.7b: Records of medicinal plants also available in Ngezi forest used traditionally as primary source of health care [Sources: FTEA, Beentje (1994) and Nahonyo *et al.* (2002)]

Species	**Disease treatment**
Albizia adianthifolia	Minor medicine against inflammation and dizziness, roots for skin diseases. Roots and stem bark to treat scabies, bronchitis, snake bites and to keep away evil spirits
Anacardium occidentale	Roots to prevent abortion
Ancylobotrys petersiana	Roots and leaves to treat minor cases
Annona senegalensis	Roots used to treat head-ache, stomach-ache, kirambi (sickle cell) and liver diseases
Antidesma venosum	Seeds, leaves, twig to treat liver and abdominal pains, coughs, chistosomiasis scabies, fits, diarrhea, dysentery and constipation
Asparagus falcatus	Roots to treat venereal diseases
Blighia unijugata	Roots to treat epilepsy and hernia
Bridelia micrantha	Roots to treat liver, bark to treat dysentery in children
Caesalpinia volkansii	Seeds to treat trachoma
Chassalia umbraticola	Leaf infusion used to treat fever
Croton sylvaticus	Aphrodisiac (root and stem bark), hernia
Dichrostachys cinerea	Leaves and roots to treat snake bites, wounds and boils, stomach ache.
Dichrostrachys cinerea	Leaf infusion used to treat fever
Dodonaea viscose	To treat impotence (roots)
Euclea racemosa ssp. *Schimperi*	Roots and stem barks to treat swelling, chest pains, schistosomiasis, purgative laxative and tamagoa
Ficus exasperate	Roots used to treat pneumonia
Flagellaria guineensis	Fruits used to treat veneral diseases
Funtumia Africana	Latex for minor medicinal used for burns, constipation, incontinence (state of mind being inconvenient)
Macaranga capensis	Leaves used to treat allergy
Mangifera indica	Leaves to treat stomach-ache, diarrhea
Olyra latifolia	Leaf infusion to treat swollen spleen
Pandanus kirkii	Roots for aphrodisiac
Paullinia pinnata	Root infusion used to treat cough linctus
Pluchea sordida	Leaves used to treat dementia (insanity)
Psiadia punctulata	Laves used to treat rashes
Rauvolfia mombasiana	Roots used to treat stomach-ache and primary stages of

	diabetes (5 pcs of twigs per does)
Sorindeia madagascariensis	Roots used against malaria, hookworms and hemorrhoids. Treating breeding of women and women pains while in monthly periods. Stem bark to treat syphilis sores
Suregada zanzibarensis	Leaf infusion used to treat fever
Synaptolepis kirkii	Roots are used to treat vomiting and impotence.
Tabernaemontana ventricosa	Milk sap from fruits and stems to heal wounds
Tamarindus indica	Seeds laxative
Terminalia catappa	Bark and roots to treat catarrh (inflammation of the mucous membrane), diarrhea, dysentery, skin diseases and asthma
Uvaria spp. (several of them)	Leaves and roots used to epilepsy, malaria treatments and lunacy (insanity, madness)

4.1.7 Conservation values of the forest

Ngezi forest reserve is categorized among the top high priority sites of the East African Coastal sites. Important priority sites are those with high levels of biodiversity, by using species richness and degree of endemism together with the actions, which cause primary threats to the long-term survival of these sites.

The approach for listing Ngezi Forest Reserve as amongst high priority sites include over four plant species and five animal species (IUCN 2000). The coastal forest on Mafia and Pemba Islands both of which receive almost 2000mm of average annual rainfall contain fewer endemic plant species compared to their counterparts on the mainland Tanzania.

Ngezi is the only largest remaining forest in Pemba having some of the vegetation formations that are important locally and globally. The moist forest has assembled species population not found elsewhere on the East African Coastal Forests. *Antiaris toxicaria* is considered rare globally; however it is quite common in Ngezi associated with *Quassia undulata* and *Bombax rhodognaphalon*, species which are otherwise restricted to East African lowland coastal forests. The moist forests also contain montane species of *Cassipourea, Erica* and *Drypetes.* Besides, the reserve is also a globally unique habitat for *Quassia indica* with formidable populations in the swamp forest and the Madagascan link of *Chrysalidocarpus* and the monotypic swamp species of *Typhonodorum lindleyanum*.

The *Erica* heath-land is a very unique habitat confined to Ngezi and Mafia Islands. It is one of the most vulnerable habitats to fire hazards; hence its conservation should be of global significance. Other habitats are economically important as sources of forest products, which includes timber, fruits and building materials (as evidenced in coastal dry evergreen forest), whereas the mangrove formations are essential as source of various building materials and for providing sanctuary marine life.

The primary cause of the loss of diversity is the habitat perturbation that results from the increase of human populations and human interactions with ecological ecosystem. Plant species have provided local populations in the vicinity of the reserve and town residents a variety of forest products, the most important reason for preserving

diversity is the role that micro-organisms, plants and animals play in providing free ecosystem services (Holdren & Ehrlich 1974).

The loss of genetically distinct population within a species affects the entire species. It becomes difficult to recognize that the species has reached a danger mark needing instant steps to save it. Some of the rare and endemic species have not even been listed in world IUCN Red list such as *Ensette* and *Erica mafiensis*. Constant annual fire wipes out the *Erica* heathland e.g. the 1988 incident. The real impacts on biodiversity of the habitat have not been monitored. The impact is not only on plant diversity but also for the wildlife at large. There are other factors such as runaway human population growth, acid rains (rain polluted by oxides of nitrogen and sulphur produced by oil combustion from motor vehicles going through reserve) and climatic changes induced by human beings in areas close to the reserve in considering forest reserve.

These arguments explain the basic causes and consequences of habitat destruction and alterations and give reason for great concern about their future including their protection. Conservation of the forest is important to protect the numerous genetically diverse populations to ensure the persistence of a species against any environmental changes that occur naturally. The existence of many plant populations spreads the risk so that unfavorable conditions in one or a few habitats do not threaten the entire species, like what normally happens to unique habitats like *Erica* bushland against fire or to what would happen if any catastrophe ever befall on *Typhonodorus lindleyanum* (a monotypic taxon) in its limited distributions of its occurrences in swamp forests.

Pemba Island is presumed to have been deforested where some areas were affected harder than others. Many plant species have been lost even before being described. This may have been affected by rapid growth among communities of small-scale cultivators mainly through immigration labour force to work in the clove plantation. The tree species *Syzygium aromaticum* (Syns. *Eugenia aromatica*/*Caryophyllus aromaticus*) was introduced to Zanzibar and Pemba in 1818 and rapidly became a major crop for export.

Its cultivation involved clearing of large forest areas. Many plant species and even animal species may have been lost in the process before even being known to science. Up to 1840's most of Pemba was covered with forest. Forest clearance for clove plantation and other food crops (plantations and rice) took place in the last 150 years. It is estimated that over 95% of forestland was destroyed. Today Ngezi is the only large forest area remaining in Pemba. Other small forest areas are Ras Kiuyu and Msitu Mkuu forests (all < 20ha). Ngezi Forest Reserve is thus part of the historical and cultural inheritance of the people of Pemba apart from its other biological values.

4.1.8 Conservation Status of the forest

Ngezi Forest Reserve possesses a large number of near endemic species and a few strictly endemic and rare species. Pemba island, located 05^0 20'S, 39^0 45'E has own endemic/near endemic species different from the other offshore islands of Zanzibar and Mafia. It is supposed to possess the highest levels of endemism species (especially in wildlife species). There are four (4) endemic species which include *Chrysalidocarpus pembanus*, *Erica mafiensis* (sharing with Mafia Island), *Ensete proboscoideum, Allophylus vestivus* (near endemic), *and Ananas comosus* var. Ngezi

forest reserve also ranks higher in terms of species – richness compared with its closely located Jozani Forest Reserve. According to the present study, Ngezi Forest Reserve possesses total number of 355 plant species compared with at least 291 vascular plant species of Jozani Chwaka Bay National Park, Zanzibar. Rare species include *Quassia undulate* (moist forest), *Erica mafiensis* (in heath bushland only), *Allophylus vestivus*, *Eugenia capensis*, ssp. *multiflora* [=*Eugenia* sp.nov, Rodgers (1986), Beentje (1990)], much more widespread than previous reports. *Typhonodorum lindleyamum* confined to limited swamps (Plate 3a and 3b).

Aleast 60 new species of vascular plants were recorded during this survey. The new list adds to the checklist of flora of Pemba documented from previous surveys. Undescribed species include *Cyphostemma* sp.nov., *Uvaria* sp.nov., and *Tarenna* sp.nov. These may later turn out to be new endemic species. Table 4.8a below illustrates new vascular plant species identified in Ngezi forest during a survey in January 2005.

Table 4.8a: List of new records of plant species from Ngezi forest, Pemba

Acanthaceae
Hygrophylla auriculata

Adiantaceae
Pellaea leucomelas. Hook.
Aloaceae
Aloe massawana. Reynolds.

Annonaceae
Annona senegalensis. Pers.ssp.*senegalensis*
Sphaerocoryne gracilis. Verdc.
Uvaria acuminata. Oliv
Uvaria lucida Benth.ssp.? *lucida.*

Apocynaceae
Voacanga africana. Stapf; raised sandy beaches.

Asclepiadaceae
Taccazea apiculata. Oliv. Climber in coral rag

Bignoniaceae
Adansonia digitata.L. isolated trees on coral rock coastal forest.

Celastraceae
Loesenerielia africana. (Willd.) N.Halle ssp. Richardiana (Cambess.)N.Halle
Salacia leptoclada. Tul

Combretaceae
Combretum sp. Vent ssp. *paniculatum.*

Compositae
Ageratum conyzoides
Psiadia punctulata (DC.) Vatke

Connaraceae
Agelaea setulosa

Cyperaceae
Cyperus dermatatus.
Cyperus erectus.(Schum.) Mattf. & Kuk.
Cyperus polystachyus. Rottb.var.laxiflorus (Benth.) K.Lye.
Fimbristylis dicotoma. (L.) Vald.
Fuirena ciliaris. (L.) Rottb.
Fuirena ochreata. Kunth.
Ebenaceae
Euclea racemosa ssp.*schimperi*

Euphorbiaceae
Acalypha neptunica.Mnell.Arg
Antidesma membranaceum. Mnell.Arg.

Flacourtiaceae
Xylotheca tettensis.

Gramineae
Panicum brevifolium L.
Sacciolepis curvata

Hymenophyllaceae
Microgonium erosum (Willd.) Copel. Records from literature.

Leguminosae – Papilionaceae
Eriosema parviflorum. E.Mey.
Indigofera trita.
Sophora tomentosa. L.ssp.*tomentosa*
Teramnus labialis (Linn.F.) Spreng

Liliaceae
Chlorophytum sp.

Loganiaceae
Strychnos panganensis. L.F

Malvaceae
Hibiscus surattensis. L.
Melochia corcholifolia. L.

Onagraceae
Ludwigia abyssinica. A.Rich.
Ludwigia jussiodes.
Ludwigia stolonifera. (Gnill. & Perr.) Raven

Orchidaceae
Calanthe sylvatica (Thon. & Lindley).

Palmae
Calamus deerratus. G.Mann& H.Wendl.

Polypodiaceae
Microsorum punctatum (L.) Copel; New for Ngezi & (P&Z)
Ophioglossaceae
Ophioglossum reticulatum L.

Pteridaceae
Cyclosorus interuptus (Willd.) H.Ito
Cyclosorus tottus (Thunb.) Pichi.serm. (840m too high for P&Z)
Dicranopteris linearis. Altitude too high in FTEA
Elaphoglossum lastii (Bak.) C.Chr; epiphytic
Pteris acanthoneura. Alston.
Pteris atrovirens (Willd.)

Rubiaceae
Pentadon pentandrus (Schumach. & Thonn.). Vatke
Psychotria amboniana.
Psychotria riparia. (K.Schum.& K.Krause) Petit.
Spermacoce confusa. Gillis.
Trianolepis africana. Hook.F

Rutaceae
Toddalia sp.

Sapindaceae
Dodonaea viscosa. Jacq.

Schizaeaceae
Lygodium microphyllum (Cav.) R.Br.
.
Tiliaceae
Grewia plasiocarpa.

Verbenaceae
Clerodendrum glabrum. E.Mey.
Clerodendrum hildebrandtii. Vatke.
Stachytaphytta urticifolia. Sims.

Vitaceae
Ampelocissus Africana
Cissus phymatocarpa.
Cissus rotundifolia.
Cyphostemma duparquetii (Planch.) Desc.

Table 4.8b: List of new records of non vascular (mushroom) plant species from Ngezi forest, Pemba

Microporus xanthopus (Fr.) Kuntze
Phellinus sp.
Ganoderma sp.1
Ganoderma sp.2
Pleurotosus sajur – carju
Trametes cf. gibbosa
Trametes vesicolor
Microporus sp.1
Trametes elegans
Microporus sp.2
Laetiporus sulphorus (chicken of the woods)
Funalia polyzona
Schizophyllum commune
Xylaria sp.

4.1.9 Endemic, endangered and introduced plant species

Endemic species

Ngezi Forest reserve contains few strict endemic species or narrow range endemics, which include the following:

- *Connarus* sp.nov.
- *Chrysolidicarpus pembanus*.
- *Ensette proboscidium*.
- *Ananas comosus* var. (wild variety of *Ananas*).
- *Erica mafiensis* (found also in Mafia Islands).
- *Vangueria* sp. nov.vel.gem.aff. (Burgess *et al*. 2000).
- *Uvaria* sp.nov. (Not in Beentje 1990)

These are known as narrow endemics confined to a small area such as Ngezi Forest Reserve only. This low rate of floristic endemism somehow contrasts with the early theory that Island floras should usually be rich in endemic genera and taxonomically isolated groups (Burgess *et al*. 2000).

The intensive anthropic perturbations about 2000 years ago are postulated to have reduced island species to small populations. These small populations were vulnerable to become extinct due to effects of genetic unviability, catastrophic events and the limited immigration rates from the mainland into the islands.

However, Ngezi Forest Reserve shares many near endemic species with other Indian Ocean Coastal Forests and the Eastern Arc Forests. These are also known as broad endemics being distributed to a larger Zanzibar-Inhambane Regional Centre of endemism. These endemics include those listed in Table 4.9 below. The Island species supports the theory that Pemba Island was linked to mainland Tanzania which separated from it about 10 million years ago.

Table 4.9: Endemic species of the Zanzibar-Inhambane regional centre of endemism including Lowland and Eastern Arc Forests occurring in Ngezi forest and surroundings in Pemba.
Key: Som. = Somalia, K= Kenya, Z = Zanzibar, P = Pemba, Maf = Mafia, Moz = Mozambique, MN = Mozambique Niassa, Mal = Malawi, K1-7 = distributions across Kenyan regions. T3 = Tanga, T6 = Coastal Tanzania including Mafia, T8 = Lindi and Mtwara regions.

Family	Species name	Distribution	Notes
ALOACEAE	*Aloe massawana*	K7;T3,6;Z,P&Mg	Herb
ANNONACEAE	*Sphaerocoryne gracile* *Uvaria acuminata*	K7;T3,6&8,P,Mg S.sam;K7;T3,6,8;P,Z	S/L Liana
APOCYNACEAE	*Rauvolfia mombasiana* *Strophanthus zimmermannii*	K7; T3, 6;Z,P;MZ K7; T3, 6;Z, P	Shrub or small tree
ARACEAE	*Culcasia orientalis* *Zamioculcas zamiifolia*	K7;T3,6,8;Z,P K1,7;T3,6,Z,P,Moz, - Mal	Climber Shrub
ARARIACEAE	*Cussonia zimmermannii*	K7;T3,6,8;P, Maf	Tree
ASCLEPIADACEAE	*Secamone retusa* *Tylophora stenoloba*	K7;T3,6;Z,P;Mn, Mz K7;T3,8;Z,P;Mn	Climber Climber
BOMBACACEAE	*Bombax rhodognaphalon*	K7;T3,6,8;P;Mn, Mz,m-ms	Timber tree
BORAGINACEAE	*Ehretia bakeri*	K7;T2,3,6,8;P	Shrub or tree
COMPOSITAE	*Pluchea sordida* *Vernonia sanzibarensis*	K4,7;T2,3,6,8;Z,P K7;T3,6,8;P	Shrub Shrub
Family	**Species name**	**Distribution**	**Notes**
COMMELINACEAE	*Aneilema clarkei* *Murdonia axillaries*	K7,T6;P K7;P	Herb Herb
CONNARACEAE	*Cnestis confertiflora*	T6;P	Liana / Shrub
CYPERACEAE	*Cyperus hildebrandtii*	K7,T3,6;Z,P	Herb
DILLENIACEAE	*Tetracera litoralis*	K7;T6;P	Shrub / Liana
MALVACEAE	*Gossypioides kirkii*	S.Som;K7;T3,6,7,8;P;-Mn,Mz	Shrub
MENISPERMATACEAE	*Tinospora oblongifolia*	K7;T3,6;Z,P	Liana

MORACEAE	*Dorstenia tayloriana*	K7;T3,6,8;P	
MYRTACEAE	*Eugenia sp.nov.(Vaughan 1676) = Eugenia capensis ssp.multiflora*	P,Z	Shrub
OCHNACEAE	*Ochna thomasiana*	K7;T3,6;P	Shrub
PANDANACEAE	*Pandanus kirkii*	K7;T3,6;Z,P	
RUBIACEAE	*Chassalia umbraticola* *Lampothramnus zanguebaricus* *Lagynias pallidiflora* *Psychotria holtzii* *Psydrax kaessneri* *Psydrax recurvifolia*	K7;T3,6,8;Z,P,MN Som;K1,7;T3,6,8; P K7;T3,6;P K7;T3,6,8;P K7;T3,6,8;P,MN K7;T3,6;P	Shrub New tree for Pemba Shrub Shrub Shrub Shrub
SAPOTACEAE	*Inhambanella henriquesii* *Manilkara sansibarensis* *Manilkara sulcata*	K7;T3,6;P,Mz,Mal K7;T3,6,8;Z,P K1,4,7;T3,6;Z,P	Tree Tree Tree
SIMAROUBACEAE	*Quassia undulata*	K7;T3;P	Timber tree
THYMELIACEAE	*Synaptolepis kirkii*	K7;T3,6,8;Z,P,Moz	Shrub / Liana
TILIACEAE	*Grewia stuhlmannii*	K7;T3,6,8,P	
VERBENACEAE	*Premna hildebrandtii*	K4,7,T3,6,8;P	Shrub
VITACEAE	*Cissus phymatocarpa* *Cissus quinquiangularis* *Cissus sciaphylla* *Cyphostemma duparquetii*	K4,7,T3,6,8;Z,P K7,P K7;T3,6,8,P K7;T3,6,Z,P	Climber Climber Climber Climber
ZINGIBARACEAE	*Costus sarmentosus*	K7;T3,6,Z,P	Herb
PTERIDOPHYTES	*Stenochlaena tenuifolia*	Z,P,Moz	Climber

Threatened plant species

Having carried out field data and analyzing them it is possible to identify threatened species, and determine their IUCN categories. Major pressures and threats have also been identified. Tree forest species are outstanding economically at the source of many products essential to society (timber, fuel, medicines, food). Therefore, they are

prone to decimation from harvesting. Second, they are prominent environmentally, as they are the keystone forest species forming tree canopy and helping to stabilize the environment by fixing CO_2, preventing soil erosion and sustaining the water reservoir in the ecosystem. The trees are dominant ecologically as they determine a wealth of interactions. Conservation *in situ* is the primary method to sustain target species from decline and safeguard their genetic resources (Frankel *et al*. 1995).

Table 4.10: Threatened plant species of Ngezi forest reserve, Pemba

Species name	Pressures and threats	Conservation values	Conservation measures
Afzelia quanzensis	Exploited for timber, fuel wood. Timber exports trade by Arabs since 1900. (Moomaw 1960) considers it as premium timber for high class.	Not in IUCN; but in Forest Ordinance, threatened status insufficiently identified	Experimental plots for plantation (Annon.1902, Wood 1966)
Aloe masawana	Forest disturbance and collected for medicine and gardens	All *Aloe* spp. in Appendix II (other 5 *Aloes* from S. Africa in Appendix I)	*Ex situ* protection in government garden. Restrict collection
Antiaris toxicaria	Lesser timber value for construction, plywood, flooring, crates	Key species in moist forest protects epiphytes like *Vittaria elongate*, Pemba flying fox roosting trees and bird nest	Restrict cutting for timber
Manilkara sansibarensis	Timber resistant to wear and tear. Heavily exploited, durable in water, dhow building	Not included in the Red list	*In situ* conservation.
Dalbergia melanoxylon	Special wood for carvings	Not included in IUCN, but being discussed as a threatened species; but in Red List Summary Report 2000, LR/nt	Control its being harvested from forest reserve. Does well in plantation
Acampe sp. (Orchidaceae)	Harvest for garden plants. Threatened category	All *Acampe* spp. in Appendix II	Protect tree harvests
Aerangis hologlatis	Threatened category	Appendix II	Control harvests
Bulbophyllum sp.	Threatened category	All spp. in App. II	Restrict harvesting
Calanthe volkensii	Threatened category	All spp. in App. II	Restrict harvesting
Disperis johnstonii	Threatened category	All spp. in App. II	Restrict harvesting
Eulophia sp.	Threatened category	All spp. in App. II	Restrict harvesting
Nervilea umbrosa	Threatened category	All spp. in App. II	Restrict harvesting

Vanilla roscheri	Threatened category	All spp. in App. II	Restrict harvesting
Vanilla zanzibarica	Threatened category	All spp. in App. II	Restrict harvesting
Milicia Excelsa	Being over harvested for premium timber	Covered by Forest ordinance 1995; Cover under Red list Summary Report 2000 as LR/nt	Stop issue of licences, Monitor regeneration
Chrysalidocarpus pembanus	Endemic and vulnerable species	Not listed in IUCN but very important to list it in App. I/II	Well distributed in moist and dry coastal forests
Vittaria elongata	Vulnerable only to moist forest	Not in IUCN categories	Protect keystone trees
Erica mafiensis	Destruction of heathland by fire especially caused by hunters in dry season	Endemic and restricted to two sites only in Ngezi Forest Reserve. The heathland here is very unique	Stop man-made fire by restricting entry and collection of fuelwood, poles
Typhonodorum lindleyanum	Rare habitats, restricted to few swamps	Species in the genus, rare	Conserve the swamps, amenity
Psilotus nudum	Rare species	Should be included in IUCN category	Identify all sites where it grows
Xylotheca tettensis	Rare	Red list, Summary Report 2000 Vu BH 2c	Identify all uses of the species

Introduced plant species

In the mixed moist forest the exotic species, apart from playing the role of beating up the gaps created by overharvested timber trees, they are usually useful timber trees in their countries of origin. These exotic species, with their countries of origin in brackets include *Calopyllum inophyllum* (Borneo mahogany), *Cordia alliodora* (Mexico), *Casuarina equisetifolia* best firewood in the world (Indomalasia, also pioneer seashore tree, *Artocarpus altilis* (Pacific Islands, cultivated tropical fruit tree less often for timber) *Artocarpus heterophyllus* (native of tropical ASIA excellent timber tree for furniture besides producing huge edible fruit), *Cedrella odorata* (Mexico, West Indies to North Argentina) highly regarded for joinery of all kinds (formerly most favoured for cigar boxes), *Maesopsis eminii* (Tropical Africa probably Uganda) it is becoming a noxious weed; *Tabebuia rosea* (Mexico to venezuela), *Terminalia arjuna* (India).

Other exotic species include *Terminalia catappa* (India, Barbados and Malay Pensinsular), *Terminalia ivorensis* (West Africa), *Mangifera indica* (Indomalaysia, also cultivated for fruit), *Eucalyptus* ssp. including *Eucalyptus camaldulensis* (Australia). Some of these exotic trees were intoduced to Ngezi forest incidentally by humans or monkeys and wild pigs especially fruit trees of Art acarpus spp. *Mangifera indica*, *Cocos nucifera* (naturalized in East Africa and *Terminalia catappa*. Some lowland native forest species of *Khaya anthotheca* and *Entandrophragma* are useful enrichment plantation trees such as in Cameroun. These two species have been tried in Ngezi forest reserve. *Tectona Grandis* is a native to Burma, India, and Indonesia to the Phillipines. It is a highly priced plantation tree in Tanzania popularly known as teak. It is widely used for quality timber.

Some species have beeen introduced to Ngezi as a conservation measure. Such species which are endemic in their countries of origin were translocated to new suitable sites which act as refugia in case of holocausts in their natural habitats. Ngezi forest reserve in Pemba Island is a useful isolated refugium site for such rare species facing extinction in their native countries. This principle is recommended in the ''Plant Conservation in protected Natural Areas'' (Given 1994). These species include *Typhonodorum lindleyanum (*Madagascar, Mascarene and now in most lawland coastal East African forests), *Calamus* sp. and *Quassia indica* (India). Another species also introduced to Ngezi is *Quassia indica*, which is endemic to India. Both species occur in very fragile swamp habitats that can easily be destroyed and hence make the species become extinct.

4.2 Fauna

4.2.1 Mammal occurrence and distribution

Only a few of the large mammal species reported to be present in Ngezi were encountered during the survey either through direct observation or signs (Table 4.11). Mammals tended to occur in all forest areas though habitat types and human interference influenced the distribution. Various species of mammals were recognised within Ngezi forest and the surroundings (Appendix 3). The most abundant group of mammals at Ngezi forest are bats and the Black Rat (*Rattus rattus*) and Tree Hyrax (*Dendrohyrax validus*) that were estimated by call sites. Other large mammals sighted physically during the survey included the Zanzibar Red Colobus (*Piliocolobus kirkii*), Pemba Green Monkey (*Cercopithecus aethiops nesiotes*). Basically Pemba Green monkeys was the most commonly sighted animal and almost in all habitat types. It was also the only animal which featured most from foot count transects records. Most other species were recorded from signs such as galagos, genets, civets and owls. The team was lucky to get a specimen of the Greater galago at Konde village from children who were playing with it and took photographs and measurements. The distribution of most species was widespread within the forest and their occurrence outside the forest reserve was not common except for few such as monkeys who are also common in farmland areas. The distribution of most species is possibly shrinking due to hunting, farming, settlements and human disturbances. Below is a synopsis of some key animal species of Ngezi - Vumawimbi forest reserves.

Table 4.11: Animals and animal signs observed during foot count in Ngezi – Vumawimbi forest reserves, Pemba (January 2005)

SN	Species	Observation	Sightings	Transect/Frequency					
				T1	T2	T3	T4	T5	T6
1	Vervet monkeys	Animals	1	18					
		Animals	1	12					
		Animals	1		1				
		Animals	1		2				
		Animals	1			3			
		Sign	Food remains			1			
		Sign	Droppings and food remains			1			
		Sign	Ground mark				1		
		Signs	Urine				2		
		Animals	1				9		
		Sign	Droppings					1	

		Animals	1					4	
		Sign	Footmarks					4	
		Sign	Droppings					1	
		Sign	Skull						1
		Sign	Droppings and urine						1
2	Bushbaby	Animals	1	1					
		Sign	Food remains			1			
		Animals	1					1	
3	Marsh mongoose	Signs	Remains of feed (snails)		2				
		Signs	Foot print		1				
4	Tree hyrax	Signs	Pellets and urine		1				
		Signs	Pellets and smell			1			
		Signs	Sound			1			
		Signs	Urine and smell			1			
		Signs	Smell			1			
5	Ngawa	Signs	footprint		2	1			
		Animal	1					1	
6	Bushpig	Signs	Dung and feeding signs		1				
7	Bats	Signs	Smell			1			
8	*Rattus rattus*	Animals	1				1	1	1
9	Domestic dog	Signs	Footprints					1	

As seen from Table 4.11 above only few animals were recorded along the transects during the foot count. Out of the 9 animal species recorded only 4 were seen live including vervet monkeys, bushbaby, civet cat, and Black rat whereas the rest were recorded from animal signs only. Again like the resulsin Jozani National park the amount of data collected did not suffice to perform any meaningful calculations for animal density except for vervet monkeys which featured in almost all transects. At mean strip width of 27.7 m (pooled for all 6 transects) the vervet monkey density was estimated at 121 animals per km^2 a relatively high density not found in many places. Vervet monkeys also registered a high index of relative density at 0.9 signs per km covered during the foot count. Other animals with index of relative density in parenthenses were bushbaby (0.07 signs km), marsh mongoose (0.21 signs km), tree hyrax (0.34 signs km), ngawa (0.21 signs km), bushpig (0.07 signs km) bats (0.07 signs km), Black rats (0.21 signs km) and domestic dog 0.07 signs km). However, despite animals like Black rat showed very low occurrence from foot count transects they are one of the most abundant animals in the forest. The small number was due to hiding and freezing habit when they sense disturbance.

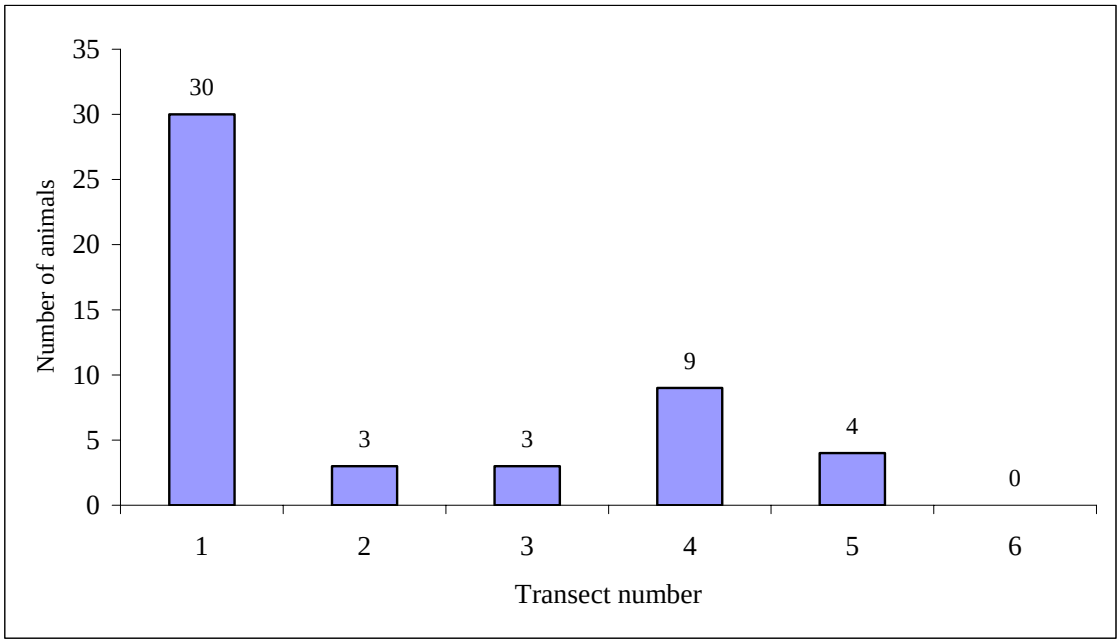

Figure 4.4: Number of vervet monkeys observed on 6 foot count transects sampled in Ngezi – Vumawimbi forest reserves, Pemba (January 2005).

Zanzibar Red Colobus (*Piliocolobus kirkii*) (Kima punju)

Seven individuals were introduced in Ngezi from Jozani in 1979 to establish a herd. The numbers incresed and curenlty their numbers are estimated to be over 35 individuals. It is not clear of their exact number, as it is very difficult to sight them. The colobus are currently confined to the east of the forest in Kisiwani area because to the west of the forest the colobus were being hunted and there is heavy human disturbance. No colobus was seen during the foot count but three individuals were seen on a separate visit to Kisiwani area. There have been no reports of negative impact arising from the introduction of the colobus in Ngezi or rather it is not apparent at least at the moment. The forest habitat in Ngezi is very ideal for the colobus and there is a big potential for the species to increase in numbers.

The Zanzibar red colobus is a species endemic to Zanzibar. It is listed as endangered in the IUCN threatened species categories and appears in Appendix I of CITES. It was investigated by Sir John Kirk, the Governor General of Zanzibar in 1868 and named after him. Other members of the red colobus group are widespread. The Zanzibar red colobus weighs 7 - 13 kgs. and exhibits diverse dietary habits, sometimes reported as crop pest. Its preferred habitat includes the ground water, coral rag, and deep soil and mangrove forests. Occurrence in cultivated and areas under fallow is reported to be due to loss of preferred habitat. The Zanzibar red colobus is the flagship species of Zanzibar's terrestrial conservation effort and a major tourist attraction. The conservation effort of the colobus started over 134 years ago because in 1868 Sir John Kirk described the colobus as "rare" in Zanzibar. Official role of the colobus protection began in 1919 and continued during the Sultan of Zanzibar regime. Since 1995 local community support has been sought in the conservation of the colobus.

African Clawless Otter (*Aonyx capensis*)

For the first time this animal has been reported to occur in Ngezi (Pemba). It is a widely distributed species in African permanent fresh water bodies, which include lakes, rivers and streams where its food (mainly cabs and catfish) is abundant. This species is most active at night and so making its observation difficult for many people. A single animal was recorded at Makangale swamp where dung deposits were also evident. The observation becomes the first record of the species on Pemba Island. This species is widely distributed in Africa and is placed under CITES Appendix II. The population of African Clawless Otter and its conservation status in Pemba need to be checked.

Pemba Blue Duiker (*Cephalophus monticola pembae*) (Paa wa Pemba)
This is a rare, threatened and an endemic sub species to Pemba. Once abundant in the forest their numbers have been severely reduced by hunting and possibly habitat loss. Sightings of the same are now very rare and none was seen during the whole survey. Their population size remains unclear but most probably very low. Blue duikers are diurnal forest antelopes. Males are usually smaller weighing on the average 4.6 kg. than females who weigh on the average 5.4 kg. Blue duikers feed primarily on fruits, foliage and fungi although ocassionally they have been observed to feed on small mammals, reptiles, birds and insects.

Wild Boar (*Sus scrofa*) (Nguruwe mwitu)
This was a European species introduced to Pemba in the 16th century by the Portuguese who occupied the island by then. They became feral, numerous and very destructive to crops. Of recent their numbers have dwindled severely due to heavy hunting and habitat loss. This has probably made the animals to become more secretive occupying deep forest areas. None was seen during the survey. Only few sightings are reported by the local people.

Pemba Green monkey (*Cercopithecus aethiops nesiotes*)
Although the taxonomy of this subspecies in relation to its siblings in Zanzibar, Mafia and mainland Tanzania is complex, it is generally agreed that this is subspecies and is endemic to Pemba (Pakenham 1984). The Pemba vervet is found in a variety of habitats in Pemba Island especially places with large trees and farms. These vervets are known to be more destructive to crops than *Cercopithecus mitis*. Although present in Ngezi forest, they are mostly found in peripheral areas of the forest in areas bordering farmland. However, the vervets are also fairly common in the forest and were encountered in almost all 6 foot count transects. They were the most common, widespread and relatively most abundant animal species in the area. Sightings ranged from 1 individual to over 20 individuals in one place. Animals seen alone or in small numbers were basically due to inability of the observer to see other members of the herd. The distribution and abundance of vervets in Ngezi suggests that this is one of the most successful species in the area.

Prosimians (galagos)

Greater Galago (*Otolemur garnettii garnettii*)
This is a threatened species according to the IUCN redlist. They prefer diet of mangoes, pawpaws and similar fruits. The Garnett's galago occurs in coastal forests of Eastern Africa including Pemba and Zanzibar and it is very common in both islands. It is confined to coastal forests and thickets and the Eastern Arc Mountains. During the survey in Ngezi forest, Greater galagos were mostly heard from vocalisation both

in the forest and inhabitated areas. A specimen was obtained from children in Konde village. Vocalisations suggested that galagos are fairly common in the area.

Galagos are found only in Africa south of the Sahara but are absent at the Cape. Morphologically similar species can be identified by vocalisation. Galagos occupy a range of habitats from forest, thickets, wooded savannah, deciduous woodland to tree-crop plantations depending on the species. Habitat loss and possibly hunting are probably the greatest potential threats to galagos.

Javan or Rasse Civet (*Viverricula indica rasse*) (Ngawa)

This is an exotic species introduced to Pemba and Zanzibar at an early date but it is not exactly known when. It belongs to India-Indochina-Malaya region and was brought to Pemba by the Javanese sailors. The secretions from the civet, which are used in perfume industry, is believed to to be the main reason Javan sailors introduced the species in every place they went. The civet secretions are also known to be a remedy to swellings. The species has become relatively successful and ha established itself on the island. It is widely distributed occupying a variety of habitats, and their sightings are fairly common. In Pemba there is no indigenous African civet hence the introduced civet flourished unchallenged. In Zanzibar since its introduction the civet has coexisted with the African civet *Viverra civetta*. No negative impacts have been established in Zanzibar between the Javan civet and its counterpart the African civet with which they share habitats.

Small mammals

There is a significant gap in the knowledge of taxonomy and distribution of smaller mammals, especially forest species and those, which are nocturnal or difficult to detect such as bats, rodents and shrews. On the other hand shrews, bats, galagos, rodents, antelopes and elephant shrews are mammal groups showing the highest levels of endemism in coastal forests. Most small mammals observed were caught in traps and some were seen during night drives. Few animals were sighted opportunistically. Rodents particulalrly Black rat *Rattus rattus* was very common in all forest habitats. It is the most abundant small mammal in Ngezi. Only few shrews were observed through capture in pitfall traps. Shrews are probably not common in the area. Marsh mongooses are present and at least one sighting and a number of signs were observed. There was one sighting of slender mongoose. Lack of capture of most small mamamals and few sightings during survey suggest that most of them are locally rare.

Shrews

Shrews of East Africa are not well known, their distribution is restricted and do not commonly occur in all habitats. Generic and species diversity in coastal forests is lower than in the Eastern Arc Mountain forests (Burgess and Clarke, 2000). Although Zanzibar shrew species richness is comparatively high in relation to most coastal forests on the mainland the situation is different in Pemba. Only 3 specimens were obtained during the survey with over 462-trap effort. On the other hand Zanzibar has 2 genera and 4 species of shrews including the African Giant Shrew (*Crocidura olivieri*), Zanzibar Pygmy Shrew (*Crocidura fuscomurina*), larger Savanna Shrew (*Crocidura viaria*) and the Indian Musk Shrew (*Suncus murinus*). The Zanzibar Pygmy Shrew is the most common and widespread species in Africa (Burgess and Clarke, 2000).

Rodents (Muridae)

At least three types of rats occur in Pemba all of them introduced species. These include White - bellied house mouse (*Mus musculus gentilis*), Brown or Common rat (*Rattus norvegicus*) and Black or House rat (*Rattus rattus*) (Moreau and Pakenham, 1941; Pakenham, 1984). Archeological evidence and past records and studies do not indicate presence of other rat species in Pemba. Of the three species *Rattus rattus* is the most common and abundant rodent in Ngezi forest. It is found in all habitats and featured more than any other trapped species. There was no sighting or report on the other two species.

Our sampling yielded only a single species of rodent, *Rattus rattus*, the Black Rat. This species is known world wide as a pest of human dwellings, as a destroyer of fresh and stored food and food products. Rodents and their relationships with people are increasingly receiving more attention than has been the case in the past (Singleton *et al*., 2003). They are important as reservoirs of several diseases, including plague.

On Pemba, however, *Rattus rattus* is known not only as a pest of dwellings, but it was in addition trapped in all habitats sampled, including relatively dense forest, in Ngezi forest reserve. In most forest reserves on the mainland, even in those surrounded by villages and cultivation, *R. rattus* is only found at the edge of forest near human settlements and other native rodent species are known to occur inside forest. In coastal forests as well as those of the Eastern Arc, usually several species of rodents are present (Msuya *et al*. 2004, Burgess *et al*. 2000, Stanley *et al*. 1998). Even on Zanzibar the nearest island to Pemba, at least five species of native rodents are present (Nahonyo *et al*. 2002).

On some islands in the Western Indian Ocean region, more extensive studies have been conducted on the Black Rat in relation to its control, effects on human health, and on the native endemic species of rodents on those islands. Such is the case on Madagascar, which also has an endemic rodent fauna (Duplantier & Rakotondravony 1999) and the granitic islands of the Seychelles, which like Pemba, appear to have no native rodents, but do have both *Rattus rattus* and *Rattus norvegicus*; the only other terrestrial mammals found there are bats (Hill *et al*. 2003).

***Rattus rattus* as pest**

When reviewing the literature, what is surprising is that there appears to have been little attention paid to the ecological role of *Rattus rattus* on Pemba. This species is recognized as a major pest of man and his crops, but we found no published references to its abundance, breeding or effects on agriculture and humans on Pemba. There are numerous studies conducted in many countries on the negative effects of the Black Rat (as well as other *Rattus* species) on oil palm plantations and this species is also known to be a pest of coconuts on Mafia and SongoSongo Islands (K. M. Howell, pers. observ.; C. A. Msuya, pers. observ. 2005). In addition, studies have indicated the negative effects of the introduced Black Rat on native fauna, including birds (Hill *et al*. 2003).

***Rattus rattus* as vector of diseases**

The Black Rat is widely recognized not only as involved in the transmission of plague (through the plague bacillus, *Yersinia pestis*) but also potentially in the transmission of murine typhus, relapsing fever, leishmaniasis, leptospirosis and many undescribed

viruses. Recent work has pointed to the role of *Rattus rattus* on islands as important in the transmission of *Fasciola hepatica*, a fluke (flatworm) important in the human disease fascioliasis. Valero *et al*. (1998) studied experimentally infected *Rattus rattus* on Corsica in Italy, and suggested that *Rattus rattus* found in the wild may act as a reservoir for the fluke and contributed to its wide extent on Corsica. Mas-Cona *et al*. (1999) found that human fascioliasis was present even where the fluke was not a veterinary problem, suggesting that *Rattus rattus* may be important in the life cycle of the parasite. Helminth parasites of *Rattus* also may be involved in the transmission of parasites to cattle as well.

Specific observations and recommendations on *Rattus rattus* in Ngezi - Vumawimbi forest reserves

The lack of data on *Rattus rattus* (and any other rodents which may be found on Pemba, such as *Rattus norvegicus*) is of concern not only with regard to Ngezi forest reserve, but also to the well being of the human population on all parts of the island and the economy generally.

The lack of published data from Pemba on *Rattus rattus* leads to the suggestion of the following priorities:

The need for regular, periodic trapping surveys of *Rattus rattus* (and possibly *Rattus norvegicus* and others) using standardized techniques, to follow the reproductive trends in the rodent populations.

It is important to recognize the disease potential present in the *Rattus* population, which is found not only in association with dwellings, but also in natural and disturbed habitats. Evidence suggests that any intensive study of rodents will yield various types of viruses.

If suitable funding and personnel can be found, it should be feasible to conduct parasite surveys at the same time as the general rodent surveys are conducted. There is every likelihood of finding new viruses, because such was the case when a population of *R. norvegicus* was studied in Australia (Macdonald *et al*. 1999).

There is also a need to carefully assess the damage done to various crops (as well as possibly to tree seeds and seedlings) by *Rattus rattus*. This could be done with the assistance of local farmers using a participatory research process, as well as by quantified assessment of crop damage in the field.

The issue of whether or not other rodents were ever found on Pemba is of much more than theoretical interest, it has considerable ecological implications. This might be done by careful examination of fossil remains, as well as examining bones associated with early human settlements excavated in Pemba.

Bats

At least 14 species of bats occur in Pemba and 42% of the bat species known for Pemba were recorded in Ngezi forest during the survey. Bats are abundant in Ngezi and surrounding areas occupying a variety of habitats including forest, woodland, thickets and caves. Two bat species occurring in Pemba are threatened, including the Pemba flying fox (*Pteropus voeltzkowi*) which is endemic to Pemba and is classified by IUCN as threatened, and Decken's Horse-shoe Bat (*Rhinolophus deckeni*) which is

considered threatened though there is data deficiency is establishing its actual conservation status. The diversity of bats and their abundance seems to dominate in the total counts of all mammals encountered.

A large roost of the small insectivorous bats (*Hipposiderus caffer*) was found just outside the forest at Makangale village. The bat cave site is an attraction for tourism and of conservation importance. During a brief visit to the site the bat population in the caves was estimated to be about 5,000. Many other species of bats were roosting in forest and came out to feed at dusk/night on either insects or fruits around the villages and swampy areas.

Among these was the endemic Pemba Flying Fox (*Pteropus voetzkowi*), which could be recognized by, is large size and flight in many parts of the island as they came out to feed as soon as the darkness approached. The highest count of these bats leaving the forest was made from an observation point at the edge of Makangale swamp, where an estimate of 40 bats were crossing a point per minute as from 18.45hrs to 19.30hrs. Bats were heading to the north, dispersing into cultivation in the surrounding and to longer distances. A quick estimate of Pemba Flying Foxes that crossed the observation point was about 1,800 individuals on that particular evening. Another well-established roost for the flying foxes is that at graveyard forest patch at Kidike village where the population is estimated to be 8,000, but fluctuating with seasons. During this study we realized there was a need for identifying the existing roosts for these bats in Ngezi forest and setting up a monitoring programme.

Pemba flying fox (Popo wa Pemba) (*Pteropus voeltzkowi*)

Pemba flying fox is one of the largest bats weighing 500g with a wingspan of one metre. It is russet in colour with black wings. This is an endemic species to Pemba and was listed by IUCN as Critically Endangered species in 1996. The bat occurs in colonies of up to 1000 individuals roosting in tall trees in forests, overgrown clove plantations and semi agricultural areas. It also occurs in graveyards hence reinforcing its association with ancestral spirits as explained in the local folklore.

The conservation of Pemba flying fox gained international attention in early 199's after a publication in *Oikos* journal which alarted the interntional community of the threats facing the species due to mainly hunting for food and habitat loss. Two programmes were established to involve communities in the effort. The SMZ in collaboration with CARE conducted an island wide survey to estimate the bats population numbers and roosting sites.

There has also been a local initiative by the loca communities to conserve the flying fox's main roosting site at Kidike (Mjini Ole). Since 1992, 200 bats migrated to the village graveyard and started roosting on Migulele trees (*Antiaris toxicaria*) the dominat and large trees at the graveyard. The graveyard roost later became a local and international conservation and tourist attraction. Villagers established Kidike Environmntal Club an NGO that deals with the strict protection of the roost and bats as well as environmental issues in general. The NGO operates using funds from member's contributions, some small contributions provided by visitors coming to the site, and some international organizations such as International Flora and Fauna of UK and other countries. The NGO with 80 members (but only 20 active) closely monitors activities at the roost site and no one is allowed to enter the area without their permission. Reports show that at least 10 bats die per month through fighting and natural causes. When bats go out to feed often tend to come back with new

individuals who do not leave the roost hence making it grow in size. The bats are not reported to cause a serious problem to the people except eating of mangoes but the area has only few mango trees hence the impact is minimal. One of the potential problems indicated by the Kidike NGO leaders is that the main roosting trees for the bats the Migulele are not showing a good sign of regeneration. Conservation authorities in Pemba have to make sure that this very important roost is monitored, protected and maintained. This should include continued assistance by the SMZ (Natural Resources Authorities) to Kidike NGO activities.

4.2.2 Relative abundance of animals

Overall the few mammals present appeared to be widely distributed in the study area though individual species or groups tended to occur more in certain habitats than others. The catch was highly skewed towards rodents (*Rattus rattus*) and to some extent amphibians. The low catch among amphibian groups was attributed to the lack of rain during the survey time. Few mammals except Vervet monkeys were physically seen in the six transects covered during the animal foot count census to warrant any meaningful density calculation.

The relative abundance of some mammals is summarized in Table 4.12 below. Factors including occurrence and distribution, population numbers, rarity and endemism have been taken into account.

Table 4.12: Total number of fauna specimens captured in traps (bucket pitfalls, snaps, Sherman's, cage) in Ngezi forest, Pemba (January 2005)

Transect (T)	**Animal group**				**Total**
	Shrews	**Rodents**	**Reptiles**	**Amphibians**	
1. Kwa Joshi trail	0	5	10	6	**21**
2. Makangare bwawani	3	20	2	27	**52**
3. *Erica* bushland	0	0	3	1	**4**
4. Chokaani coral rag	0	7	6	0	**13**
5. *Maeopsis* mixed stand	0	10	1	6	**17**
6. Machopeni	0	14	5	3	**22**
Total	**3**	**56**	**27**	**43**	**129**

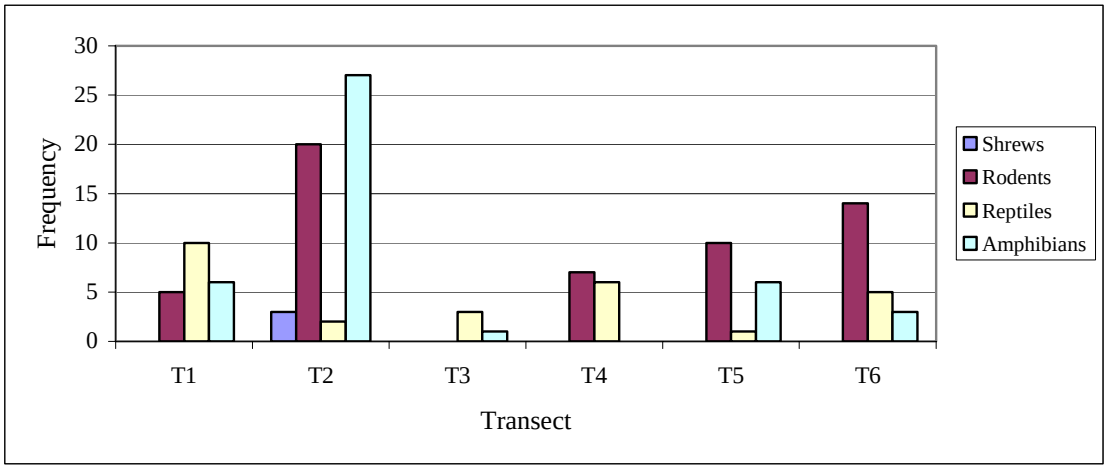

Figure 4.5: Total catch of various taxonomic groups of fauna using bucket pitfalls, snap and live traps in Ngezi forest, Pemba (January 2005)

Table 4.13: Relative abundance of some vertebrate groups and species in Ngezi - Vumawimbi forest reserves, Pemba (Source: This survey; various sources)

Animal group	Species	Relative abundance
Mammals	Pemba Blue Duiker	Rare
	Shrews	Rare
	Galagos	Moderate
	Zanzibar Red Colobus	Rare
	Bats	Abundant
	Pemba flying fox	Abundant
	Vervet Monkeys	Abundant
	Wild boar	Rare
	Rodents	Very abundant
	Civets	Rare
	Marsh mongoose	Rare
	Cape Clawless Otter	Rare
Birds	Waterbids	Abundant
	Pemba scops Owl	Moderate
	Dickson's Kestrel	Abundant
	Pemba Green Pigeon	Moderate
	Pemba Sunbird	Abundant
	Pemba White Eye	Abundant
	Violet-backed Starling	Rare
	Crowned Hornbill	Abundant
	Other bird groups	Moderate
Reptiles	Snakes	Abundant
	Chameleons	Rare
	Lizards and skinks	Abundant
Amphibians		Moderate

4.2.3 Animal species richness and diversity

The indices of species diversity considered only those species captured in the traps. The Shannon Weaver diversity index takes into account the number of individuals for each species as well as the total number of species. Three main taxonomic groups including mammals (shrews and rodents) reptiles and amphibians were captured on the traps. This included 2 species of mammals, 3 species of reptiles and 3 species of amphibians. When other species not captured on the traps are considered then a higher number of species could be recorded. The number of species trapped on each transect were: trapline 1 (4 species), trapline 2 (6 species), trapline 3 (2 species), trapline 4 (4 species) trapline 5 (3 species) and trapline 6 (4 species). When considering the main taxonomic groups captured on the diversity was H' was found to be 0.4965 with H'_{max} = of 0.6021 and homogeneity J = 0.8246. The species diversity for pooled results estimate the species diversity H' = 0.6669 and H'_{max} = 0.9031 and homogeneity J = 0.7385. No attempt was made to estimate species diversity for individual transects due to the poor catch.

4.2.4 Important habitats for animals

Different animal groups occur in different habitat types. Although certain animals can occur in a variety of habitats but there are habitats, which are more ideal for a species or taxonomic group. Most mammals utilise the forest and thicket habitats as they provide both sufficient food and cover. However some animals may occur in less desirable habitats mainly due to loss of habitat or disturbances in the desirable areas. The forest habitat is particularly important for primates and prosimians and also other animal groups such as bushpigs, rodents, shrews, bats, amphibians and invertebrates. The forest is the habitat that harbours a high diversity of species and animal groups. Other habitat types tend to be supposedly ideal for limited number of animal groups or species generally due to resources limitations and other environmental attributes.

Table 4.14: Distribution of different habitats in Ngezi - Vumawimbi forest reserves, Pemba

Species	F	WG	EL	RP	CR	M	MF	FM	MW
Zanzibar Red Colobus	*								
Pemba Blue Duiker	*	*			*				
Wild boar	*								
Galagos	*	*			*	*	*	*	
Mongooses									*
Shrews		*							
Bats	*	*		*	*	*	*		
Vervet Monkeys	*	*	*	*	*	*	*	*	*
Birds	*	*	*	*	*	*	*	*	*
Reptiles	*	*	*		*	*	*	*	*
Amphibians	*	*						*	*
Molluscs	*				*		*	*	*
Lepidoptera	*	*	*	*	*	*	*	*	*
Odonata									
Orthoptera									

Legend: F = moist forest, WG = wooded grassland, EL = *Erica* bushland, RP = rubber plantation, CR = coral rag, M = Maeopsis forest, MF = mangrove forest, FM = Farmland, MW = marshes/wetlands

4.2.5 Animal movement and migration

Jozani forest and surrounding areas are remnants of the rain forest and receives a substantial amount of rain during the long and short rains. As such variation in environmental parameters like humidity and temperature variation is low (UNEP, 2001). This tends to make the seasonal differences minimal. Most of the forest remains evergreen. Plants produce fresh leaves, flowers and fruits for most of the year depending on phenology. Animals therefore are able to get their requirements in the same area for most of the year. Some animals in search of food and shelter or water exhibit daily, short-term movements. In certain situations animals are forced to move from one area to another due to human disturbances such as hunting. These movements are generally confined within the forest area or may extend outside in some places for certain species. For most species particularly large mammals, heavily hunted and shy animals, areas outside protected areas are encroached and disturbed hence do not form favourable habitat for the animals. The local people reported no specific movement routes for the animals.

4.2.6 Birds

Bird survey on Pemba was conducted opportunistically in Ngezi forest and the surrounding areas with a few observations made along Vumawimbi and Chokaani beaches. The exercise was conducted in January when field conditions were generally dry with limitation of fresh water bodies, no breeding activities and absence of migratory species. About 45% of the species reported in previous surveys (Pakenham, 1979) were recorded with addition of Violet–backed Starling (Table 4). Ngezi forest being one of the least disturbed habitats on the island is diverse in microhabitats that are suitable for birds and other forms of life. The forest is important in hosting almost all Pemba endemic bird species (Pemba Green Pigeon, Pemba Scops-Owl, Dickson's Kestrel, Pemba Sunbird and Pemba White-eye were found in Ngezi forest).

Pemba Green Pigeon was common but difficult to detect. Flocks of up to 15 individuals were found in forest near forest gate office and Machopeni area feeding quietly in high canopy. The population of Pemba Scops Owl in Ngezi forest based on calls is relatively high when compared to areas outside the forest. While camping in the forest, Scops Owl calls were heard throughout the nights from all corners and their territorial spacing is estimated to be about 300m. The high abundance of this species may be explained by food (*Rattus rattus*) available in the Ngezi forest as supported by our trapping success (Appendix 2). Pemba Sunbird and White Eye were common in forest and cultivation.

Pemba Scops Owl (*Otus pembanensis*)

This small owl is endemic to Pemba Island where it inhabits densely foliaged habitats including forests, clove plantation, mangrove and patches of forests that are used as graveyards. Observations made in Ngezi Forest Reserve suggest that the population of the owl is relatively high in the forest. Calls were recorded throughout the night from mid-canopy with territorial spacing of about 300m. The intensity of calling was high from sundown until midnight and less so until dawn. Assuming that there is even distribution of this species in Ngezi forest and in other areas on Pemba Island, the population may be considered as marginally threatened.

4.2 7 Reptiles

Within Ngezi forest and its surroundings (cultivations, sandy and coral rag beaches and wetlands) suitable habitats for reptiles are well represented. Fifteen (62.5%) of the known reptile species on Pemba (Pakenham, 1983) were recorded during the study period (Appendix 2). The most abundant and widely distributed species of the reptiles in Ngezi forest was the Pemba endemic skink (*Mabuya albotaeniata*). The species was very common in leaf litter on forest floor and less common in cultivation and settlements where they coexist with *Mabuya striata.*

Marine forms were not encountered since much of the surveys were carried out in terrestrial environment. The sandy beaches around Vumawimbi are prospective areas for the breeding of Green Turtles. However, due to disturbance resulting from fishing and beach visitors the area seems unsafe for sea turtles to breed.

4.2.8 Amphibians

The community of amphibians on Pemba Island may be considered as East African coastal. The species richness on the island is low when compared to that of Zanzibar and other areas along the coast of East Africa. Seven species from 4 families were recorded on this study suggesting addition of two records from the previous

knowledge (Table 4.11 and Appendix 6). Pakenham (1983) reported 6 species with a notion of inadequate collecting. This study was conducted under dry condition when most of the amphibians were expected to be aestivating. Conducting a further survey under wet condition may yield some additional species.
Unconfirmed species of *Phrynobatrachus* was collected in Ngezi forest around Kwajoshi and Machopeni. According to previous reports the only member of this genus found on the island is *P. pakenhami*, which is endemic to Pemba. However, The taxonomic status of *Phrynobatrachus parkenhami* is very uncertain due to the fact that the animals collected on Pemba do not fit well with the description of both *P. pakenhami* and *P. acridoides*. The snought-vent measurements and body texture of the three specimens collected suggest a different species. In this report the species is questionably been regarded as *P. pakenhami*.

4.2.9 Endemic species of animals

Many species on Pemba and Zanzibar have existed or evolved in isolation from mainland Tanzania for thousands of years. This has resulted in the development of a number of endemic and near endemic species. At least 27 fauna species are known to be endemic to Pemba (Table 4.15).

Table 4.15: Endemic and near endemic fauna species and sub species of Pemba (Source: Moreau and Pakenham, 1941; Pakenham, 1984; Kingdon, 1997; Burgess and Clarke, 2000)

Family/Species	Common name	Status
Mammals		
Colobus badius kirkii	Zanzibar red colobus	Endemic to Unguja, introduced to Pemba
Otolemur garnettii	Garnetts Galago	East African coastal forests endemic
Galagoides zanzibaricus	Zanzibar Galago	East African coastal forests endemic
Cercopithecus aethiops	Vervet monkey	Endemic sub species to Pemba
Pteropus voetzkowi	Pemba Flying Fox	Endemic to Pemba
Dendrohyrax validus neumanni	East African Tree Hyrax	Endemic to Pemba and Unguja
Cephalophus monticola pembae	Blue Duiker	Endemic to Pemba
Birds		
Falco dickinsoni	Dickinson's Kestrel	Endemic to Pemba
Nectarinia pembae	Pemba Sunbird	Endemic to Pemba
Zosterops vaughani	Pemba White-eye	Endemic to Pemba
Treron pembaensis	Pemba green pigeon	Endemic to Pemba
Zostrerops vaughanii	Pemba white eye	Endemic to Pemba
Terpsiphone viridis ungujaensis	African Paradise Flycatcher	Endemic to Pemba and Unguja
Accipiter tadiro pembaensis	Pemba African Goshawk	Endemic to Pemba
Otus pembaensis	Russet Scops owl	Endemic to Pemba
Reptiles		
Phelsuma abbotti	Pemba Day Gecko	Endemic to Pemba
Lygosoma pembanum	Pemba Island Writhing Skink	Endemic to Pemba

Mabuya albotaeniata	Pemba Island Skink	Endemic to Pemba
Leptotyphlops pembae	Pemba Worm Snake	Endemic to Pemba
Lycophidion pembanum	Pemba Wolf Snake	Endemic to Pemba
Natriciteres pembana	Pemba Marsh Snake	Endemic to Pemba
Phrynobatrachus sp. *"pakenhami"?*		Endemic to Pemba
Amphibians		
Phrynobatrachus sp. "*pakenhami*"?		Endemic to Pemba
Lepidoptera (Butterflies)		
Acraea egina pembanus		Endemic to Pemba and Zanzibar
Family/Species	**Common name**	**Status**
Pseudacraea boisduvali pemba		Endemic to Pemba
Euphaedra neophron rydoni		Endemic to Pemba
Bebearia orientis insularis		Endemic to Pemba

New records of fauna species

During the survey 15 new records for mammals, birds, amphibians and Lepidoptera were observed (Table 4.16). Very little research work has been done in Ngezi and in Pemba as a whole. It is anticipated that with more research more species will be observed and most possibly endemic to Pemba. For example the lack of rain during the last survey resulted in poor catch of amphibians. It was likely that with good rain many more species would have been obtained. A further survey of the fauna of Ngezi and Pemba as a whole is highly recommended in order to have a comprehensive inventory of fauna species of Pemba.

Table 4.16: New record of fauna of Pemba

Family/Species	**Common name**	**Status**
Mammals		
Aonyx capensis	Cape Clawless Otter	New record to Pemba
Birds		
Cinnyricinclus leucogaster	Violet-backed Starling	New record to Pemba
Reptiles		
Panaspis sp.		New record to Pemba
Amphibians		
Schoutedenella xenodactyloides		New record to Pemba
Hyperolius sp.		New record to Pemba
Lepidoptera (Butterflies and Moths)		
Acraea encedon Linnaeus		New record to Pemba
Acraea pseudolycia Butler		New record to Pemba
Spialia diomus Hopffer		New record to Pemba
Zizeeria knysna Trimen		New record to Pemba
Family/Species	**Common name**	**Status**

Byblia anvatara acheloia Boisduval		New record to Pemba
Charaxes varanes vologeses Mabille		New record to Pemba
Junonia oenone oenone Linnaeus		New record to Pemba
Eurema hapale Mabille		New record to Pemba
Bicyclus anynana anynana Butler		New record to Pemba
Bicyclus campinus Aurivillius		New record to Pemba
Ypthima rhodesiana Carcasson		New record to Pemba

4.2.10 Threatened and endangered animal species

A number of animal species found in the survey area and surroundings are threatened. These include 8 mammals and 3 reptiles (see Table 4.17). At least one species, the Hawksbill turtle (*Eretmochelys imbricata*) is critically endangered. A number of factors have led to this situation, mainly explotation, hunting, and habitat loss and fragmentation. The impact of various factors is known to vary between species.

Table 4.17: Threatened and endangered animal species listed in IUCN redlist, and species listed in CITES Appendices found in Ngezi – Vumawimbi forest reserves and surrounding areas, Pemba (CR = critically endangered, EN = endangered, VU = vulnerable, LR = lower risk, DD = data deficient)

Animal group	Common name	Scienfific name	Conservation status	
			IUCN Redlist	CITES Appendices
Rhinolophidae (bats)	Decken's Horse-shoe Bat	*Rhinolophus deckeni*	DD	
Pteropodidae	Pemba flying fox	*Pteropus voetzkowi*	?	
Galagonidae (bushbabys)	Greater galago	*Otolemur garnettii*	LR, nt	
Cercopithecidae (monkeys)	Pemba green monkey	*Cercopithecus aethiops*	DD	II
	Zanzibar Red Colobus	*Piliocolobus kirkii*	EN, B1a	II
Viverridae (mongooses and civets)	Marsh mongoose	*Atilax paludinosus*	EN, B1 + 2c	
Procaviidae (hyraxes)	East African Tree hyrax	*Dendrohyrax validus neumanni*	VU. B1 + 2c	
Bovidae	Blue Duiker	*Cephalophus monticola*		II
Chelonidae (turtles)	Green Turtle	*Chelonia mydas*	EN, A1 abd	I
	Hawksbill Turtle	*Eretmochelys imbricata*	CR, A1, abd, 2bcd	I
Chamaeleonidae (chameleons)	Flap-necked Chameleon	*Chamaeleo dilepis*		II

4.2.11 Introduced species of animals

Islands like Zanzibar are often affected by introduction of alien species by various dispersal agents including humans (Table 4.18). In the past 500 years at least five mammals and one lizard have been introduced to Zanzibar and Pemba (Moreau and Pakenham 1941). Most of these species are still surviving in the islands. The impact of the introduced animals to indigenous species is unknown. The Javan civet, however, is reported to coexist with the indigenous African civet. The presence of most other species on the islands, however, is attributed to the natural dispersal agents such as air, water and land crossing before the geological separation of islands from the mainland during the ice-age. Also subsequent geologic processes after the ice-age

created land bridges or shallow continetal shelf which allowed animals to go through (Moreau and Pakenham 1941).
During the survey and when conducting foot transects it was observed that there were many feral dogs in the forest. Some appeared to be out of control. The presence of feral dogs in the forest affects the pristine nature of the forest and needs to be controlled. There is also a potential danger of spread of rabies due to the presence of dogs and many bats that act as vectors of rabies.

Table 4.18: Some animal species introduced to Pemba and Zanzibar

Common name	Scientific name	Area introduced	Agency	Introduction date	Current status
Mammals					
Wild boar/Black pig	*Sus scrofa*	Pemba and Zanzibar	Portuguese	16th century	Present
Javan civet	*Viverricula indica*	Pemba and Zanzibar	Indian community	Unknown	Present
Common House Mouse	*Mus musculus*	Pemba	Stowaway	Unknown	Present
Black Rat	*Rattus rattus*	Pemba and Zanzibar	Stowaway	Unknown	Present
Zanzibar red colobus	*Piliocolobus kirkii*	Introduced to Pemba from Zanzibar	SMZ	1979 (seven individuals)	Present

4.2.12 Fish

Five fish families of fresh or brackish water recoded at the study area. In the study area there is no permanent river but there are several ponds and swamps. Nine villages surrounding Ngezi are Msuka, Kijijini, Tondooni, Mkia wa Ng'ombe, Jiwe moja, Makangale, Bandari kuu, Kipangani, and Gombani. Most of the information on fish and fisheries in Pemba waters is in many cases similar to what was reported in Jozani National Park (Nahonyo *et al*. 2002).

4.2.12.1 Fisheries resources

Fisheries resources found on Pemba waters include fish, prawns, sea cucumbers, seaweeds and lobsters. These are mainly exported but finfishes are used for local consumption. All these resources are also available at villages around the Ngezi forest. Other marine resources like prawns, lobsters, and seashells have declined in recent years. In the past decade these resources were collected in substantial amounts in the inter-tidal zones but nowadays one must do SCUBA diving in deep sea to collect them. Other resources like Sea-shells (bivalve, mollusks and cockles) are used domestically since their production is low (FAO/Department of Environment Zanzibar, 1999).

4.2.12.2 Fish species occurrence, endemism and diversity in Ngezi

Ngezi forest is found northern part of Pemba Island. Pemba as part of Zanzibar in region No.51 FAO of the global fisheries sector. It has a number of species (Carcasson, 1977; Bianch, 1985), which are common and distributed throughout the region (FAO, 1984a). In Ngezi there are at least 57 fish families (Appendix 7a and 7b) and not less than 100 fish species (Appendix I and II). None of the families are endemic to Zanzibar. Most of the fishes obtained in this area are found elsewhere in the region according to FAO (1984a, 1984b, 1984c, 1984d; Bianch, 1985).

4.2.12.3 Fish movement and migration

Movement and migration is a common phenomenon for animals including fishes. Movements could be for feeding purposes, escaping predation, or escaping unsuitable conditions.

The migrations like other characteristics of the species have some adaptive significance, ensuring favourable conditions for the existence and reproduction of the species. The cycles of migrations usually consist of:

1. Spawning migration: movement of fishes from the feeding grounds to the spawning grounds
2. Feeding migrations: movement away from the spawning grounds to the feeding grounds

Most marine species are migrants. Migration between marine and estuarine ecosystems has ecological and commercial significance. In Ngezi fishermen report large numbers of fish migrating from deep-water areas into the shallow seagrass beds when the sea is rough and turbulent. These fish return to deep water when the sea is calm.

Feeding migration

Feeding migration is normally accompanied by the changes of the tidal regime at Ngezi. When water recedes to a low tide the juvenile and mature fishes tend to migrate to deeper waters. When tide in the bay reaches high water mark the fishes especially the detritivorous, omnivorous and herbivorores also migrate to the feeding grounds in shallow waters.

In general carnivorous species constitute 50-70 % of the fish. Godman and Talbot (1976) reported that many of the carnivorous fish appear not to be highly specialized to a given food type but instead are opportunistic feeders, taking whatever is available to them.

Herbivores and coral grazers make up the next largest groups of fishes and account for 15% of the species. Of these, Scaridae and Acanthuridae are most important. The remaining fishes are considered to be omnivores and include all families of fishes on the reef (i.e. Pomacentridae, Chaetodontidae, Pomacanthidae, Monacanthidae, Ostraciidae, Tetraodontidae). A few groups, mainly small schooling fishes in the families Pomacentridae, Clupeidae and Atherinidae, are zooplankton feeders.

4.2.12.4 Fish habitats and spawning areas

Fishes and mangroves

Mangroves are one of the most productive ecosystems. They harbour a diversity of fish species due to the presence of organic matter (dissolved or particulate), detritus from plant litter and their associated organisms (bacteria, fungi, micro, macro and meio fauna). Between 80% and 90% of the inshore landing in East Africa comes from artisanal fishers who operate within 22 km limits to territorial waters (Anon, 1979). The presence of mangroves in Ngezi makes the area a potentially important habitat for fish and fishing.

Large predators enter the mangroves with incoming tide (Sasekumar *et al*., 1984; Blaber *et al*, 1985). The lack of important piscivorous fish reported in some mangroves (Blaber 1980; Bell *et al*., 1984) seems to relate to high turbidity and very low depth where predators become less effective. Most of the fish species breeding in mangrove areas completes all their lifecycle there (Thallot, 1992). This situation is

also expected to occur in shallow water in Ngezi area. The lack of many potential predators in the area provides a suitable environment for the juvenile fish grow to maturity.

The first order consumers have been noted to determine estuarine fish communities (Blaber 1980). First order consumers including Gerreidae, Atherinidae, Clupeidae, Teraponidae, Acropomatidae, Apogonidae and Gobiidae (Blaber 1980) were found to dominate in Gazi fishing community (Kimani *et al*, 1996). Short term feeding migration of reef fishes into the creek may represent a connectivity and energy transfer between the two ecosystems.

Fishes and seagrass

Fishes are abundant in seagrass beds and many of them feed within the bed removing considerable biomass. Ogden (1980) reported that herbivore fishes are not resident in seagrass beds, but migrate during the night from surrounding reefs. Larger fish e.g. rays and sharks are important in structuring seagrass communities through carnivorous species preying on fish, which graze on seagrasses so reducing grazing pressure. Seagrasses provide an important nursery habitat for the juveniles of many fishes such as Tarwhine (*Rhabdosargus sarba*), Eastern Blue Grouper (*Achoerodus viridis*) and Yellow-finned Leatherjacket (*Meuschenia trachylepis*). The young fish feed on small animals living among seagrass leaves and use the seagrasses to hide from larger predators. Most of these fish will leave the seagrass meadows and migrate to other habitats, such as kelp beds and rocky reefs, as they get older.

For many other fishes such as Pipefishes, White's Seahorse (*Hippocampus whitei*), Southern Pygmy Leatherjacket (*Brachaluteres jacksonianus*), Leaf Fish (*Ablabys taenionotus*) and Blue-spot Goby (*Pseudogobius* sp.) seagrasses provide lifelong habitat. Sea grass meadows are ecologically important habitats in marine environments as they are:

- places of great attraction of larger marine organisms, especially fishes in search of good feeding areas
- good nursery grounds for juvenile stages of commercially important shrimps, crabs, lobsters and fishes
- important feeding sites for adult fishes and birds.

In Ngezi fishermen reported that mangroves and seagrass meadows were important fish habitat and spawning areas. Mangroves were particularly important for prawn breeding; it was reported that most prawns breed in the mangroves.

4.2.12.5 Threatened species of fish (IUCN threat categories)

There are several factors, which may lead to fish species to become threatened. The causative agents of the threat are usually humans and human activities. It is commonly known that some species of sharks, swordfish, Billfishes are threatened (Table 4.19). Many of these fish occur in deep water sea or are the local people do not easily see benthic species. These fish are also not usually caught by artisanal fishermen hence are not locally reported, although distribution maps show that they occur on Zanzibar (FAO, 1984a, 1984b, 1984c, 1984d; Smith and Heemstra, 1991).

Table 4.19: Threatened fish species (IUCN) reported as occurring in Pemba and Zanzibar (Source: FAO, 1984a, 1984b, 1984c, 1984d; Smith and Heemstra, 1991, http://www.redlist.org/info/links.html)

FAMILY	SPECIES	*ENGLISH NAME*	IUCN STATUS
SERRANIDAE	*Epinephelus tukula*	Potato grouper	LR
LABRIDAE	*Cheilinus undulatus*	Hampered wrasse	LR
CARCHARHINIDAE	*Carcharhinus plumbeus*	Sandbar shark	LR
CARCHARHINIDAE	*Carcharhinus Taurus*	Grey nurse shark	EN
CARCHARHINIDAE	*Carcharhinus falciformis*	Silky shark	LR
CARCHARHINIDAE	*Galeocerdo cuvier*	Tiger shark	LR
SERRANIDAE	*Cromileptes altivelis*	Barramund grouper	LR
SERRANIDAE	*Epinephelus fuscoguttatus*	Flowery grouper	LR
SERRANIDAE	*Epinephelus malabaricus*	Malabar grouper	LR
SERRANIDAE	*Epinephelus tauvina*	Greasy grouper	LR
SCOMBRIDAE	*Thunnus maccoyii*	Southern bluefin tuna	LR
SYPHYRNIDAE	*Sphyrna lewini*	Scalloped hammerhead	LR
SYPHYRNIDAE	*Sphyrna mokarran*	Great hammerhead	LR
SQUALIDAE	*Centrophorus uyato*	Southern dogfish	VU
LAMNIDAE	*Isurus oxyrinchus*	Short fin mako	LR
	Glyphis sp.	Bizan river shark	CR
PRISTIDAE	*Pristis microdon*	Larger tooth saw fish	CR
RHINOBATIDAE	*Rhynchobatus djiddensis*	White spotted wedge fish	LR
DASYATIDAE	*Taeniura lymma*	Ribbon tail stingray	LR
MOBULIDAE	*Manta birostris*	Giant Atlantic manta	LR
MYLIOBATIDAE	*Aetobatus narinari*	Spotted eagle ray	LR

Key: LR = Lower risk, VU = Vulnerable, EN = Endangered, CR = Critically endangered

4.2.12.6 Fishing and fish production

(a) Number of Fishers

A survey conducted by Commission for Natural Resources found that there were 23,734 fishers on Zanzibar, of which 11,769 were based on Pemba Island and 11,965 were in Unguja Island. (FAO/Department of Environment Zanzibar, 1999)

(b) Fishing vessels

Fishing vessels employed include dugout canoes, outrigger canoes; planked motorized boats and planked sailing boat. A survey conducted by the Commission for Natural Resources showed that there were 5,149 fishing vessels on Zanzibar, on Unguja 2,933 and 2,216 on Pemba (FAO/Department of Environment Zanzibar 1999). During the

survey most of catch records shows that the fishing vessels dugout canoe, mashua and sailing were mostly used at 56.17%, 26.96% and 16.85% respectively.

(c) Fish production

Data on fish production from Pemba and Zanzibar suggests that fish production has been declining progressively in the last two decades. There are several factors, which have contributed to that decline:

(i) Increase of fishing pressure (caused by increased fishing effort)
(ii) Decrease of small pelagics, believed to be the main source of food to bigger fish
(iii) Habitat degradation due to use of destructive fishing gears and techniques.

It has been reported at Ngezi most fishers in the area fishing commercial fish species. These include Cowries, Sea cucumber, Crabs, Octopus, Squids, Lobsters and Shrimps. The fishers depend both external and internal markets. External markets are in Mombasa where they are sold as semi processed or fresh fish. Internal market is mainly tourists' hotel Manta Reef and local people. According to fisheries catch stastics the record were as follows Msuka 60,922 Kg, Kijijini 18,869 kg, Tondooni 14,535 kg, Mkia Ng'ombe 11,120 kg, Jiwe moja 625 kg, Makangale 4,420 Kg, and Bandari Kuu 895 Kg. (Source: Ngezi survey, January 2005).

(d) Fishing gears

Fishing gears in Unguja and Pemba reported by the fishermen and Commission for Natural Resources (CNR-Fisheries, 1997) are gillnets, shark nets, small scale purse seines, a variety of fishing lines (troll-lines, hand lines, long lines) fish traps, fishing weirs, spear guns and beach seines. However, some of the fishing gears such as spear guns and beach seines are illegally used because they are banned in Zanzibar due to their destructive nature. Fishing traps, weirs and spear guns are made locally. Fishing lines, mostly nylon monofilaments are imported and available in sufficient quantities in various shops. There is adequate availability of fishing gears and equipment but their prices are high compared to the purchasing power of most artisanal fishers (FAO/Department of Environment Zanzibar, 1999). During the survey most catch records obtained from hand line, beach seine and spears at 31.11%, 22.22% and 17.77% rate respectively. Other fishing gears contribute about 28.9 %.

(e) Habitat type

Most fishes caught at Ngezi area are mainly from thirteen habitat types. Namely as Caves, Coastal, Coral reefs, Deep coral reefs, Demersal, Epi-pelagic, Inshore, Muddy, Pelagic, Seagrass, Shallow reefs, Reefs and Estuary. Demersal species contribute large amount followed by pelagic and Epi-pelagic at 51.6%, 23.6% and 10.1% respectively. Other remaining habitat types contribute 14.7%.

(f) Fishing grounds

The fishing ground is the area where fish are caught by using various fishing gears. In the Ngezi fishing grounds are described in various forms, these are Coastal, Shallow waters, and Sand bottom, Coral reefs, Deep sea and Mangroves. In general most fish catch are obtained from four main fishing grounds, these are Coastal and Deep seas

both contributes 26.67 % and Shallow waters and coral reefs contributes 25.6% and 18.9 % respectively. Other remaining fishing grounds in totality contribute 28.83%.

4.2.12.7 Threats to fisheries resources

Marine biodiversity threats are divided into two aspects: proximate threats and root causes.

Proximate threats

The main human activities that damage marine organisms and ecosystems include: over exploitation, physical alterations and habitat loss, pollution, introduction of alien species and global climate changes.

Root causes

The main causes of biodiversity loss lie in demographic pressure and unsuitable use of natural resources; economic policies that fail to value the environment and its resources, insufficient knowledge and its poor application, and weakness in legal and institutional systems (Dugan, 1990; WRI/IUCN/UNEP, 1992).

4.2.12.8 Fisheries conservation

Management of fisheries in Zanzibar, as in other developing countries has been problematic. The reason for such problems is due to the fact that management objectives are not defined:

- The open-access nature of the fisheries, the shortage of alternative employment opportunities to the fishers and the poor economy could constrain the effort tailored to manage fisheries
- Fisheries management plans in general do not exist; instead short time approaches are used in attempts to manage fisheries resources.

4.2.3 Invertebrates (Lepidopterans and Odonata)

Collection revealed a rich invertebrate fauna (477 individuals) as follows: A total of 134 Butterflies were collected. These belonged to 35 species from eight families. Light trap and sweeping produced 195 moths belonging to 13 families. Lastly, 146 Odonata (Dragonflies and Damselflies) representing nine species from three families were also collected. Several Odonata were not identified to species level.

A checklist of the butterflies, moths and Odonata collected during this survey is given below. The number of individuals of the three groups from each transect is presented in Appendix 8a, 8b and 8c. Transect 3 had a significantly low abundance of butterflies and moths compared to the others. The highest abundance of butterflies and moths was obtained from transect 1 and 6.

The number of singletons among butterflies was 14 species (41.18%), indicating that the survey was far from being exhaustive. Some species must have been missed during the survey. This low coverage reflects the short time spent in sampling. The large number of moths collected during this survey is a result of the effective light trap that was used.

First records

A number of butterflies (11 species in total) collected from Ngezi Forest Reserve are recorded for the first time from Pemba Island. These are indicated by an asterisk (*) in the checklist.

Endemic species

Four of the collected species are endemic. *Acraea egina pembanus* is on record as being endemic to Pemba Island (Kielland, 1990). However we have recorded this species from Zanzibar Island (Jozani Forest), therefore this species should be treated as endemic to Pemba and Zanzibar Islands. Three other species, *Pseudacraea boisduvali pemba, Euphaedra neophron rydoni* and *Bebearia orientis insularis* are endemic to Pemba (Kielland, 1990). The first has been recorded from Ngezi forest and the last is frequently seen in garden with palm trees nearby (Kielland, 1990).

Forest-dependent species

Twelve of the recorded species are forest-dependent. They are found only in forest habitats (sometimes in thick woodland also). Among these are *Bicyclus campinus*, which feeds on grass species (Gramineae), *Amauris niavius dominicus* whose larval food plant is *Gymnema sylivestre* (Asclepiadaceae), and *Euphaedra neophron rydoni* whose food plant has not been recorded. *Lachnoptera iole ayresi* has been recorded on *Rawsonia usambarensis* (Flacourtiaceae) and *Vismia orientis* (Guttifera). Larvae of *Pseudacraea lucretia* feed on several species of family Sapotaceae e.g. *Chrysophyllum viridifolium*.

Other invertebrates

Apart from the systematic sampling which included Orders Lepidoptera and Odonata, other invertebrates were also observed, and some collected on an *ad hoc* basis. This opportunistic sampling revealed a rich invertebrate fauna, which included gastropods, dung beetles, mosquitoes, bees and millipedes, and many dung beeteles were everyday found trapped in bucket pitfalls. Notable among these are the mangrove whelk *Terebralia palustris* (Potamididae), which was abundant in mangrove swamps near, transect 6. A pond in transect 2 and wetland area near transect 6 harboured, among others, *Bulinus nasutus* (Planorbidae). Live individuals and shells of the land snail *Achatina* sp. (Achatinidae) were scattered in Ngezi Forest and surrounding areas.

In addition to the above two honeybee colonies were observed at transect 1 and 5 in *Odyndea zimmermanii* trees. This tree species is listed in the IUCN Red Data Book as globally rare. Other invertebrates observed in Ngezi forest and surrounding area included adult beetles (Scarabaeidae), millipedes (Chilopoda), and mosquitoes (Culicidae) C*ulex* and *Aedes* species.

Specific potential threats to invertebrates

Invertebrates generally have a high reproductive potential, and they can survive as long as their habitats are preserved. The major threat to the biodiversity of this area, therefore come from habitat destruction.

Butterflies and moths are herbivores as larvae, and they are totally dependent on specific plant species for their survival. Habitat loss, forest fragmentation and other human activities that lead to loss of plant biodiversity are, therefore, the greatest threat to these insects.

The Odonata larvae are aquatic predators. These and other aquatic organisms are very sensitive to changes in the physical conditions and chemical composition of the water in which they live. Chemical pollution, agricultural chemicals and fertilizers, which end up in the water bodies, and silting from soil erosion, are the main threats to these organisms.

Some butterflies are prized by collectors due to their beauty. In some countries the law protects species of Butterflies such as lycaenids. Other prized species include large colourful species such as *Charaxes* spp. and *Papilio* spp. Butterfly collecting for local and export markets is potentially a threat to some species. There is need to find out whether or not this activity is actually taking place in Pemba.

Invertebrates conservation values

Insects make up a very large proportion of the biodiversity of any terrestrial and fresh-water habitat. They are a crucial in all food chains in their habitats, as food to a wide range of animals, and as predators. In addition, they pollinate flowering plants and, through herbivory, they control the growth and spread of plant species.

Aquatic insects are important in maintaining aquatic ecosystems, and as indication of the health or otherwise of these habitats.

Insects also have an aesthetic value, and some species are highly prized by collectors.

Specific recommendations on invertebrates conservation

The conservation of the invertebrates of Ngezi Forest must be based on the conservation of their habitats, since even a slight change in the forest or fresh-water bodies can result into a major decline in the dependent invertebrate fauna. Human population pressure and the accompanying increase in demand for forest products and land for agriculture should be managed in order to have a balance between exploitation of the resources and the conservation of the natural environment. In the absence of human interference most invertebrates can sustain their population since they have a high reproductive potential. It is therefore imperative that the habitats of the area (forest, freshwater bodies, salt-water marshes, mangrove swamps and others) should be conserved.

4.4 Socio-economic Survey

4.4.1 Demographic characteristics

A total of 200 respondents were interviewed through interview-administered questionnaires; among them 101 (50.5%) were males and 99 (49.5%) were females.

Age Structure

The respondents reported themselves to have ages ranged from 18 to 80 years. Many were in the age class of 18-30 (36%) and 31-42 (36%) years, while 22% were in the age class 43-54 and very few (3% and 4%) were in the age classes 55-66 and 67-80 years respectively. Although the number of males and females in the age classes were statistically similar, the oldest age class was dominated by females (Figure 4.6).

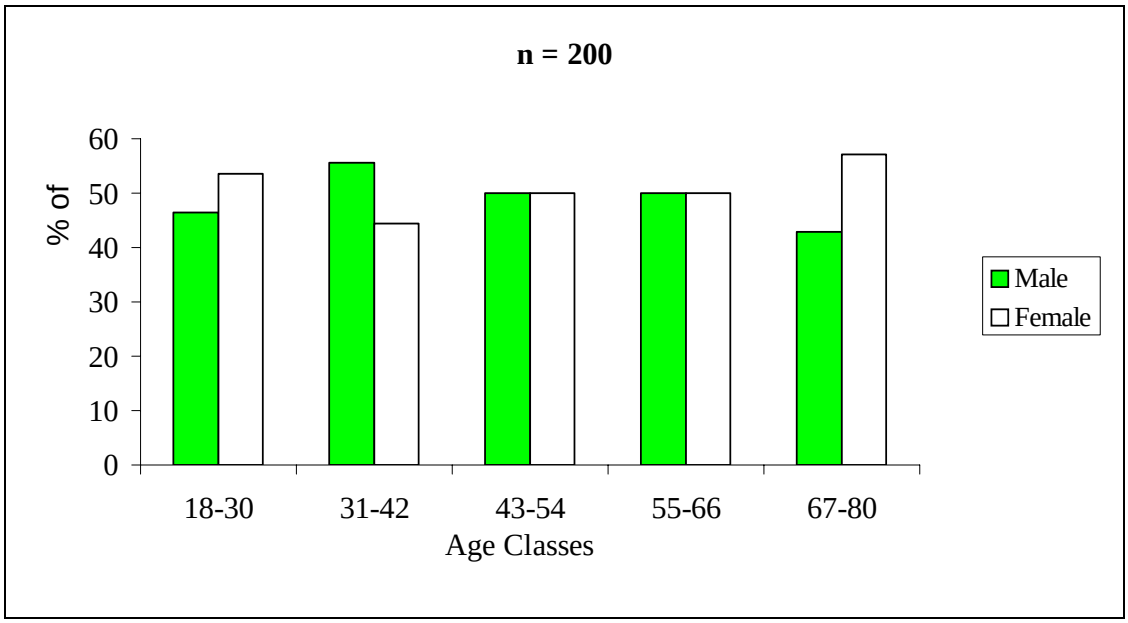

Figure 4.6: The declared age classes of the 200 respondents from the study villages combined

Length of residence

Of the interviewees, 151 (76%) were found to be resident in the area while 49 (24%) were immigrants. Mji mwema village appeared to have the highest number of immigrants (60%) compared to other villages (Figure 4.7) probably because it is one of the newly formed villages in the area.

Socio economic characteristics of the people in the studied villages

Local community in the villages around Ngezi depend mainly on Agriculture, some livestock keeping, small-scale business and fishing for their livelihood. Farming was reported to be the highest (80%) income source, while fishing appeared to be important to some respondents (9.5%). At least 8.5% of the respondents said they were either practicing some small business or were carpenters. Very few respondents (2%) said were the government employees, or had some kind of jobs where they got paid salaries. Of the interviewed respondents, those from Msuka Gombani appeared to have the highest number (92%) of farmers while those from Mkia wa Ng'ombe had the highest (37%) number of fishermen. Only few (10%) respondents from Makangale reported to have some sort of employment from the government, either working with the forestry department or as teachers indicating poor economy of the community around Ngezi forest (Figure 4.8).

4.4.2 Crops grown

Cassava, sweet potatoes, millet and bananas were some of the crops reported by the respondents in the area. A majority (69%) of the respondents said that they grew these crops mainly as source of food, and only occasionally they sold cassava for some cash.

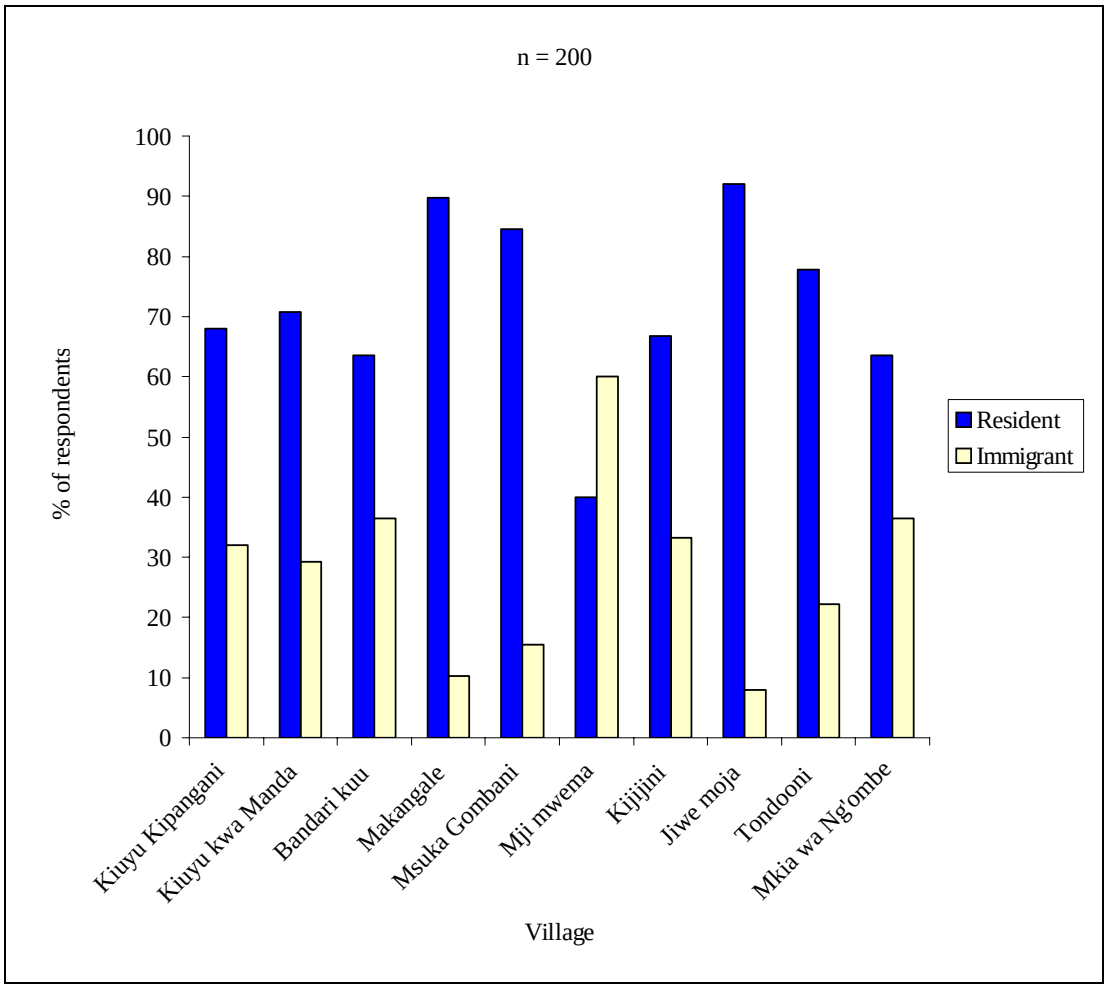

Figure 4.7: Reported origins of the respondents in the studied villages

4.4.3 Livestock keeping

Animals possessed by people in the study area include chicken, cattle, goats, dogs, cats, ducks and guinea fowls. Majority of people keep cattle (58.9%) and goats (30.5%). Dogs are possessed by quite a good number of people (12.8%), while only few (1%) people own guinea fowls. All cattle owners (100%) said they tied their animals in the field and left, while chicken were left to find food themselves. The respondents said that livestock was mainly source of food (chicken, ducks and guinea fowl) and for small business (mainly cattle) when one needed some money.

4.4.4 Resource utilization

Many respondents regarded Ngezi forest as an important area in terms of resource acquisition. Firewood and timber (Figure 4.9) appeared the most important resources that were obtained from this forest although the majority complained about the difficult in obtaining them after the start of total protection programme. Other resources like building materials, materials for handcrafts and food (especially wild meat, fish and wild fruits) materials appeared to be obtained from the area. Many respondents did not feel free in mentioning these resources in fear of being caught as

poachers. They said, some people were allowed to enter the forest through bribing the guards, indicating some conflicts

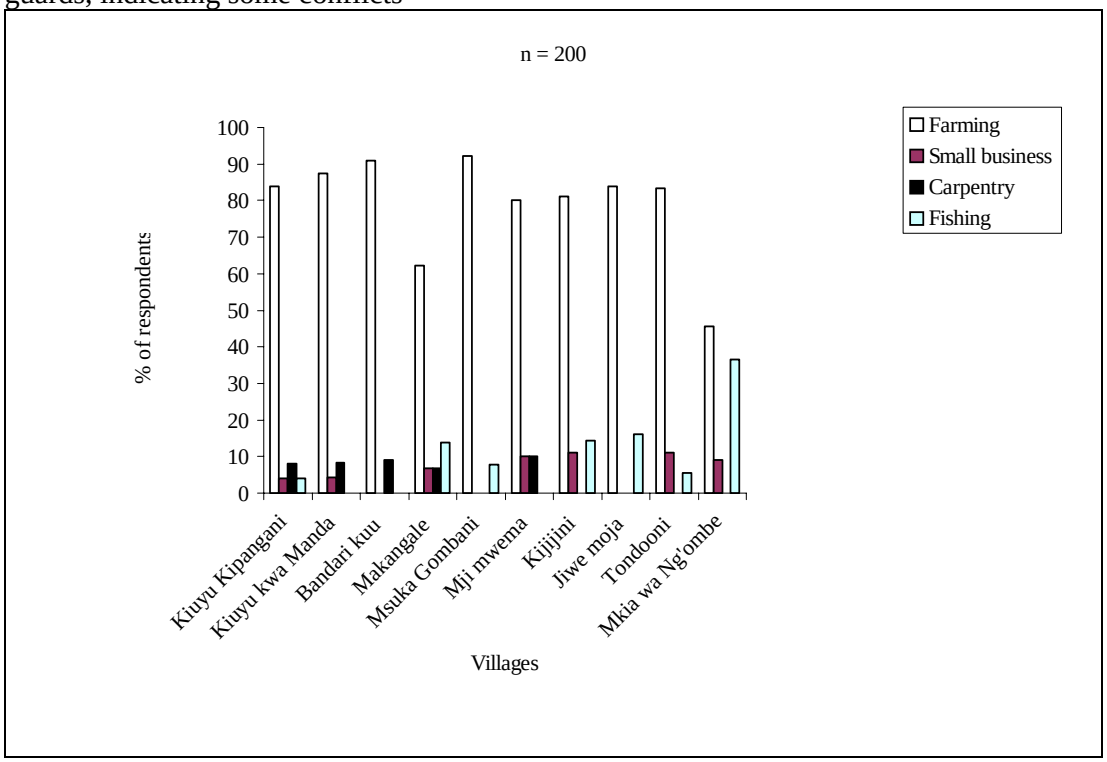

Figure 4.8: Reported activities/occupation of the respondents in the studied villages

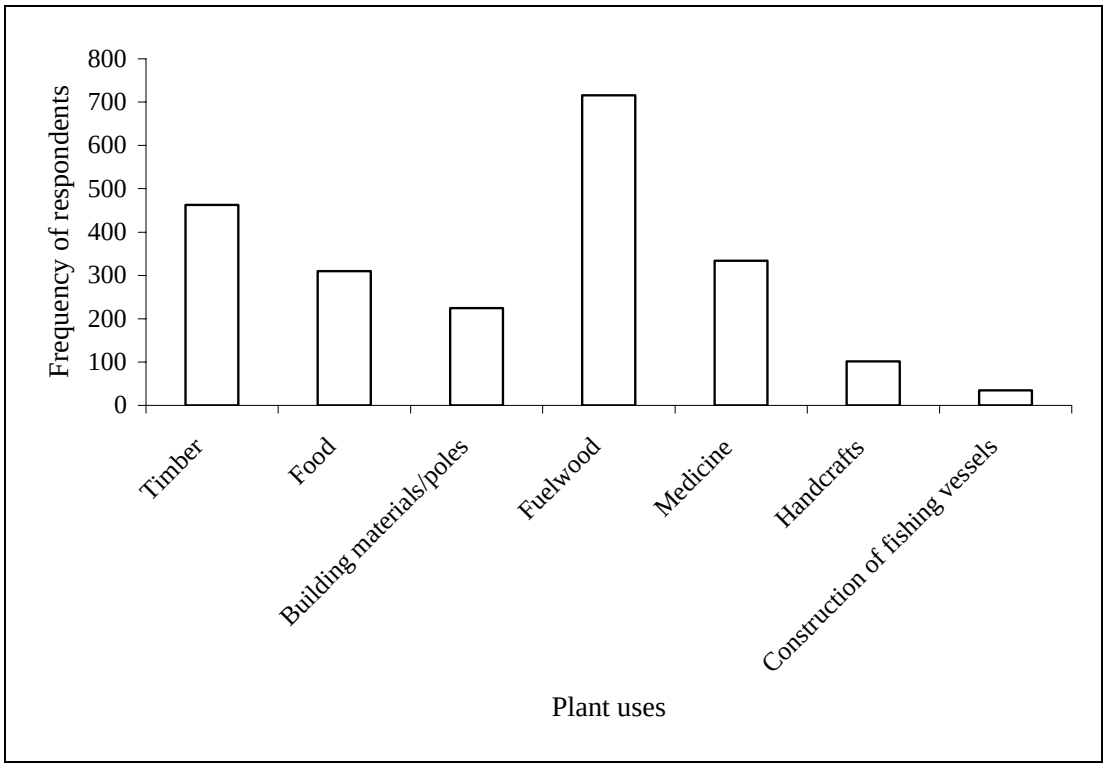

Figure 4.9: Declared uses of the forest products by the respondents from the studied villages

between the villagers and foresters. They said they wanted to be given at least some use rights for their basic needs. Interestingly is that, some respondents reported that, they got promised to be given some alternative areas where they would be obtaining their basic needs, but this had never been kept since then.

Ngezi forest was also regarded as an important area for cultural activities. Many (86%) respondents reported some important areas where traditional prayers/worshiping practices were conducted. The most (75%) common area was called "Kwa Shariff". Only few respondents (4%) did not know if there were such areas in this forest, majority of whom were immigrants. Also, the area was reported to be useful in terms of plant and animal produce (Appendix 1c and 9c).

As seen above, Ngezi forest is facing large pressure from the community around it. The main problem is that, majority of people living adjacent to this forest depend on it for many uses, which is not a new thing to all communities around forests all over the world (Pimbert and Pretty, 1995). All people around Ngezi appear to use firewood as source of energy for cooking, and further, depend on it for other important day to day needs (Figure 4.9). Also the study by Khatibu and Suleiman, (1993) indicated this severe use of the forest resources especially firewood. They suggested that if Ngezi forest is really to be protected, and then collection of firewood and poles should be completely stopped or alternatively be allowed only in limited areas. The idea was good, but one has to consider the really effect to the surrounding community, especially under the fact that, the forest appears to be their main source of firewood and other basic needs for life. Robinson and Redford, (1994); Metcafe, 1995; Adams and Hulme, 2001 and Brown, (2002), argue that, local communities can contribute to the conservation of natural systems only if their needs are met. They should be given user rights of these resources; but in most countries they are seldom recognised.

Studies suggest that, ignoring the dependence of local people on the park resources for their subsistence needs and emphasizing law enforcement tend to aggravate the conflict between them and PAs managers (Sharma, 1990). This was also observed in the interviews undertaken in the study area. The respondents, especially those very close to the forest appeared unhappy with the management of this forest. They showed their need to be given some user rights (Table 4.19) of the forest as it was in the past.

Some respondents in Manda village said that there are people around the forest who sometimes went to the area just for the purpose of destroying. One in Manda said, that despite the fact that she never went to destroy the forest, she would never report any illegal incidence because their village despite it being a way to the forest, when it came to employment, none of the village members was taken. A similar situation is said to be common in many developing countries, where around protected areas people who feel excluded intentionally destroy natural resources (Pimbert and Pretty, 1995). In India, resentment by local people to national parks legislation led to acts of sabotage and civil disobedience. Villagers set fire to large areas of the protected areas such as the Kunha National Park of Madhya Pradesh (Gadgil and Guha, 1992).

4.4.5 Threats to biodiversity

Some plants (Mvule, Ukindu, Mkandaa, and Mshubiri mwitu) and animals (Wildpigs, chesi and hyraxes) were reported as either completely disappeared or remained in small numbers. Reasons behind this were said to be over exploitation for plants and illegal hunting for animals. Respondents declared that, before the present programme of complete protection started, people were free to enter the forest hence did a lot of destruction. Other reported reasons were such as weather change, sabotage while others did not know any of the causes although declared the disappearance of some plants and animals.

Wild pigs were reported as completely disappeared animals in Ngezi forest. The respondents said that Wamakonde were the main poachers of these species, where they used them as a source of food. Other respondents (2%) further reported that, wild pigs were killed because of their destructive nature. Plants reported as completely disappeared were mainly used for fuel wood (54%) and timber production (20%). Some respondents felt disadvantaged as a result of total protection of Ngezi forest. They said they lost their freedom to use the forest produce, and even in passing in the forest. Others indicated their concerns on the loss of access to building poles and firewood (Table 4.20). However, many respondents (33%) appeared happy with the present protection system.

Table 4.20: The reported disadvantages experienced after the initiation of total protection programme at Ngezi forest

Disadvantage	Frequency	Percentage (%)
None	66	33
Loss of freedom to use the forest for everyday needs	39	19
Lack of wild meat	5	2
Lost access to building materials and firewood	92	46
Total	**202**	**100**

Source: Field data, (January 2005)

Following the high demand of the forest products by the surrounding community, the study predicted that if measures are not taken, then Ngezi forest would be in serious danger in the near future. Studies by Khatibu and Suleiman, (1993); Smith and Scherr, (2002); Ngece, (2003) also indicated the high demand of firewood and other forest products by the community around forests. The study by Khatibu and Suleiman, (1993) also suggested some alternative provisions to the community such as use of efficient stoves, establishment of a programme on integrated land-use around the area, introduction of tree planting for different purposes etc. All these ideas appear useful, but the main problem for their implementation is the size of the land available in relation with the population growth rate of the area. Many respondents complained that they had small land, and the little they had was existed. What makes things worse is the promise made by the Ministry on providing the locals with alternative land for their basic needs. Some respondents reported this and they indicated to be unhappy with the situation hence indicating some conflicts between the two groups.

4.4.6 Future management of Ngezi Forest Reserve

When it came to what respondents had as suggestions for harmonious conservation of the area, many (40%) said they wanted to have an access to small uses of forest

produce, especially firewood and building materials (Table 4.21). However, quite a good number of respondents (22%) said that the forest should continue to be protected for present and future generations. It appeared that, some people were illegally allowed to enter the forest through bribing the guards, which can be detrimental to the forest if care will not be taken. All these and others were offered as comments for future to serve the forest (Table 4.21).

Table 4.21: The declared suggestions/comments offered by the respondents regarding their views for future management of Ngezi forest

Comment	Frequency	Percentage (%)
They should continue protecting the forest	56	22
They should consider us for small uses such as firewood and building materials	102	40
There should be an equal utilisation of forest products	5	2
Considerations for employment of members from the village around Ngezi	27	11
Seasonal hunting of small mammals should be allowed sometimes in the year	1	0
Provision of social services from the management	3	1
No comments	23	9
The government should keep the promise of providing alternative to forest use	14	5
Benefit sharing to all villages around Ngezi forest	13	5
Utilization to be allowed to trees old enough, or dropped dry tree trunks	4	2
Provision of Conservation education to the community	9	3
Total	**257**	**100**

Having seen the comments/suggestions from the respondents, it appears that the community around Ngezi forest is desperate in getting their user right of the forest. Many said they wanted to be allowed to use the forest especially for their basic needs. In a way, this appeared reasonable, although one has to work it out before the rule is out. Previous studies around Ngezi have suggested that the area should be changed to a higher status in conservation (Pirinen, 1995, Abdullah *et al*. 1996). Pirinen, (1995) further indicated that, the management of Ngezi forest natural resources also means that local communities should be fully involved in and benefit from the management of natural forests and conservation areas. Pirinen further suggested the improvement of traditional relationship between villagers and foresters. These suggestions appear relevant for the area, but more effort is needed to successfully meet the target of conserving the area.

The idea of changing the area to National Park appears useful, but one has to consider other drawbacks to this step. Since the land they possess is small compared to population annual growth rate obtained (5.4%) (URT, 2002), a more user-friendly technique could be found to avoid most of the side effects. Since the community around indicated their desire to use some important resources, then one need to find something worthwhile.

From the declared information it appears that collaborative[1] (Technical Expert Group of Protected Areas, 2003; Berkes, 2004) forest management would be the best approach to manage Ngezi forest. Studies indicate that effective forest conservation can only be achieved through considering communities as contributors to the management systems and the realization of their tenure rights (Pimbert and Pretty 1995; Wily, 1995; Mayers, 2001; Mayers and Vermeulen, 2002; Smith and Scherr, 2002; Ngece, 2003). Ngece, (2003) argues that, since communities around forest areas are protecting water supplies and catchments for hydropower plants, then certainly they should co-manage and benefit from the sale of these products. It should however be remembered that effective management requires procedures to enforce the agreed regulations (Hannah, 1992); and that only in a few institutions indigenous people actively secure their areas without an outside assistance (Colchester, 1997). Further, to sustainably manage forest resources, issues related to governance, decentralisation, and democratisation must be taken into account (http://www.icimod.org/focus/cpr/forth2.htm).

4.4.7 Socio economic recommendations

Local involvement

There is an urgent need for improved communication between the surrounding communities and the institutions responsible with the management of Ngezi forest to increase local awareness of the roles and activities of these institutions as partners for co-management of the area. Any future management plan of the area needs to be developed with the active participation of local communities. *The collaborative management strategy would probably be the best approach in the future*

Legal framework and clear boundary definition

There is a need to establish a legal framework under which communities can collaborate in conservation. The framework should give clear definition of boundaries of the area, rights and responsibilities to the community; therefore the responsible managers of Ngezi forest should revise the existing bylaws, legislation and policies.

Equitable benefit sharing

Structural inequalities existing within the community must be taken into account in building local level institutional mechanisms to ensure equitable distribution of forest products. At the moment there are some people benefiting from the forest through illegal use (by bribing the guards) or getting employment, while majority are not. In case there is an employment (especially non- collar jobs), every village should be equal chance of getting the job.

Status improvement

The area's conservation and biodiversity value, importance for ecosystem maintenance, and its scenic beauty warrant it being given a higher protected area

[1] A partnership by which various stakeholders agree on sharing among themselves the management functions, rights and responsibilities for a territory or set of resources under protected status. The stakeholders primarily include the agency in charge and various associations of local residents and resource users, but can also involve non-governmental organisations local administrations, traditional authorities, research institutions, and business e.t.c. It is a situation in which two or more social actors negotiate, define and guarantee amongst themselves a fair sharing of management functions, entitlements and responsibilities for a given territory, area or a set of natural resources. (Technical Expert Group of Protected Areas, 2003; Berkes, 2004).

status, which would be beneficial for both the environment and the surrounding community and which will further contribute to the national GDP. The fact that human population around the area is increasing at a high rate is an important factor to prove the area's need for a more strict protection.

Conservation education and capacity building

A large percentage of the people living in and around Ngezi forest are poor, there is a need for effective grassroots community developments to help this community. This should run over the long term in order to impact on poverty alleviation and to realise sustainable development through income diversification and livelihood security.

Most people living in and around Ngezi are illiterate; therefore appropriately targeted education could be an important component of future community development activities. Use of video shows/cinemas and study tours on the importance of forests and conservation organised to all villages around the area could be the best way in imparting knowledge to the community around Ngezi forest.

Need for revision

The suggestions put forward by Khatibu and Suleiman, (1993) and Harkonen and Seitz (1993) concerning total exclusion of the locals from any utilisation of Ngezi forest were reasonable, but one should consider this, over 75% of people around the Ngezi forest appears dependent on it for firewood, food or building materials. As seen the forest is diminishing as a result of illegal utilisation, encroachment or sabotage. Now, what is to be done? Keep excluding them for more destruction or devolving powers to them through a collaborative forest management?

6.0 EVALUATION OF BIOLOGICAL RESOURCES AND THEIR CONSERVATION VALUE

Although in terms of biodiversity Pemba and Zanzibar may not be as rich as the coastal forests (Frontier, 1995) and Eastern arc mountains on the mainland most of the species in Pemba are isolated from the mainland populations. Some are endemic or near endemic and others are races of their congeners on the mainland. Others are threatened or endangered. All these species need to be protected and some of them may need special attention and conservation programmes.

Apart from maintaining biological diveristy, plant resources at species and community level are important in many respects ranging from life support systems, climate control, ecological processes and as wildlife habitats.

A number of animal species are, like the plants, endemic or near endemic and there are also species which are threatened or endangered. Animal resources contribute to the biological diversity and also help to boost tourism. Most of the species are threatened by exploitation, habitat loss, fragmentation and pollution. Species designated endemic or near endemic and threatened need appropriate conservation programmes.

Apart from their aesthetic value, the lepidopterans (Butterflies and Moths) and Odonata (Dragonflies and Damselflies) are important as they form a large section of the natural ecosystem in terms of number of individuals and species richness. They are also important in maintaining the health of the ecosystem by controlling vegetation through their herbivory and pollination activities (lepidopterans), and by checking the population growth of other invertebrates through predation (Odonata). In addition to the above, the two groups are useful as indicators of the health of the ecosystem. They also form an important part of the food chain as a source of food to many species of other animals.

7.0 POTENTIAL THREATS TO BIODIVERSITY

Nahonyo *et al.*, (2002) reported that in the past traditional systems of land and resource use caused some damage to habitat and biodiversity but probably regeneration occurred as long as population levels were low. Human activities placed relatively little pressure on the available land resources. Also certain cultural norms helped to ensure sustainable use of resources. Rapidly growing human populations and associated socio-economic and political issues, and probably climatic changes associated with greenhouse effects all together or individually have contributed towards ecological instability. In the Eastern Arc Mountains the immediate threats to biodiversity were identified as deforestation, forest fragmentation, forest degradation, over-exploitation of species, and the introduction of exotic species (Newmark, 2002). The situation in Ngezi - Vumawimbi is similar to that found in the Eastern Arc Mountains on the mainland. From the observations done in the field, interviews and documented literature the following were identified as threats to Ngezi - Vumawimbi forest reserves biological diversity:

i. Human population pressure

Humans are a major cause of biodiversity loss in coastal ecosystems (Martens, 1992). Pemba is experiencing a fast growing population (annual population growth rate r = 0.03). Ngezi - Vumawimbi forests are important source of fuelwood, charcoal,

building poles, medicines, food and fodder. Over-use of the resources is one major threat to the forest and loss of species. Increased population puts pressure on land for farming and crops involve land clearance and thus a loss of habitats.

ii. Grazing impact

A number of people surrounding Ngezi and Vumawimbi areas keep livestock especially cattle. Currently the number and nature of keeping livestock (see section 4.4.3 above) does not pose as as a threat to the forest resources. However, if the number of livestock does increase in future then there will be a potential threat to the forest as livestock will definitely utilises the forest for grazing and browsing.

iii. Effect of alien species

This is one of the major threats to native biological diversity (IUCN, 1990). Invasive species are found in all taxonomic groups including introduced viruses, fungi, algae, mosses, ferns, higher plants, invertebrates, amphibians, reptiles, birds and mammals. The impacts of invasive species are immense, insidious, and usually irreversible. Hundreds of extinctions, especially on islands (like Pemba), have been caused by alien species (IUCN, 1990). Article 8 (h) of the Convention on Biological Diversity (CBD) of which Tanzania is a Party states that "each Contracting Party shall, as far as possible and as appropriate, prevent the introduction of, control or eradicate those alien species which threaten ecosystem, habitats or species".

The decision to use only alien species in plantation forests may have a negative effect on the local biodiversity through destruction of the habitat prior and after planting. Such introduced exotic species may suppress local species, which may disappear from the area. For example *Maesopsis eminii* tree (Rhamnaceae) was introduced in East Usambara from western Tanzania in the 1960s. Since then the tree has been spreading fast and it is predicted that in 200 years it will cover 50% of the area originally under natural forest (Binggeli, 1989). In all forest plantations plant species diversity was low. Some are comprised of pure stands of planted trees with only a handful of local species. This may be due to low competitive ability by the local species suggesting that in the long run the area may have most of local species completely out-competed. In plantation forestry indigenous species are considered as weeds so that during tending operations they have to be weeded out. *Maesopsis eminii* have been introduced in Ngezi forest and currently forms one of key forest habitats. Plans to eliminate the species from the forest need to be carefully planned after a proper study in order to avoid a potential ecological problem that may arise for removal of large Maeopsis trees in the forest.

A number of alien species have been introduced to Pemba including the Javan civet (*Viverricula indica*), Common House rat (*Mus musculus*) and Black rat (*Rattus rattus*) (Moreau and Pakenham, 1941). Their effect remains unknown but some like the house rat are pests and potential vectors for diseases such as plague. *Rattus rattus* have been reported to cause damage to indigenous forest in New Zealand (Daniel, 1972) and to coconut palms in Fiji (Williams, 1974). Detailed recommendations on the *Rattus rattus* problem has been outlined in the text.

iv. Extraction of forest resources

Timber harvesting is one of the most pressing threats to biodiversity in the study area. The basal areas of many of the timber trees were also very low indicating timber tree sizes had already been over-harvested. Collection of fuelwood, building poles and

medicinal plants are other activities that may cause loss of species and therefore pose a threat to biodiversity.

v. Agriculture

Most of the areas in Ngezi - Vumawimbi are suitable for farming. Given the relatively high rainfall in Pemba and good soils suitable for crops such as cassava, maize, sweet potataoes, Banana, cloves, coconut palms and fruit crops most of the forest in both Ngezi and Vumawimbi has been encroached. Tha farmland has gone close to the forest such that there is no buffer zone but forest edge is where the farms start. This was evident in places such as Tondoooni, Makangare, Mkia wa Ng'ombe, Ngezi gate and Kisiwani.

vi. Habitat loss and fragmentation

This is one of the major threats to biodiversity. It arises mainly from converting natural vegetation into agricultural land or settlements. It is a major threat to most fauna species from large mammals to invertebrates. In Ngezi and Vumawimbi, forest loss and fragementation is evident in many places such that there are many encroached places and roads and passage ways are found almost everywhere in the forests. This is not a healthy situation for the forests. It has been observed in Usambara Mountains that frugivore species declined with decreasing forest fragment size. Consequently, the loss of these dispersal agents depressed tree recruitment in the course of forest fragmentation (Cordeiro and Howe, 2001). The lepidopterans (Butterflies and Moths) are completely dependent on specific plant species during their larval stage, which is the feeding stage. Any activities that result in the loss of the natural vegetation would adversely affect this group of insects. The larval stage of Dragonflies and Damselflies (Odonata nymphs) are aquatic predators. They are completely dependent on availability of fresh-water habitats. Any activity that results into modification or loss of fresh-water bodies would adversely affect the Odonata. For marine environment harvesting methods such as dynamiting and use of beach seines can cause serious habitat damage.

vii. Hunting/over exploitation

This includes both illegal and uncontrolled legal hunting. In Ngezi - Vumawimbi area hunting has been reported to affect species like wild boar, duikers, vervet monkeys, Zanzibar red colobus, and Pemba flying fox. It can be stated that huning is the primary cause of decline in numbers for most species in Ngezi - Vumawimbi followed by other factors. The Makonde immigrants are reported to be leading in hunting species such as the primates, wild boar and others. There are reports, which suggest that the currrent distribution of Zanzibar red colobus in Ngezi forest is greatly influenced by the Makonde activities. The colobus avoid areas where the Makonde are active as such they tend to be confined only in a certain relatively safe places of the forest so limiting their distribution range.

viii. Diseases

Transmission of diseases between people-wildlife-livestock has been reported to occur in Tanzania (GL-CRSP, 2002). Primates are close relatives of humans and diseases like polio, pneumonia, measles and flu and there are over 20 known, potentially lethal viruses that can be transmitted between non human primates and

humans including Ebola, Marbug, hepatitis A and B, herpes B, SV40 and SIV (Fano *et al*, nd). This may not be an immediate problem for Ngezi - Vumawimbi area but it is something to be noted and taken seriously due to increasing number of visitors in the area coming from all over the world.

ix. Pollution

Observations in Ngezi - Vumawimbi forests showed that solid waste from litter is the main source of pollution. Materials like plastics, cans, bottles, papers were often found scattered in many parts of the survey area. The number visitors coming to Ngezi is not very high at the moment hence most of this litter originates from local people passing or utilising the area.

x. Small population paradigm (Caughley, 1994)

Most of the plant and animal species and communities in Pemba are in terms of numbers small and may also be rare, endemic or near endemic. These populations are isolated from their congeners on the mainland and hence may be subjected to inbreeding. The exception here could be the marine organisms, which are possibly not separated by any barriers from other populations and flying creatures, like bats and birds (Moreau and Pakenham, 1941). Island populations of plants and animals may appear healthy but could be genetically poor. Woody vegetation communities with long generation time mostly tend to exhibit this phenomenon whereby they physiognomically look healthy but are genetically poor (Burgess and Clarke, 2000). Such plant communities eventually suffer from inbreeding depression problems and may become locally extinct. Genetic studies may be necessary to establish the genetic status of some important species so that modern techonologies may be employed to improve the genetic status of the species of interest.

xi. Declining population paradigm (Caughley, 1994)

Generally island populations have higher extinction rates than continental populations (Moreau and Pakenham, 1941). Since most of these populations are small and may not be viable, the presence of agents resulting in decline in their number often becomes detrimental. Such agents could be over-exploitation or habitat loss and fragmentation or pollution. Animals like blue duiker, wild boar (naturalised) and some plant species could be affected by this problem. These populations are known to be declining and if this trend is not halted or reversed these species are likely to go locally extinct.

xii. Tourism

The number of tourists visiting Ngezi -Vumawimbi is currently low. However, given the attractiveness of the area and if efforts are done improve the infrastructure and advertise the area there is a high possibility that the number of visitors will increase substantially. Moreover Ngezi is the most important tourist destination in Pemba. There are a number of impacts arising from tourism including cultural, economic and environmental (e.g. pollution, disease transmission). The Ngezi management may use this time to work on aspects like, limits of acceptable use, and acceptable number of visitors, which can visit the area without having serious negative impact on the environment.

Table 6.1: Summary of potential threats to biodiversity in Ngezi - Vumawimbi forest reserves, Pemba

Group	Species	Threats
Protected area		Encroachment, vegetation clearing, resources exploitation, habitat fragmentation
Mammals	Zanzibar red colobus	Hunting, habitat loss and fragmentation
	Pemba flying fox	Hunting, habitat loss and fragmentation, loss of roosting sites
	Blue duiker	Hunting, habitat loss and fragmentation, small & declining populations paradigm
	Pemba Blue Duiker	Hunting
	Galagos	Habitat loss
Group	**Species**	**Threats**
Mammals	Marsh mongoose	Habitat loss, drought
	Pemba Clawless Otter	Habitat loss, drought
Birds	Waterbirds	Water pollution, drought
	Other species	Habitat loss and fragmentation
Reptiles	Sea turtles	Exploitation, loss of nesting sites, marine pollution
	Tortoises	Wildfires, habitat loss
Amphibians		Pollution, habitat loss
Fish		Exploitation, marine pollution, habitat damage
Invertebrates	Molluscs (terrestrial, fresh water)	Pollution, wildfires
	Molluscs (marine)	Marine pollution, exploitation
	Lepidoptera	Pollution, wildfires
	Orthoptera	Pollution, wildfires
	Odonata	Pollution, wildfires

8.0 GENERAL RECOMMENDATIONS

Ngezi - Vumawimbi forest reserves have about 12 main habitat types but although these appear few the area is relatively very rich in endemic, near endemic and rare species despite its small size.

Ngezi – Vumawimbi forests have a variety of habitats rich in species. The availability of resources differs in quantity and quality from one habitat to another therefore making some habitats more vulnerable than others. In order to manage the biological resources available in the reserves. All decisions on management and planning optimization should embrace relevant factors including available technology (by local people) as well as indigenous knowledge, social-economic, cultural and political considerations (Herlocker, 1999). The managemnt plan of the forest needs to address and incorporate certain key issues for effective conservation of the area. These include the conservation of the rare, threatened, endangered and endemic species of flora and fauna. The impact of humans living on the edge of the park on the resources inside the park is an important aspect to consider when designing the management strategy of

the proposed park. Likewise, the relevant organs should investigate the possibility of including the people on the edge of the park in the planning process. In view of these, the following recommendations are put forward:

However, there are four key areas, which need to be considered when formulating the strategic conservation and management plan for Ngezi - Vumawimbi forest reserves. These include:

- the Ngezi - Vumawimbi forest reserves
- the surrounding habitats and communities involving neighbours to the forest reserves
- the coastal shoreline, beaches and associated peninsulas and islands
- the forest plantations

1. Create tourist and recreation sites to promote tourism for Pemba Island. Ngezi Forest Reserve is the only vestige of what a natural forest looked like before the large forest coverage was cleared for land use. Tourists want to take their recreations in sites of natural environmental surroundings. Create biological and cultural information flow concerning the attractions of Ngezi Forest Reserve. It was a good Government decision not to allow hotel development within the reserve. Ngezi forest is very rich in invertebrate fauna such butterflies which if properly adverstised could form a very paying ecotourism attraction.
2. Improve the road condition from Konde across the reserve to Makangale. The road section especially from the forest gate to Makangale is too narrow and with many potholes which makes driving through difficult. The section in particular, should be made more concrete. The traffic from Konde to Makangale is heavy and leads to a tourist hotel beyond Verani village. Endemic and endangered plant species are important in drawing attention of tourists who admire nature. Orchids and unique habitats like the heath-land would be exciting sites to visit. Many orchid populations are located in swamp areas of *Barringtonia racemosa*. It is a good decision to create accessible paths through these sites. Prepare self-guided tour routes to these sites. Due to the small size of the forests it is advisable to emphasize on trails and foot paths for tourists rather than the formal roadways.
3. A public land should be acquired to establish forest plantations to meet fuel crisis and sources of building poles and other forest products. A botanical garden should be established where to raise plant seedlings. People living in the surroundings of the reserve and beyond should be encouraged to raise trees for their requirements in order to reduce pressure to obtain their basic resources from the reserve.
4. Some tree species are excessively harvested for various uses. Medicinal plants especially *Croton sylvaticus*, are very effective against some diseases. Other tree species being heavily harvested for building poles and charcoal. For all these cases it is important to initiate and maintain a heavy flow of biological information through monitoring programme to arrest trends of over harvest. If any restoration is being programmed it should reflect social and economic systems of the surrounding villages.
5. Forest conservation requires explicit efforts to eliminate the invasive exotic species initially introduced to fill up gaps created by over harvesting of indigenous forest trees. To meet the timber supplies, building material and

useful fuel wood supplies the government should take considerations in establishing forest plantation in the acquired public land. Ngezi forest reserve is categorized among the 'high priority sites' for conservation along coastal forests. It is difficult to imagine if some of the endemic species were not affected by the clearance of forest to pave way for the exotic species. Exotic species are vigorous invaders of the new habitats and suppress the regeneration of indigenous species. It is recommended to monitor the impacts of the introduced trees. The impacts of *Maesopsis eminii* for the forest in Eastern Usambara are well documented. *Cedrella mexicana* in Kimboza forest is also becoming a nuisance to the neighboring habitats. However some ecologists argue that some opportunistic weed species may create only places where most of today's weeds are most information carriers of the genetic information for environmental toughness. Nevertheless, the decision to eliminate exotic species such as *Maesopsis eminii* which already forms an important microhabitat, should be done carefully after a scientific stucdy has been conducted.

6. The foresters entrusted with patrolling and maintaining the forest reserve should cope up and arrest offenders who illegally harvest forest produce. All forest routes used to collect forest produce should be blocked. Mr. Seleman showed us some of the methods the forest department staff apply to block such road trails and footpaths.
7. A management policy to conserve a maximum number of species or endangered/rare species should be avoided. Such management policy usually causes fragmentation of the forest into un-natural mosaic of succession types.
8. Compartment blocks are useful for monitoring species diversity and relocating where management efforts should be directed. Compartment boundaries are obliterated. This study could make use of the data by Rodgers *et al.* and Beentje. The boundaries of these compartment blocks should be restored. It was sadly observed to see the assignment of a higher priority to other disciplines.
9. It is important to know peoples' basic perception about their environmental awareness of forest conservation involving natural curiosity of rare plants, the primary source of commonly used necessities, focal species (flag species) e.g. save the rhino. Flag species need to be widely known by the target audience. Decision makers should attempt to have format and means of dispersing information. Neighboring communities may be very effective in the successful forest conservation.
10. The knowledge of biological diversity will be meaningless to humanity unless the motivation to use it exists. There should be economic, cultural, social and conservation links. The problems of human beings (over population, habitat destruction, uncertainity of food, medicine and shelter) can partially be solved by making parts of biological diversity a source of economic wealth.
11 A museum/reference collection should be built to accommodate limited mounted specimens of both plant and animal and invertebrate specimens occurring in the reserve, and any other historical and cultural documents. Permanent staff should be trained to manage such a museum. There is inadequate number of professionals to support conservation of Ngezi Forest Reserve. Opportunities should be made available to train enough staff. Research facilities should be incorporated into the management plan.

12 The number of plant and animal populations in the forest are either rare, endemic, small or declining. Some populations may even be not ecologically viable. Immediate measures need to be taken to serve these species from disappearing. These species should also be subjected to monitoring programmes. Furthermore, the use, extraction and harvesting of all rare plant species should be controlled even if it means banning their utilisation. Simple habitat protection and controlling exploitation may be initial measures to conserve some of the affected animal populations. Few ecological studies have been conducted in Pemba hence little is known of what was in the past and even at present both in Ngezi and on the island as a whole. An isolated island like Pemba is always a potential of finding new discoveries everytime a study is conducted. It is recommended that a survey be done to establish species present in other areas of the island outside the forest in order to understand the species present and also enable plan for appropriate species conservation strategies.

13 Using the available baseline data, there should be a close follow-up of any ecological change that might bring ecological imbalance and consequently loss of biodiversity.

14 Seek cooperation from appropriate specialists who can help to identify some of the lesser known groups of plants and animals. For example invertebrate fauna have not been exhaustively studied, and Pemba is expected to have insular species because it is an island.

15 In order to conserve the invertebrate fauna of the area it is important to conserve their habitat (e.g. forest, water bodies etc.), since they are completely dependent on it. Invertebrates have a high reproductive potential, and most insect species can sustain their population if there is minimum human interference. The chief threat for the invertebrate diversity is likely to come from loss of habitat through human activities, rather than any direct effect on the species themselves. Forest habitats are especially under pressure from surrounding human population through increased agricultural use (including cattle raising), collection of firewood and timber, and the harvesting of non-timber forest resources (medicinal plants, mushrooms, honey etc.).

16 Undertake the study of the ecology and forest dynamics of Ngezi forest to identify the key pollinators and dispersal agents in the ecosystem.

17 Monitor the introduced species of plants and animals on the ecology of the forest and determine their potential threats to the indigenous populations of plants and animals and take appropriate measures to control the situation

18 People living on the forest edge through generations have used the forest area. There are no forest plantations surrounding the forest except those of rubber. The forest has been the source for fuelwood, poles, medicines and hunting ground. Members of the local community have been earning their living from the forest resources. Therefore, a better approach should be designed to allocate resource-use areas for human activities such as extractions and farming outside the forest.

The presence of forest plantations is very important to take the pressure off the natural forest. The management strategy should aim to increase the area under forest plantation. Furthermore, increase in fuelwood prices could be a sufficient stimulus to encourage villagers to plant trees on their farms. Encouraging villagers to plant trees on their farms and around their homes or along the farm boundaries is a rational option because such trees act as

windbreak, provide shade and could be sustainably harvested as fuelwood hence stop people from harvesting in protected areas. Decentralization of nurseries as much as possible is important to minimize transport costs and by doing so every village will be able to raise enough tree seedlings for their own woodlots or sale. Local residents should be encouraged to expand plantations of fast growing species that have proved to grow well in the project area.

19 To embark on ethnobotanical surveys to identify all plant species used or with potential use to the local communities. Efforts should aim at selecting the potential species for further phytochemical investigation. Domesticating such species and development of harvesting protocols may be a useful tool for sustainable production systems. Some rare plant species should be introduced into the gardens in town (*ex situ* conservation).

20 Evaluate the agricultural practices in areas surrounding the forest to determine potential threats to biodiversity arising from these practices including use and disposal of pesticides and other pollutants

21 The local community's awareness, willingness and attitude towards biodiversity conservation are very important aspects. Educate local community through workshops or other means on the need, importance and benefits of biodiversity conservation. Emphasis could be put on the positive impacts of conservation such as increase in income earnings through tourism at the national, local community and individual levels. People should also be informed of other benefits such as employment opportunities to local people and improved social services such as health and education from revenues accrued from wildlife conservation. The importance of forests in influencing weather conditions can also be addressed.

22 Indigenous knowledge should be incorporated in the management of biodiversity. The approach should be communal resource management which satisfies communal needs and sustainable biodiversity conservation. In this respect community forest management should be emphasized to ensure effective forest conservation.

23 Integration of biodiversity management with land use resources is an effective approach of conservation. Planning should therefore include provisions of zonation and dermarcation of core areas in which sensitive species and ecosystems are protected. Establishment of a buffer zone may help to control entry and encroachment into the forest in order to maintain a healthy forest

24 To initiate and maintain a flow of biological information from the site. The focus should be on habitat stability. Habitat changes and their consequences on biodiversity change should be monitored through follow-up studies.

25 Initiate monitoring programmes to monitor changes in key biological and physical resources, environmental parameters and human demography in the project area

   i. A monitoring system is required to evaluate the consequences of the rapid decline of the forest and assess the prospects for their restoration. The major threats to the ecological conditions of the forest include timber exploitation, habitat degradation, land clearance for agriculture, fuel wood collection, building materials, medicinal plant uses and many other human activities involving forest resources

   ii. It is important to have regular basic ecological data such as rainfall, termperature and humidity

iii. Ensure that Zanzibaris are trained to develop the capacity and institutional strength in cooperation with other organs to carry out monitoring

iv. Monitor vegetation changes in areas where this survey was conducted. This study has provided a baseline data from which to start the monitoring

26 Improve the publicity of Ngezi - Vumawimbi forest reserves at the same time taking precaution on the effect of having too much ecotourism. Emphasize on high paying low volume tourism.

27 This report provides conditions outside the forest in 2005. There is a need to conduct modelling to predict the situation on long-term basis say 50 years. The strategic plan should incorporate data on what is happening outside and inside the forest reserves.

9.0 REFERENCES

Annon (1902) Forestry in German East Africa. Indian forester 1902: 372-374.

Abdullah, H.S., Ali, M.S. and Kurikka, T. (1996) *Ngezi Forest Reserve Management Plan*. Zanzibar Forestry Development Plan, Tech. Paper No. 31.

Adams, W. & Hulme, D. (2001) Conservation & Community changing narratives, policies & practices in African conservation. In *African wildlife & livelihoods: The promise & performance of community conservation* (eds D. Hulme & M. Murphree), pp. 9-23. James Currey Ltd, Oxford.

Archer, A. L. and Mwinyi, A. A. (1995) *Further Studies on the Two Duiker Species and the Suni Antelope in Zanzibar*. Ministry of Agriculture Livestock and Natural Resources, Zanzibar.

Beentje, H. J. (1990) Botanical Assessment of Ngezi Forest, Pemba. FINIDA Report to the Commission for Natural Resources, Zanzibar.

Beentje, H. J. (1994) *Kenya Trees, Shrubs and Lianas*. National Museum of Kenya, Nairobi.

Begon, M., Harper, J. L. and Townseed, C. R. (1996) *Ecology: Individuals, Populations and Communities* 3rd Edition. Blackwell Science Ltd. Oxford.

Bell, J.D., Pollard, D.A., Burchmore, J.J., Pease, B.C. & Middleton M.J. (1984) Structure of a fish community in a temperate tidal mangrove creek in Botany Bay, New South Wales. *Australian Journal of Marine and Freshwater Research* 35, 33-46.

Berkes, F. (2004) Rethinking Community-Based Conservation. *Conservation Biology*, 18, 621-630.

Bernard, H.R. (1994) *Research methods in Anthropology: qualitative and quantitative approaches*, 2nd edn. Sage publications, Oaks, London, New Delhi.

Bernard, H.R. (2002) *Research methods in Anthropology: Qualitative and quantitative approaches*, 3rd edn. AltaMira Press, England.

Bianch, G. (1985) *Field Guide to Commercial Marine and Brackish Water Species of Tanzania*. FAO Species Identification sheets for Fishery purposes TCP/URT/4406 and FAO (FIRM) Regular Programme 199 PP.

Binggeli, P. (1989) The Ecology of *Maesopsis* Invasion and Dynamics of the Evergreen Forest of the East Usambaras, and their Implications for Forest Conservation and Forestry Practices. In: *Forest Conservation in the East Usambara Mountains Tanzania*. (Eds. A. C. Hamilton and R. Bensted-Smith). The IUCN Tropical Forest Programme.

Blaber, S. J .M., Young, J. W., and Dunning, M. C. (1985) Community structure and zoogeographic affinities of the coastal fishes of the Dampier region of north-western Australia. *Australian Journal aof Marine and Freshwater Research* 36, 247-266.

Blaber, S. J. M. (1980) Fish of the Trinity inlet system of north Queensland with noted on the ecology of fish faunas of tropical Indo-Pacific estuaries. *Australian Journal aof Marine and Freshwater Research* 31, 137-146.

Brown, K. (2002) Innovations for conservation and development. *Geographical Journal*, 168, 6-17.

Bryce, J.M. (1967). *The Commercial Timbers of Tanzania*. Tanzania Forest Division Booklet Utilization Section, Morogoro.

Budowski, G. (1965) Distribution of tropical rain forest species in the light of successional process. *Turrialba* 15: 40-42.

Burgess N.D., Kock, D., Cockle, A., FitzGibbon, Jenkins P. and Honess P. (2000) Mammals. Pp 173-199. In: Coastal Forests of East Africa.Burgess N.D and Clarke P. (eds) IUCN 2000.

Burgess, N.D. and Clarke, G.P. (2000). *Coastal Forests of East Africa.* The IUCN Forest Conservation Programme.

Carcasson, R. H. (1977) *A field guide to the Coral Reef Fishes of the Indian and West Pacific Oceans*.320 pp.

Carr, A. (1987) Impact of non-degradable marine debris on the ecology survival outlook of sea turtles. *Mar.Poll.Bull*. 18*: 352-357.*

Caughley, G. (1994) Directions in conservation biology (review). *J. Animal Ecology* 63: 215-244.

Chhabra, S. C. and Uiso, F.C. (1991) Antibacterial Activity of some Tanzanian Plants used in traditional medicine. *Fitioterapia* 62: 499 – 503.

Chhabra, S.C., Mahuna. R. L. A., and Mushiu, E. N. (1987) Plants used in Medicine in Eastern Tanzania. I. Pteridophytes and Angiosperms (Acanthuceae to Canelacceae). Journal of Ethnopharmatology 21: 253 – 277.

CITES (1998) *Checklist of Convention on International Trade in Endangered Species of Flora and Fauna* (CITES). CITES Secretariat/World Conservation Monitoring Centre.

CNR-Fisheries (1997) Frame Survey Fisheries Act, 1988

Colchester, M. (1997) *Salvaging Nature*: Indigenous peoples and Protected Areas. In *Social Change and Conservation: Environmental politics and impacts of National Parks and Protected Areas* (eds K.B. Ghimire & M.P. Pimbert), pp. 97-130. UNRSD, UK.

Cordeiro, N. J. and Howe, H. F. (2001) Low Recruitment of Trees Dispersed by Animals in African Forest Fragments. *Conservation Biology* 15(6): 1-9.

Crawley, M. J. (1997) *Plant Ecology*. Blackwell Scientific Publications. Oxford/London/Edinburg/Boston.

Daniel, M. J. (1972) Bionomics of the strip rat (*Rattus r. rattus*) in a New Zealand Indigenous Forest. *New Zealand Journal of Science* 15: 313-341.

Davies, G. (Ed.) (2002) *African Forest Biodiversity: A Field Survey Manual for Vertebrates*. Earthwatch Institute. Europe.

Dransfield, J. (1986) PALMAE. In Polhill, R. M. (Ed.), Flora of Tropical East Africa. A.A. Balkema/Rotterdam/Boston/Greeway, P.J.

Dugan, P. J. (1990) *Wetland Conservation: A review of current issues and require action*. Gland: IUCN

Duplantier, J-M & Rakotondravony, D 1999. Chapter 21. The Rodent Problem in Madagascar: Agricultural Pest and Threat to Human Health.pp. 441-459. In: Ecologically-based Management of Rodent Pests. Singleton, G.R., Hinds, L.A., Leirs, H. & Zhang, Z. (eds). Australian Centre for International Agricultural Reseaach. Canberra.

Dytham, C. (2003) *Choosing and using Statistics: a biologist's guide*, 2nd edn. Blackwell Publishing, London.

Fano, A., Cohen, M. J., Cramer, M., Greek, R. and Kaufman, S. (nd) *Of Pigs, Primates, and Plagues: A Laypersons Guide to the Problems With Animal - to - Human Organ Transplants*. Medical Research Modernisation Committee http://www.mormcmed.org/pigs.html

FAO (1984a) *Species Identification sheets for fishery purposes. Western Indian Ocean fishing area 51*. Volume I. (Eds. W. Fisher, and G. Bianch) Marine Resources Service, Fishery Resources and Environment Division, FAO Fisheries Department, Rome Italy. DANIDA.

FAO (1984b) *Species Identification sheets for fishery purposes. Western Indian Ocean fishing area 51*.Volume II. (Eds. W. Fisher, and G. Bianch) Marine Resources Service, Fishery Resources and Environment Division, FAO Fisheries Department, Rome Italy. DANIDA.

FAO (1984c) *Species Identification sheets for fishery purposes. Western Indian Ocean fishing area 51*.Volume III. (Eds. W. Fisher, and G. Bianch) Marine Resources Service, Fishery Resources and Environment Division, FAO Fisheries Department, Rome Italy. DANIDA.

FAO (1984d) *Species Identification sheets for fishery purposes. Western Indian Ocean fishing area 51.*Volume IV. (Eds. W. Fisher, and G. Bianch) Marine Resources Service, Fishery Resources and Environment Division, FAO Fisheries Department, Rome Italy. DANIDA

FAO/Department of Environment Zanzibar (1999) *Towards Integrated Management and Sustainable Development of Zanzibar's Coast.* FAO/Department of Environment, Zanzibar

Frankel, O. H. Brown A.H.D. and Burdon J.J. (1995). *The Conservation of Plant Diversity.* Cambridge University Press.

FRONTIER (1995) *Coastal Forest Research Programme; Status Reports for 11 Coastal Forests in Coast Region, Tanzania* (Eds. G. P. Clarke & A. Dickinson). Frontier-Tanzania Technical Report No. 17. The Society For Environmental Exploration and The University of Dar es Salaam.

Gadgil, M. & Guha, R. (1992) This fissured land: an ecological history of India, Oxford University Press, and Delhi. *In* Pimbert, M.P. & Pretty, J.N. (1995) Parks, people and professionals. Putting participation into protected area management, Discussion paper. United Nations institute for Social Development, Geneva.

Gates, C. E. (1969) Simulation study of estimators for the line transect sampling method. *Biometrics* 25: 317-328

Gause, G. f. (1934). The struggle for Existence. Williams and Wilkins. Baltimorel reprinted 1964 by Hafner, New York.

Given, D. E. (1994) Principles and practice of plant conservation. WWF/IUCN. Timber Press. Portland, Oregon.

GL-CRSP (2002) *Integrated Assessment Results to Aid Policy Decisions in Ngorongoro Conservation Area, Tanzania*. POLEYC Project of the Global Livestock Collaborative Research Support Program (GL-CRSP). University of California. Report 79pp.

Godman, B. and Talbot, F. (1976) *Aspects of the ecology of coral reef fishes* pp 125-154. In Jones D.A. and R. Endean (eds). Biology and geology of coral reefs Vol.III. Biology Academic Press, New York.

Goldman, H. V. and Walsh, M. T. (1997) *A leopard in jeopardy: an anthropological survey of practices and beliefs which threaten the survival of the Zanzibar leopard* (*Panthera pardus adersi*). Conservation Section, Commission of Natural Resources, Zanzibar.

Greenway. P.T. (1973). A classification of the vegetation of East Africa. Kirkia 9: 1-68.

Hannah, L. (1992) *African people, African Parks: An evaluation of Development Initiatives as a means of improving Protected Area Conservation in Africa*. Conservation International, Washington DC.

Harkonen, K. R. and Seitz C. J. (1993) Conservation and Tourism Development in Ngezi Area, Northwest Pemba. Report on the Village Survey made in the Tondooni Village, Ngezi, Pemba 1993. ISBN 951-47-7897-9

Herlocker, D. (1999). Rangeland Resources in East Africa. Their Ecology and Development GTZ, Nairobi.

Hill, M.J., Vel, T. & Shah, N.J. (2003) The morphology, distribution and conservation implications of introduced rats, Rattus spp. In the granitic Seyechlles. African J. of Ecology 41: 179-186.

Holden, J.P., and Ehrlich, P.R. (1974) Human Population and the global environment. Agm.Sci, 62: 282-292.

http://www.earthdive.com/
http://www.redlist.org/info/links.html
IUCN (1990) Biodiversity in Sub-Saharan Africa and its islands. IUCN. *Species survival Commission* Paper No. 6.
Jacobs, M. (1988) *The tropical rain forest: Africa encounter*. Springer-Verlag, Berlin, Heidelberg, New York.
Khatibu, M. I. and Suleiman, R. H. (1993) Women's participation in Forestry Activities in Zanzibar. Zanzibar Forestry Development Project Technical Paper No.6. Zanzibar Forestry Development Project Phase II.
Kielland, J. (1990) *Butterflies of Tanzania*. Hill House, Melbourne and London.
Kimani, E. N., Mwatha, G. K., Wakwabi, E. O., Ntiba, J. M. and Okoth, B. K. (1996) Fishes of a shallow Tropical Mangrove Estuary, Gazi, Kenya. *Mar. Freshwater. Res. 47*: 857-868.
Kingdon, J. (1997) *The Kingdon Field Guide to African mammals*. Academic Press, London.
Leskinen, J. and Silima, P. A. (1993) *Unguja and Pemba coral rag forests inventory*. Zanzibar Forestry Development Project Technical paper No. 10.
Leskinen, J., Pohjonen, V. M. and Mbarouk, S. A. (1997) *Woody biomass inventory of Zanzibar islands*. Report 35pp.
Macdonald, D.W., Mathews, F. & Berdoy, M. 1999 Chapter 3. The Behaviour and Ecology of Rattus norvegicus: from Opportunism to Kamikaze Tendencies. Pp. 49-80. In: Ecologically-based Management of Rodent Pests. Singleton, G.R., Hinds, L.A., Leirs, H. & Zhang, Z. (eds). Australian Centre for International Agricultural Research. Canberra.
Marshall, S. (1994) *The status of the Zanzibar leopard*. Zanzibar FS, Commission for Natural Resources.
Martens, E. E. (1992) Coastal wetland utilization. Pp 115-134 in S.A. Crafter, S.G. Njuguna and G.W. Howard (Eds) *Wetlands of Kenya. Proceedings of the* KWWG *seminar on wetlands of Kenya, Nairoibi, Kenya, 3-5 July 1991*. IUCN, Gland.
Martin, J. G. (1995) *Ethnobotany.* Chapman & Hall, London.
Mas-Cona, M.S., Estaban, J.G., & Bargues, M.D. 1999 Epidemiology of human fascioliasis: a review and proposed new classification. Bulletin of the World Health Organization 77: 340-346.
Masoud, T. S., Finnie, D., Omar, A. B., Basha, A. U. and Wild, R. G. (2001) Zanzibar Red colobus Monkey Conservation Strategy: A long term strategy for the survival of the Zanzibar Red Colobus Monkey *Piliocolobus kirkii*. Department of Commercial Crops, Fruits and Forestry/Ministry of Agriculture, Natural Resources, Environment and Co-operatives.
Mayers, J. & Vermeulen, S. (2002) *Company-Community Partnerships*: From raw deals to mutual benefits? International Institute for Environmental and Development,, London.
Mayers, J. (2001) *Company-Community Forestry Partnerships*: From raw deals to mutual benefits?, Vol. 2004. International Institute for Environmental and Development.
Mbuya, L. P., Msanga, H. P., Ruffo, C. K., Birnie, A. and Tengas, B. (1994) *Useful trees and shrubs for Tanzania: Identification, Propagation and Management for Agricultural and Pastoral Communities.* Regional Soil Conservation Unit (RSCU) and Swedish International Development Authority, Dar es Salaam and Nairobi.

Migdoll, I. (1987) *Field Guide to the Butterflies of Southern Africa.* New Holland, London.

Moomaw, J. C, (1960) A study of the plant ecology of the Coast Region of Kenya Colony, British East Africa. Government Printer, Nairobi.

Moreau, R. E. and Pakenham, R. H. W. (1941) *The Land Vertebrates of Pemba, Zanzibar and Mafia: A Zoo-Geographical Study*. Proceedings of the Zoological Society of London Series A. Vol. 110 Parts 3 and 4.

Msuya, C.A. Sangu C. K., Kayombo, C.K., Howell, K.M., Ndangalasi H.J., Seleman, H., Ngalason, W. and Kihaule, P.M. 2004. Biological Diversity of the Mbarawara and Ruawa-Likonde plateaus in Lindi Region, Tanzania. Report to The Royal Denish Embassy, Dar es Salaam. Tanzania.

Mturi, F. A. (1991) *The Feeding Ecology and Behaviour of the Red Colobus Monkey* (*Colobus badius kirkii*). PhD Thesis, University of Dar es Salaam.

Mturi, F. A. (1993) *Ecology of the Zanzibar red colobus monkey, Colobus badius kirkii (Gray, 1968), in comparison with other red colobines*. pp243-263. In: Biogeography and Ecology of the rain forests of Eastern Africa (Eds. J. Lovett and Wasser). Cambridge University Press.

Mueller – Dombois, D., Bridges, K.W and Carson, H.L. eds. (1986) Island Ecosystems. Biological Organizations in selected Hawaian communities. Hutchinson-Ross. Stroudsburg Dar. 583 pp.

Nahonyo, C. L., Mwasumbi, L. B. and Bayona, D. (1997) Status of Woodland Vegetation and Utilisation in the MBOMIPA Project Area, Iringa Rural District, Tanzania. Research Document for the MBOMIPA Project/DFID.

Nahonyo, C.L., Mwasumbi, L.B., Eliapenda, S., Msuya, C., Mwansasu, C., Msuya, T.M., Mponda, B.O. and Kihaule, P. Jozani –Chwaka Ba. Proposed National Park Biodiversity. Inventory Report. Submitted to Care Tanzania Department of Commercial Crops, Fruits and Forestry. Serikali ya Mapinduzi Zanzibar.

Newmark, W. D. (2002) *Conserving Biodiversity in East African Forests: A study of the Eastern Arc Mountains*. Ecological Studies 155. Springer, Berlin.

Ngece, K. (2003) *Forestry conservation in East Africa*. Community-based forestry is the answer, Vol. 2004. East African Ecotourism Development and Conservation Consultants Nairobi, Kenya.

Nkunya, M. H. H., Weenen, H., Bray, D. H., Mgani, Q. H. and Mwasumbi, L. B. (1990a) Antimalarial activity of Tanzanian plants and their active constituents: The genus *Uvaria. Planta Medica 57(1991).*

Nkunya, M.H.H., Weanen, H., Bray, D.H., Mgani, Q.A. and Mwasumbi, L. B. (1990b). Antimalarial activity of Tanzanian plants and their active constituents; the genus *Uvaria planta medica.*Paper 24/490 930 Biological Activities.

Nowak, K. E. (2000) *Red Colobus Monkey: daily Caloric Intake, Activity, and Dietary Protein*. Pp 32.

Ogden, J. C. (1980) *Fundamental relationships in Carribean seagrass beds* pp 173-198 In: Phillips, R.C. and C.P. McRoy (eds). Handbook of Seagrass biology: An ecosystem perspective. Earland STPM Press. NY 353pp.

Oliver Bever 1986.Relative density and Relative frequency In: Krebs C. J. 2nd Edition. Ecological methodology.

Pakenham, R. H. W. (1984) *The Mammals of Zanzibar and Pemba Islands*. pp80.

Pakenham, R. H. W. 1979. The Birds of Zanzibar and Pemba. British Ornithologists' Union. London.

Pakenham, R.H.W. 1983 The Reptiles and Amphibians of Zanzibar and Pemba Islands 177: 1-39.

Pegler, D. N. (1977) A preliminary agaric flora of East Africa. *Kew Bulletin Additional Series* 6: 1-615.

Pikkarainen, T. (1991) *Inventory of Jozani and Ngezi Forests: Results.* Forestry Department, Zanzibar & FINNIDA, Kuopio.

Pimbert, M.P. & Pretty, J.N. (1995) *Parks, people and professionals*. Putting participation into protected area management, Discussion paper. United Nations institute for Social Development, Geneva.

Pinhey, E. C. G. (1961) *A Survey of the Dragonflies (Order Odonata) of Eastern Africa.* British Museum, London.

Pinhey, E.C.G. (1965) *Butterflies of Southern Africa*. Nelson, London.

Pirinen, T. (1995) Conservation Consultancy Report. Zanzibar Forestry Development Project Technical paper No. 18. Zanzibar Forestry Development Project Phase III.

Polhill, R. M. (1968) Conservation of vegetation in Africa, South of the Sahara. In: Hedberg, O. ad Hedberg, I. (eds). *Acta Phytogeogra. Suec*, 54.

Polhill, R.M. Beentje, H.J, et al. (1952 – Present). Flora of Tropical East Africa. A.A.Balkema, Rotterdam/London.

Robinson, J.G. & Redford, K.H. (1994). Community-based Approaches to Wildlife Conservation in Neotropical Forests. In *Natural Connections: Perspectives in Community-based Conservation* (eds D. Western, R.M. Wright & S.C. Strum), pp. 300-319. Island Press, United States of America.

Ruffo, C. K. (1992) *A report on species identification for Jozani and Ngezi Forest Inventory*, Forestry Department, Zanzibar & FINNIDA, Kuopio.

Ruffo, C.K., (1991). A Report on Species Identification for Jozani and Ngezi Forest Inventory. Unpublished Report. Tanzania Forest Research Institute, Lushoto.

Salvat, B. (Ed) (1987) *Human impacts on coral reefs*: *Facts and recommendations*. Antenner Museum E.P.H.E., French Polynesia.

Sasekumar , A. Ong, T. L. Thong K. L. (1984) Predation of mangrove fauna by marine fishes. (Eds. E. Soepadmo, A. N. Rao, D. J. MacIntosh). Proc As Symp Mangr Env Res Manag, Kuala Lumpur. 25-29 August 1980: 378-384.

Scholtz, C. and Holm, E. (1985) *Insects of Southern Africa.* University of Pretoria, Pretoria.

Shunula, J. P. (1990) A survey of the distribution and status of mangrove forests in Zanzibar, Tanzania. Environmental studies series No. 5. Comission for Lands and Environment.

Siex, K. S. and Struhsaker, T. T. (1999) Ecology of the Zanzibar Red Colobus Monkey: Demographic Variability and habitat Stability. *International Journal of Primatology* 20 (2): 163-190.

Silkiluwasha, F. (1981) The distribution and conservation status of the Zanzibar red colobus. *African J. Ecol.* 19: 187-194.

Singleton, G.R., Hinds. L.A., Krebs, C.J. & Spratt, D.M. (eds). 2003 Rats, Mice and People: Rodent Biology and Management. Australian Centre for International Agricultural Research, Canberra.

Smiet, A. C. (1989) *Human impact on mountain forest in River Konto area: Vegetation and transect studies*. Konto River Project. Project Communications No 11, Malang.

Smith, J. & Scherr, S.J. (2002) *Forest Carbon and local livelihoods*: Assessment of opportunities and policy recommendations Center for International Forestry Research, Indonesia.

Smith, M. M. and Heemstra, P. C. (Eds.) (1991) *Smiths' Sea Fishes.* 1st Edition. Southern Book Publishers, Johannesburg, 1048pp, 144pls.

Stanley, W.T, Kihaule, P.M., Howell, K.M. and Hutterer,R. 1998. Small Mammals of the Eastern Arc Mountains,Tanzania. J. East Afr. Nat. Hist. **87**: 91-100.

Stohlgren, T. J., Falker, M. A. and Schell, L. D. (1995) A Modified Whittaker Vegetation Sampling Method. *Vegetation* 17: 113-121.

Struhsaker, T. T. and Siex, K. S. (1998) The Zanzibar Red Colobus Monkey: Conservation Status of an Endangered Island Endemic. *Primate Conservation* 18: 51-58.

Stuart, C. T. (1999) *A preliminary Faunal Survey of South-Eastern Unguja: With Emphasis on the Leopard (Panthera pardus adersi*). Report 39pp. Unpublished.

Swai, I. S. (1983b) *Problems associated with wildlife conservation in Zanzibar*. Unpublished report, Wildlife Division, Dar es Salaam.

Swai, I. S. (1993a) *Wildlife Conservation Status in Zanzibar*. MSc Thesis, University of Dar es Salaam.

Technical experts Group on Protected Areas, (2003) *Protected Areas and the Conservation and Sustainable use of Biological Diversity* in: http://www.sur.iucn.org/noticias/documentos/draft.pdf

Thallot, P. (1992) Importance of mangroves for Pacific reef fish, myrth or reality? *Proceedings of the seventh International Coral Reef Symposium* 2, 934-941

UNEP (2001) *Eastern Africa Atlas of Coastal Resources: Tanzania*. UNEP, Directorate for International Cooperation (DGIC) Belgium, United Republic of Tanzania.

United Republic of Tanzania (URT) (2002) Population Census of 2002. Bureau of Statistics, Dar es Salaam.

Valero, M.A., Marcos, M.D., Fons, R. & Mas Coma, S. 1998 *Fasciola hepatica* development in the experimentally infected Black Rat *Rattus rattus*. Parasitiology Research 84: 188-194.

White, F. (1983) *The Vegetation of Africa,* A Descriptive memoir to accompany the UNESCO/AETFAT/UNSO Vegetation Map of Africa. UNESCO, Paris.

Wildlife Division (1998) *The Wildlife Policy of Tanzania.* Ministry of Natural Resources and Tourism, Dar es Salaam, Tanzania.

Williams, A., Mwinyi, A. A. and Ali, S. J. (1995) *A population survey of the mini-antelope Aders' duiker (Cephalophus adersi), Blue duiker (Cephalophus monticola sundevalli), Suni (Neotragus moschatus moschatus) of Unguja, Zanzibar* Section A. Technical Paper No. 26. Commission for natural Resources Sub-commission for Forestry Zanzibar, CARE, FINNIDA.

Williams, J. M. (1974) Rat damage to coconuts in Fiji. Part I assessment of damage. *PANS* 20 (4): 379-391.

Wilson, E. O. (1992) *The Diversity of Life*. Belknap Press, Cambridge, Massachussetts.

Wily, L. (1995) *Collaborative forest Management Villagers & Governemnet*: The case of Mgori forest, Tanzania, Vol. 2004. Unyampanda village forest management committee.

Wood, P. J. (1965) A guide to some German forestry plantations in Tanga Region. *Tanzania notes and Records* 66: 203 – 206.

WRI/IUCN/UNEP (1992) *Global biodiversity strategy*. WRI/IUCN/UNEP, Washington DC:
Zar, J. H. (1996) *Biostatistical Analysis* 3rd edition. Prentice Hall, New Jersey.

TERMS OF REFERENCE

Outputs of the contract

- A vegetation map of the forest showing vegetation types and their distribution. The map should be at a scale of 1: 10,000 and in colour. Three copies of the map should be supplied (unless provided in digital form - MapInfo compatible)

- A vegetation species list for the habitats identified in the vegetation map with a quantitative assessment of species abundance.

- A complete species list with an indication of distribution and relative abundance for the following taxa: Mammals, Birds, Reptiles, Amphibians, Fish, Butterflies and moths

- A final report summarising the data collected and evaluationg the biological resources found within the forest reserves. The report should contain detailed assessment of important and endemic species, including IUCN status, conservation status and current threats. Management recommedations should also be provided.

Appendix 1a:

An annotated checklist of the Flora of Ngezi Forest, Reserve, NE, Pemba

The present account is an up-dated checklist of plant and mushroom species known to occur in Ngezi Forest Reserve including areas recently annexed to the reserve. The study incorporates species list reported by Beentje 1990 and Ruffo 1991. The species richness of the flora may increase if more intensive study is carried out. This is because some habitats were not reached at all and others were inadequately sampled. The check list is arranged alphabetically including families, genera and species. The fungi come first in the arrangement, ferns and dicots follow and monocots come last.

The additional information of the fungal flora (Harkonen *et al*. 2003) has always been neglected in the previous floristic studies. Some 13 fungal species have been recorded. Some of the specimens have only been named to generic level. This is because it was dry season during this study and the specimens were dry. For specific identifications it is necessary to have fresh materials.

Vernacular names of plants are provided for those species known by the indigeneous people. Such vernacular names are available for those plants which are economically, socially or culturally useful such as timber trees, building material species and which provide medicines, fruits, vegetables or very common species in the forest.

This checklist may prove useful for monitoring purposes, and may also be particularly useful source of information for future scientific researchers, for foresters and their auxiliary staff attached to Ngezi Forest Reserve. The list provides additional and new information for the flora of Tropical East Africa. For instance, *Voacanga africana*, *Uvaria acuminata*, *Uvaria lucida*, *Sphaerocoryne gracile* and many others, were not known to occur in Ngezi Forest Reserve in the Flora of tropical East Africa. (Polhill & Beentje 1970 – present). One specie was not known at all. Unkown sp. by Beentje is actually *Blighia unijugata.* Four species are known to generic level only. These are *Uvaria* sp., *Tarenna* sp., and *Cyphostemma* sp.

List of vascular plants and mushroom species

BN - Collection by Beentje

RMH - Collection by Rodgers, Mwasumbi and Hall. Records seen by Rodgers, Hall, Mwasumbi, Swai and Vollesen have been incorporated in this list; where I have not been able to confirm their sightings, I have indicated such.

SR - Denotes sight record by both Rodgers *et al*., and Beentje; otherwise there is a qualifier.

fi - Denotes field identification (this differs from sight record: in FI one actually gets a piece of the plant and uses keys to identify it)

M - Mwasumbi

sr – site records

Plants are arranged by family; the families are listed alphabetically, within the super groupings Mushrooms/Pteridophytes/Dicotyledons/Monocotyledons.

Mushrooms

Microporus xanthopus (Fr.) Kuntze

Previously known to cause white-rot in mountain forests and miombo. Common saprophyte, said to be rare in Tanzania

Phellinus sp.

Hard white fruit body (young)

Ganoderma sp.1

Stipulate fruit bodies, dark brown (rusty) inside with an encored white margin, and upper surface dark brown with concentric rings.

Ganoderma sp.2
Stipulate young fruit body, stripe smooth brown, continuing to round half central upper part, vest upper part cream. Lower surface all smooth cream

Pleurotosus sajur – carju
Gills corrugated, light brown. Upper surface rough light cream; upper fruit body overlying lower two ones. Fruit bodies stem less.

Trametes cf. gibbosa
Stem less, corrugated fruit body; wrinkled upper fruit body, imbricate overlapping ones; with faint concentric lines. Gills indistinct.

Trametes vesicolor
Substipitate stem of fruit body and marginal rim of fruit body is cream white. Upper surface of fruit body is dark brown with indistinct or faint concentric rings while the lower surface is dusty cream.

Microporus sp.1
On dead logs of *Maesopsis*; same location and almost similar with Xanthopus, but regular rim is not white. Indistinct concentric rings on dark purple upper funnel-shaped surface.

Trametes elegans
Substipitate on dead logs. White both surfaces.

Microporus sp.2
Funnel shaped fruit body, white cream below. Concentric stripes quite distinct, cream and light brown.

Laetiporus sulphorus (chicken of the woods)
Yellow thick layer of the fruit body with rough upper surface and quite smooth lower surface.

Funalia polyzona
Overlapping upper layers, distinct concentric strips, and cream – yellow.

Schizophyllum commune
Small fruit bodies, many clustered together on dead trunks along the road. Margins of fruit bodies irregularly, with left.

Xylaria is an Ascomycete genus which is associated with termite, but their fruit bodies are hard and inedible.

PTERIDOPHYTES: Common and rare ferns

Families	Species name	Vern. Name	Notes	Reference
Aspleniaceae	*Acrostichum aureum L*	-	Mangrove fern	RMHS – SR

	Asplenium nidus L.	-	Common birds nest-fern epiphyte on tree trunk	SR
Thelypteridaceae	*Cyclosorus interruptus* (Willd.) H.Ito			RMHS – SR
Gleicheniaceae	*Dicranopteris linearis* (Burm.f.) Undrew.		Forms dense tangles on poor soils, and after fire in many habitats	RMHS – SR
Lomariopsidaceae	*Elaphoglossum lastri* (Bak.) C. Chr.;		Epiphyte, simple fronds no indusia	
	Lomariopsis warneckei (Hieron,) Alston –	Mgimbikuti	Climbing fern, rhizome with linear brown scales	BN 4313
Polypodioaceae	*Microsorum punctatum* (L.) Copel		New for Ngezi, Pemba and Zanzibar	
Polypodiaceae	*scolopendria* (Burm.f.) Pichi-Serm.		Common terrestrial or climbing fern oil used to flavour coconut oil	SR
Davalliaceae	*Nephrolepis biserrata* (W.) Schott Phymatosorus		Common terrestrial fern	RMH 2691
Dennstaedtiaceae	*Pteridium aquilinum* (L.) Kuhn ssp.*caudatum* (L.) Bonap.		Terrestrial in ruderal situations, pioneer species	
Pteridaceae	*Pteris acanthoneura* Alston		In forest shade	M - sr
	Pteris atrovirens Willd.		In forest shade	M - sr
	Pteris hamulosa (Christ)		Woody erect/creeping rhizome in forest – FTEA 2002	
Psilotaceae	*Psilotum nudum* (L.) Beauv.		Small - terrestrial on rocks in	RMH 2784

			riverbed or epiphytic on palm trees, or terrestrial herb.	
Lomariopsidaceae	*Lomariopsis warnekei* (Hieron) Alston		Climbers in swamps	RMH 2783
Vittariaceae	*Vittaria elongata* Sw.		Small epiphyte, linear hanging usually together with birds-nest fern (Asplenium nidus)	RMH 2713

DICOTYLEDONS

ACANTHACEAE			
Species name	**Vern. Name**	**Notes**	**Reference**
Adhatoda englerana (Lindau) CB.CI.	-	Woody herb, moist forest	*
Asystasia multiflora KI.		Herb	RMH 2669
*Hygrophilla auriculata (*Schumach.) Heinc		Indicator, of seasonal wet cotton soils, a weed of ricefields	*
Justicia tenella (Nees) T. Anders		Herb, annual	RMH 2750
Pseuderanthemum tunicatum (Afz.) Milne-Redh.		Woody herb, forest	BN 4317
Ruspolia sp.		Woody herb	RMH
Whitfieldia elongata (Beauv.) C.B.CI.	Mnyenyapaa	Shrub in moist forest	RMH 251
ALANGIACEAE			
Alangium salviifolium (L.f.) Wangerin	Mavimavi	Canopy tree	RMH 2707
AMARANTHACEAE			
Achyranthes aspera L		Weedy annual herb, indicator of disturbed sites	SR
Cyathula prostrata (L.) BI.		Herb	RMH 2697
Pupalia lappacea (L.) Juss.		Herb	RMH sr
ANACARDIACEAE			
Lannea schweinfurthii (Engl.) Engl. var. *acutifoliolata* (Engl.) Kokw.	Muumba Mfupavu	Canopy tree, coastal Kenya and Tanzania, Zanzibar and Pemba	BN-fi
Mangifera indica L.	Mwembe	Mango tree, introduction from Asia usually associated with human habitation, spread in forest by humans and birds	sr
Rhus natalensis Krauss	-	Shrub, only found sterile	BN - sr
Sorindeia madagascariensis DC.	Mpilipili doria	Medium seized tree, especially in coastal bush land;East Africa and Madagascar	BN 5240

ANNONACEAE			
Annona senegalensis Pers. ssp. *senegalensis*	Mtopetope mchekwa	Shrub tree, edible fruit, medicinal roots, fuelwood	sr
*Sphaerocoryne gracile*Verdc.		Scandent shrub in coastal dry forest	sr
Uvaria acuminata Oliv.		Strong black liana coastal coral rock forest and thicket	sr
Uvaria lucida Benth.		Liana edge of coastal bushland/coral rag forest	M-sr
Uvaria sp. B. of FTEA as BN states		Liana, coastal, bushland/thicket	BN 4366
APOCYNACEAE			
Alafia caudata Stapf		Large liana, milky sap	RMH 277
Ancylobotrys petersiana (KI.) Pierre	Mbungo kidogo	Medium sized liana in forest	UOPZP (1949)
Funtumia africana (Benth.) Stapf	Mtonga, mlangamakelele	Medium to large liana	BN 4949
Landolphia kirkii Dyer	Mpoo	Large Liana	M-sr
Oncinotis tenuiloba Stapf	-	Small climber new FTEA record for Pemba	BN 4323
Species name	**Vern. Name**	**Notes**	**Reference**
Rauvolfia mombassana Stapf	Mwengechaa	Shrub/small tree	BN-fi
Saba comorensis (Bojer) Pichon	Mbungo	Large common lianfruits edible also sold in market stall and way sides	BN & CBM - fi
Schizozygia coffaeoides (Bojer) Baill.	Mtonga mwitu	shrub	BN 4310
Strophanthus zimmermannii Monach	-	Medium sized liana; south coastal Kenya, coastal Tanzania new record for Ngezi, rare species	BN 4319
Tabernaemontana pachysiphon Stapf	Mtonga mwitu	Medium sized forest margin tree	RMH 2788
Tabernaemontana ventricosa A.D.C	Mapumba ya kima	Large tree	BN 4364
Voacanga africana Stapf	-	Tall tree on raised sand beach, new record uncommon	sr
ARALIACEAE			
Cussonia zimmermannii Harms	Mpapai dume, Mpapai mwitu	Large tree in coastal thicket	BN - fi
Polyscias fulva (Hiern) Harms	Mbirimbi mwitu	Tall tree, may be introduced as it differs from local populations upland areas.	BN 4374
ASCLEPIDIACEAE			
Secamone retusa N.E Br.	-	Climber in heath and forest margins. New record for Pemba	BN 4360
Tacazzea apiculata Oliv.	-	Climber in coral rag forest	sr
BALSAMINACEAE			
Impatiens wallerana Hook.f.	Matuanange	Herbs of moist sites, especially riverbanks	RMH 2645
BIGNONIACEAE			
Tabebuia pentaphylla (Bertol) DC	Majani matano	Exotic timber tree	RMH 2690
BOMBACACEAE			
Adansonia digitata L.	Mbuyu	Isolated trees on coral rag coast forest	M - sr
Bombax rhodognaphalon K. Schum. var. *rhodognaphalon*(*rhodognaphalon*	Msufi mwitu	Tree in moist and coastal foest unlike Beentje	BN 4341

/ schumannianum)		records also in Tanzania	
BORAGINACEAE			
Boureria petiolaris (Lam.) Thulin (*Ehretia petiolaris*)	Mbunduki	Shrub or small tree in coral rag dry forest	BN 4334
Cardia alliodora (Ruiz & Pavon) Oken	Mkamasia mkodia	Introduced timber, tree	sr
CAPPARACEAE			
Cladostemon kirkii (Olv.) Pax & Gilg		Shrub or small tree in coastal thick	RMN 2771
CASUARINACEAE			
Casuarina equisetifolia L.	Mvinje	Large introduced tree on beach crest, now being naturalized	sr
CELASTRACEAE			
Elachyptera parvifolia (Oliv.) N.Halle		Big liana >10 igh	RMH
Maytenus senegalensis (Lam.) Excell	Mdinga ndewe mnyonyao	Small piny tree	RMH 2706
Species name	**Vern. Name**	**Notes**	**Reference**
Mystroxylon aethiopicum (Thumb.) Loes	Mlimbolimbo	Medium sized tree or shrub forming bush	RMH 2782
Salacia elegans Oliv.	Mguko	Shrub or liana	RMH 2782
Salacia leptoclada Tul.		Liana	M-sr
Salacia madagascariensis (Lam) DC –	Mtora, mtoria, mguku	Liana, yellow roots	M-sr
CHRYSOBALANACEAE			
Hirtella zanzibarica Oliv.		Large tree	RMH - sr
Parinari curatellifolia Benth.ssp. *curatellifolia*	Mmbura	Large tree	BN 4342
COMBRETACEAE			
Combretum paniculatum Vent	-	Spreading large liana on tall trees where it forms bush. Bright red flowers.	BN 4375 m-sr
Combretum sp.cf. u*mbricola*	-	Liana over canopy trees	Sr
Terminalia boivinii Tul. [T.fatraea]	Mkunguni	Branched tree coastal forest and thicket	BN - fi
Terminalia catappa L.	Mkungu	Inroduced tree	sr
Terminalia ivorensis A. Chev. *or Terminalia superba* Engl. & Diels	Mkungu india	Introduced timber tree	RMH – sr
Terminalia sambesiaca Engl. & Diels		Large tree	RMH - sr
COMPOSITAE			
Ageratum conyzoides L.	Kimavi cha kuku; mtumbaku	Annual weedy herb in ponds and fields	M - sr
Pulchea sordida (Vatke) Oliv. & Hiern.	-	Woody herb/small shrub	RMN - sr
Psiadia punctulata (DC.) Vatke	Mkengeta; mwezi upande	shrub	M – sr
Vernonia zanzibarensis Less.	Mtumbako mwitu	Shrub especially in edges of *Erica mafiens is* and coastal dry forest	RMH 2760
CONNARACEAE			
Agelaea pentagyna (Lam.) Baill.		Liana	M- fi
Connarus sp. nov. = 4159/Rodgers et al.		Liana	M- fi
Cnestis corniculata Lam.		Liana	BN 4370
DICHAPETALACEAE			
Tapura fischeri Engl.	Mtama mwitu	Medium tree	RMH 2658

DILLENIACEAE			
Tetracera litoralis Gilg	Mkala Mpalafisi	Shrub, extends to coastal Kenya, Tanzania	BN 4315
EBENACEAE			
Diospyros consolatae Chiov.	Mjengo	Tree, coastal dry forest and thicket	BN 4328
Euclea racemosa Murr. ssp. *schimperi* (A.C.D.) F.White	Mdaa-mwitu		RS
ERICACEAE			
Erica mafiensis Engl.. (= Phylippia mafiensis)	Mdamba	Shrub forms denses, dominant bush; Endemic	BN 4337
Hypericum sp.	-	Forms dense mat on ponds in moist forest	M - fi
ERYTHROXYLACEAE			
Species name	**Vern. Name**	**Notes**	**Reference**
Erythroxylum emarginatum Thonn.		Shrub on coastal thicket	BN - fi
EUPHORIBIACEAE			
Acalypha neptunica Muell.Arg.	Muweza	Shrub in moist forest	M - fi
Antidesma membranceum Muell. Arg.	Msisimizi	Shrub/small tree	Greenway 2702
Antidesma venosum Tul.	Msisimizi	Shrub or smalltree	BN 4365
Bridelia micrantha (Hochst.) Baill... –	Mkarati, Mtutututu	Small tree, building poles, terminat-resistant	RMH 2669
Croton scheffleri Pax	-	Shrub	RMH 2708
Croton sylvaticus Kraus	Mdawadawa	Tree in moist	RMH 2671
Drypetes natalensis (Harv...) Hutch. var. *leiogyna* Brenan	Mjafari, mgandama, msunduri	Tree, restricted to coastal Kenya, NE and west Tanzania, Zanzibar	BN 4302
Drypetes reticulata Pax	-	Tree, coastal evergreen and moist forest	RMH 2761
Erythrococca kirkii (Mull.Arg.) Prain	Mgombere	Shrub in coral rag forest	RMH 2673
Flueggia virosa (Willd.) Voigt	Mkwamba	Shrub	BN - fi
Macaranga capensis (Baill.) Sim. -	Mlangamakelele, Mkaranga	Canopy tree	sr
Margaritaria discoidea (Baill.) Webster var triplosphaera (Baill.) Webster	-	Large tree in dry coastal forest. Used as building poles	RMH 2683
Phyllanthus nummulariifolius Poir.	-	Annual herb	BN 4301
Suregada zanzibariensis Baill.	Mdimu msitu	Shrub or small tree	BN 4216
Tragia furialis Bojer	Weni, Kiwavi	Trailing climber, stinging	BN - sr
Uapaca guineensis Mull. Arg.	Mchenza msitu	Large tree in moist forest and swamp forest	BN 2615
Uapaca sansibarica Pax	-	Large tree new for Pemba	RMH - sr
FLACCOURTIACEAE			
Casaeria gladiiformis Mast.	-	Medium tree	RMH 2681
Flacourtia indica (Burm.f.) Merr.	Mchongoma	Tree	BN - fi
Ludia mauritiana Gmelin		Shrub	RMH 2761
Rawsonia lucida Harv... & Sond.	Mpera mwitu	Tree	RMH 2693
Xy*lotheca tettensis* (Klotzsch) Gilg var. *kirkii* (Oliv.) Wild -	Mchakachaka	Shrub	M - sr
GOODENIACEAE			
Scaevola prumieri (L.) Vahl	-	Salt bush, succulent on coastal sandy beach	M - sr

GUTTIFERAE			
Calophyllum inophyllum L.	Mtondoo	Exotic timber tree	SR
Garcinia livingstonei T. Anders	-	Tree	RMH - sr
Harungana madagascariensis Poir.	Mdamudamu	Forest margin tree, small tree in forest relicts	SR
ICACINACEAE			
Apodytes dimidiata Arn. ~. var. *acutifolia* (A. Rich.) Boutique	-	Tree on edges of *Erica* bushland	SR
Leptaulus holstii (Engl.) Engl.		Small shrub	
LECYTHIDACEAE			
Species name	**Vern. Name**	**Notes**	**Reference**
Barringtonia racemosa (L.) Sprang	Mtomondo (mke)	Tree in swamp forest, host of many epiphytic orchids	RMH 2744
Barringtonia asiatica (L.) Kuntz		Canopy Tree	Introduced
LEGUMINOSAE – CAESALPINIACEAE			
Afzelia quanzensis Welw.	Mbambakofi, mkongo	Forest tree, coastal	SR
Caesalpinia bonduc (L.) Roxb.	Mkomwe, Mkete	Spiny bush forming rambler	M - sr
Caesalpinia volkensii Harms		Liana with prickles, restricted to Uganda, Kenya and Tanzania	BN 4377
Cassia sp.	-	Hairy shrub	M – sr
Erythophloeum suaveolens (Guill... & Perr.) Brenan	Mwavi	Canopy tree	SR
Tamarindus indica L.	Mkwaju	Canopy tree/emergent in coastal thicket	BN - fi
LEGUMINOSAE – MIMOSACEAE			
Albizia adianthifolia (Schumach.) W.F. Wight	Mchapia tumbili	Canopy tree	RM 2727
Dichrostachys cinerea (L.) Wight & Arn.ssp.*cinerea* –	Mvunja shoka	Small tree especially in disturbed areas and forest edge	BN - sr
Entada pursaetha DC	Mkuungo, Mukuno	Large Liana	SR
Mimosa pudica L.	Kifa uongo	Weed, edge of seasonal pond	M - sr
Prosopis sp.	-	Introduced tree	Reported
LEGUMINOSAE – PAPILIONACEAE			
Dalbergia melanoxylon Guill. & Oerr	Mpingo	Medum coastal thicket/ forest tree	BN 4348
Desmodium adscendens (Sw.) DC.		Trailing herb	M - sr
Eriosema parviflorum E. Mey.	Mchunga mbuzi	Fringing swamp	M - sr
Indigofera astragalina DC.		Woody herb	M - sr
Indigofera trita L.f.		Bush forming woody herb edge of bushland	M - sr
Millettia oblata Dunn ssp. i*ntermedia* Gillett		Tree	RMH 2716
*Mucuna gigantea (*Willd.) DC.	Upupu	Large liana	SR
*Teramnus labialis (*Linn.f.) Spreng		Fringing swamp	M - sr
Pterocarpus indicus Willd.	Mdamudamu	Introduced large branched tree as a boundary market	SR
Sophora tomentosa L. ssp. *tomentosa*	Mtupwa	Shrub, seashore for fish poisoining	M - sr
LENTIBULIARACEAE			
Utricularia gibba L.		Submerged herb in pools/swamps	RMH 2785

LOBELIACEAE			
*Lobelia anceps (*Thunb) Thulin	Kikwayakwaya	Herb, forest margins	BN – sr
Anthocleista grandiflora Gilg	Mpamba mwitu	Tree of swamp forest	SR
Strychnos angolensis Gilg	Mvinje Msitu	Liana	RMH 2778
Strychnos panganensis Gilg	Mbugu-bafe	Bush forming liana, coastaldry forest	M – sr
LYTHRACEAE			
Species name	**Vern. Name**	**Notes**	**Reference**
Pemphis acidula Forst. & Forst .f.	Mkaa pwani	Shrub on coral beac crest	BN - fi
MALPHIGIACEAE			
Acridocarpus zanzibaricus (L.) A. Juss.	Mkenge wa Paka	Liana/climber, coastal thicket. Somalia to Central East Tanzania	SR
MALVACEAE			
Gossypioides kirkii (Mast...) J. B. Hutch	Mpamba mwitu	Shrub	BN 4316
Hibiscus surattensis L.	-	Scrambling herb	M -sr
Hibiscus tiliaceus L.	Mkakawa	Shrub on beach	RMN 2703
MELASTOMATACEAE			
Dissotis rotundifolia (Sm.) Triana	Kichinja uthia Mchenja ziwa	Creeping herb	BN - SR
Melastomastrum segregatum (Benth.) A. & R. Fernandes	-	Shrub edge of pools/swamps	RMH 2768
Tristemma mauritianum J.F. Gmel.	-	Shrubby herb marshy open sites	RMH 2718
MELIACEAE			
Cedrela mexicana M. Roem	-	Introduced timber tree	SR
Entandophragma sp.	-	Timber tree said to be introduced	BN
Khaya anthotheca? (welw.) C.D.C.	-	Introduced timber tree	SR
Trichilia emetica Vahl	-	Tree	RMH – SR
Xylocarpus granatum Koen.	Mtonga	Mangrove tree species	BN - sr
MENISPERMACEAE			
Discoreophyllum volkensii Engl. var. *volkensii*		Liana	RMH 2769
Tinospora oblongifolia (Engl.) Troupin	-	Liana, new record for Pemba	BN - sr
Triclisia sacleuxii (Pierre) Diels var. *sacleuxii*	-	Liana	BN 4344
MENYANTHACEAE			
Nymphoides cf. kirkii (NE Br.) ined.	-	Floating aquatic in ponds, new record for Pemba	BN sr
MORACEAE			
Antiaris toxicaria Lesch.	Mgulele	Canopy timber tree	SR
Artocarpus altilis (Parkinson) Fosberg	Mshelisheli Mfenesi mfuu	Introduced tree with edible breadfruit	SR
Artocarpus heterophyllus Lam.	Mfenesi (Jackfruit)	Introduced tree	SR
Dorstenia tayloriana Rendle	-	Woody herb, rare new for Pemba	BN 4372
Ficus exasperata Vahl	Msasa dume	Canopy tree	SR
Ficus lutea Vahl	Mlangawa	Canopy tree	RMH 2783
Ficus rokko Warb. & Schweinf..	Mlandenge	Canopy tree	SR
Ficus scasselatii Pamp	Mtonga mwitu	Large tree	BN - fi

Ficus sur Forssk. [*F.capensis*]	Mkuyu	Canopy tree	RMH 2680
Milicia excelsa (Welw.) C.C. Berg (*Chlorophora excelsa*)	Mvule	Canopy timber tree	SR
MYRTACEAE			
Species name	**Vern. Name**	**Notes**	**Reference**
Eucalyptus sp – Mkaratusi	Mkaratusi	Introduced may be more than one species	SR
Eugenia capensis (= Vaughan 1676)	Mkaage	New species restricted to Zanzibar and Pemba only	BN 4219
Syzgium cordantum Krauss	Mzambarau ziwa	Medium tree in heathland, swamps and coastal forest	SR
Syzygium cumini (L.) Skeels –	Mzambarau	Naturalized canopy tree	BN 4238
NYMPHAESCEAE			
Nymphaea nouchali Burm... var. *zanzibarensis* (Casp.) Verdc.	Myungiyungi	Aquatic herb	BN -sr
OCHNACEAE			
Ochna chomasiama Engl. & Gilg		Shrub in coastal forest	M - sr
Sauvagesia erecta L			RMH 2735
OLEACEAE			
Olea woodiana Knobl.	Mchunga mwitu	Tree in coastal forests	BN 4332
ONAGRACEAE			
Ludwigia abyssinica A. Rich.	-	Shrubs in muddy silt ponds	M –sr
Ludwigia jussioaeoides Desr	-	Herb, in seasonal wet ponds moist forest	M - sr
Ludwigia stolonifera (Guill. & Perr.) Raven		Prostrate herb in seasonal ponds/wet sites	M - sr
OXALIDACEAE			
Averrhoa sp. (*A. carambola* in Forestry records)	Mbirimbi	Introduced tree	SR
PASSIFLORACEAE			
Adenia gummifera (Harv.) Harms var. *gummifera*	-	Climber in forest edges/disturbed sites	BN 4346
Adenia rumicifolia Engl.	Mgole	Climber in forest margins	RMH 2677
Piper betle L.	Mtambuu	Small climber possibly introduced	BN 4368
RHAMNACEAE			
Colubrina asiatica (L.) Brongn.	-	Climbing shrub	BN - fi
Maesopsis eminii Engl.	Msisi	Introduced timber tree	SR
Scutia myrtina (Burm.f.) Kurtz	Msoo	Climber with spines, new for Pemba	BB - fi
RHIZOPHORACEAE			
Bruguiera gymnorrhiza (L.) Lam.	Mchonga	Mangrove tree	SR
Cassipourea euryoides Alton		Medium sized tree	Rare species
Cassipourea gummiflua Tul. var. *verticillata (*N.E Br.) J. Lewis	Msikundazi	Medium sized tree	BN - sr
Ceriops tagal (Perr.) CB Robinson	Mkandaa Mweupe	Mangrove tree	BN - sr
Rizophora mucronata L	Mkoko	Mangrove tree	SR
RUBIACEAE			
Agathisanthemum bojeri Klotzsch	-	Herb open sites	RMN – sr
Canthium mombazense Baill.		Shrub	BN 4343

Species name	Vern. Name	Notes	Reference
Chassalia umbraticola vatke ssp. *umbatricola*	Mwango Mpelepele	Shrub	RMH 2649
Craterispermum scheweinfurthii Hiern		Small tree	Greenway 1482
*Cremaspora triflora (*Thonn.) K. Schum.ssp. *confluens* (K.Schum.) Verdc.	Mkanja	Shrum or small tree	BN - fi
Geophila repens (L.) I.M. Johnston	-	Herb	RMH 2790
Guettarda speciosa L.	Mkaa pwani	Beach tree	RMH 2704
Heinsia zanzibarica (Boj.) Verdc	Mfifiyo	Shrub or small tree	M - sr
Keetia gueinzii (Son.) Bridson,	Mpendapendapo	Climber/liana forming bush	RMH - sr
Kraussia speciosa Bullock	-	Shrub/small tree	BN 4325
Kohatia sp.		Herb fringing a swamp	M - sr
Laygnias pallidiflora Bullock			
Lampthrothamus zanguebaricum Hiern	Mkokobara mchesi	Small tree	M - sr
Leptactina platyphylla (Hiern) Wernh.	Mbuni mwitu	Small tree for poles	BN 4378
Oldenlandia lancifolia (Schumch.) DC. var. scarbridula Bremek	-	Herbs in seasonal pools/swamps	M - sr
Pavetta sp.		Shrub	RMH 2647
Pentas micrantha Bak.	Kivuma nyuki	Forest edges or open sites Herb	RMH 2647
Pentodon pentandrus (Schumach. & Thonn.) Vatke var. *minor* Bremek	-	Weak herb in balck damp soils of ponds/swamps	M - sr
Polysphaeria parvifolia Hiern	Mkanja	Shrub	SR
Psychotria sp.	-	Shrub	BN 4311
Psychotria holtzii (K.Schum) Petit var. *holtzii*	Mangwe	Shrub in heathand, forest edges	BN 4359
Psychotria lauracea (K.Schum) Petit	Msigande	Shrub	RMH 2725
Psychotria riparia (K.Schum. & K. Krauss) Petit.		Shrub	Vaughan 742
Psychotria schliebenii Petit var. *schliebenii*		Shrub	RMH 2659
Psychotria tanganyikensis Verdc.var. *ferruginea* Verdc	-	Shrub	RMH 2724
Psydrax kaessneri (S. Moore) Bridson [*canthium kaessneni*]		Shrub in heathland	RMH 2751
Psydrax livida (Hiern) Bridson [*Canthium huillense*]		Shrub	RMH 2799
Psydrax recurvifolia (Bullock) Bridson	Mtengeji	Scandent shrub or small tree	RMH – sr
Pyrostria bibracteata (Bak.) Cavaco [*Canthium bibracteatum*];	Mfupapu	Shrub or small tree	RMH 2763
Spermacoce princeae (K.Schum.) Verdc. [= S.hispida L]		Herb in seasonal wet ponds	M - sr
Tarenna pavettoides (Harv.) Sims sp. *affinis* (K.Schum.) Bridson	-	shrub	BN 4361
Uncaria africana G.Don var.*orientalis* Verdc.	Msoo	Climber to canopy	BN 4388
Vangueria sp. A of FRTEA	-	Shrub, endemic	Burgess 2000
RUTACEAE			
Vepris eugeniifolia (Engl.) Verdorn	Mchunga mwitu	shrub	BN 4336
SAPINDACEAE			

Species name	Vern. Name	Notes	Reference
Allophylus griseo-tomentosum Gilg	-	Shrub or smallt ree	RMH – sr
Allophylus pervillei Bl.	Mchacha	Liana or shrub	BN - fi
Allophylus vestitus F.G. Davies.	-		BN 4339
Allophylus sp. near *grotei*	-	Shrub	BN 4330
Blighia unijugata Bak. (includes the unknown species)	Mkivuli, Mwakamwatu	Tree	RMH 2723
Deinbollia borbonica Scheff.	Mkunguma	Small tree	SR
Dodonaea viscosa Jacq.	Mkaa pwani, Mkengata	Shrub, coastal forest	M - sr
Haplocoelum inoploeum Radlk.	Mtumbi	Tree in dry coastal forest and thicket	SR
Majidea zanguebarica Oliv.	Mchenya	Canopy tree	RMH 2702
Paullinia pinnata L	Mmbugu	Climber in forests	SR
SAPOTACEAE			
Englerophytum magalismontanum (Sond.) Pennington	-	Medium tree	BN - fi
Chrysophyllum lanceolatum (BI.) DV.var. *stellatocarpum* van Royen		Small tree only known from Pemba	Peddington
Inhambanella henriquesii (Engl. & Warb.) Dubard	Msikundazi	Medium tree new for Pemba Monotypic sp. in SE Trop. Africa	BN 4389
Manilkara sansibarensis (Engl.) Dubard		Medium tree	RMN 2775
Manilkara sulcata (Engl.) Dubard		Small tree	BN - fi
Pouteria brevipes (Baker) Pennington	Mchocha jike	Canopy tree	SR
Pouteria msolo (Engl.) Peddington	Mchocha dume	Canopy tree	SR
Sideroxylon inerme L. ssp. *diospyroides* (Baker) J.H Hemsl.	-	Small branded tree	BN – fi
SCROPHULARIACEAE			
Bacopa crenata (P. Beauv.) Hepper	-	herb	RMH 2700
Limnophila indica (L.) Druce		Herb, aromatic in marsh	RMH 2669
Scoparis dulcis L.			
SIMAROUBACEAE			
Quassia indica (Gaertner) Nooteb. [*Samadera indica]*	Mtomondo dume	Tree in swamp forest an eastern Asia species, medicinal oil and insecticide	BN 4322
Quassia undulata (Guill...& Perr) D. Dietr. [*Odyendea zimmermannii*]	Mjoho	Canopy tree	BN 4307
SONNERATIACEAE			
Sonneratia alba Sm.	Mpira, Mlilana	Mangrove tree species	SR
STERCULIACEAE			
Heritiera littoralis Ait.	Msikundazi	Mangrove tree species	SR
Melochia corcholfolia L	-	Invasive herb in seasonal wet pond	M - sr
THYMELEACEAE			
Synaptolepis kirkii Oliv.	Mkatu	Small shrub or climber	SR
Species name	**Vern. Name**	**Notes**	**Reference**
TILIACEAE			
Grewia plasiocarpa K. Schum.	-	Shrub	M - sr

Grewia stuhlmannii K. Schum.	Mfukufuku	Shrub or liana forming bush	BN - fi
Triumfetta rhomboidea Jacq.	Mchokochole	Woody herb	M-sr
ULMACEAE			
Trema orientalis (L.) BI.	Mpesi	Small tree	SR
VERBENACEAE			
Avicennia marina (Forssk.) Vierh	Mchu	Mangrove tree	SR
Clerodendrum glabrum E.Mey.	Mtozatoza mlanyuni	Shrub	M - sr
Clerodendrum hildebrandtii Vatke		Shrub; coastal bushland	M - sr
Premna obtusifolia R. Br.		Shrub common in coral rock forest	RMH 2728
Stachytaphytta urticifolia Sims	Kikwayakwaya	Invasive herb	M - sr
Tectona grandis L.f.	Msaji	Introduced timber tree (teak tree)	SR
Vitex doniana Sweet	Sweet –Mfuru, mfuu	Medium tree in open areas	SR
Vitex ferruginea Schum.			M - sr
VIOLACEAE			
Rinorea arborea (Thou.) Baill.	-	Trees in Coastal Kenya to Mozambique, Madagascar	BN 4327
VITACEAE			
Ampelocissus africana (Lour.) Merr.		Liana; coastal forest on coral rock	M - sr
Cisssus integrifolia (Bak.) Planch.		Climber in forest margins. New record for Pemba	BN 4327
Cissus oliveri Gilg		Climber, not in FTEA for Pemba & is high altitude species	RMH 2666
Cissus quadrangularis L.var. *quadrangularis*		Succulent liana with winged stem segment	BN 4345
*Cissus rotundifolia (*Forssk.) Vahl.var. *rotundifolia*		Vigorous climber	M - sr
Cyphostemma sp.		Climber in coral rock forest	M - sr
Rhoicissus revoilii Planch.		Climber	BN - fi
Rhoicissus tridentata (L.f.) Wild & Drum.		Climber	BN - fi

MONOTCOTYLEDONS

ALOACEAE			
Species name	**Vern. Name**	**Notes**	**Reference**
Aloe massawana Reynolds	Mshubiri-mwitu	Succulent herb, new for Pemba	M - sr
AMARYLLIDACEAE			
Scadoxus multiflorus (Martyn) Raf.	Yungimanga	Herb	SR
ARACEAE			
Culcasia orientalis Mayo		Climber	SR
Gonatopus boivinii (Decne.) Engl.		Herb	SR
Species name	**Vern. Name**	**Notes**	**Reference**
Typhonodorum lindleyanum Schott		Herb; restricted to Madagascar and Pemba, Unguja	SR
Zamioculcas zamiifolia (Lodd.) Engl.	Wangadume	Herb	SR
BROMELIACEAE			
Ananas comosus (L.) Merr. var.	Mnanasi pori	Herb, is endemic	SR

nov.			
COMMELINACEAE			
Commelina diffusa Burm...f.		Herb	RMH 2695
Murdannia axillaries Brenan		Herb	RMH 2698
CYPERACEAE – the sedges (after Haines et al. 1983)			
Cyperus erectus (Schum.) Mattf. & Kuk. Not in Haines (1983) at low attitudes		Perrenial with creeping rhizome on seasonal wet ponds	M - sr
Cyperus macranthus Boeck		in ponds	M - sr
Cyperus prolifer Lam. ssp. *isoclados* Kukenth		Perrenial in permament wet ponds and swamps	RMH 2756
Cyperus polystachyus Rottb.var.*laxiflorus* (Benth.) K. Lye		Tufted perennial in dry ponds	M - sr
Cyperus tenax Boeck. var *tenax*			RMH 2754
Eleocharis acutangula (Roxb.) Schult.		Annual in seasonal and permanent pools	RMH 2741
Eleocharis geniculata (L.) Roem. & Schult.		Annual in seasonal ponds and streams	RMH 2742
Fimbristylis longiculmis Steud.		Tufted perennial in ponds	RMH 2737
Fuirena clavisetta Poir.		Perennial in open swamps' edges.	RMH 2732
Fuirena ochreata Kunth.		Common in swamps	M - sr
Fuirena umbellata Rottb.			RMH 2729
Cyperus lanceolata Poir.			RMH 2733
Cyperus mundtii (Nees) Kunth.		Perrenial	RMH 2730
Rhynchospora candida (Nees) Boeck			RMH 2740
DIOSCAREACEAE			
Dioscorea sansibarensis Pax	Mchochoni, Ndiga, Vikwa	Wild yam, climber; new record for Pemba	BN 4314
FLAGELLARIACEAE			
Flagellaria guineensis Schum.	Mkalamu, Mpelewa	Climbing shrub	M - sr
GRAMINEAE – the grass family			
Imperata cylindrical (L.) Raeuschel	Msufi wa bara, moto moto	Worst perrenial in cultivated land	sr
Olyra latifolia L.		Weed in damaged forest	RMH 2665
Oplismenus sp.			SR
Panicum brevifolium L.			M – sr
Panicum laticomum Nees			RMH 2652
Panicum parvifolium L.			RMH 2753
Panicum subflabellatum Stapf			RMH 2738
Paspalum vaginatum Sw.			RMH 2736
Pseudoechinolaena polystachya (Kunth.) Stapf			RMH 2726
Sacciolepis curvata (L.) Chase			M – sr
Schizachyrium rupestre (K. Schum.) Stapf			RMH 2755
Setaria megaphylla (Steud.) Th. Dur. & Schinz			FTEA
Stenotaphrum dimidiatum (L.) Brongn.	Pemba grass	Native of Pemba fodder, and effective cover in supprg weeds	SR
Vetiveria nigritiana (Benth.) Stapf		Fragrants in scent making	RMH –sr
LILIACEAE			
Species name	**Vern. Name**	**Notes**	**Reference**
Asparagus falcatus L.	Kinywele	Climber	SR
Chlorophytum sp.			M – sr
Dracaen deremensis Engl.		Small shrub of high forest, also coral rag forest. New recordfor Pemba	RHM 4363
Dracaena laxissima Engl.	Mpelwa	Sarmentose shrub	RHM 26
Sansevieria conspicua N.E Br.	Mkonge pori	Succulent herb in coastal thicket	SR
MUSACEAE			

Ensete sp. *near proboscideum* (Oliv.) Cheesm = Musa acuminata colla	Mgombatumbili	Wild banana; endemic to Ngezi Forest; A vulnerable species	BN 4362
ORCHIDACEAE – the orchids			
Acampe sp.			RMH - sr
Aerangis hologlottis (Schltr.) Schltr.			RMH 2787
Aerangis kirkii (Reichb.f.) Schltr.			RMH 2765
Bulbophyllum sp.			RMH – sr
Calanthe sylvatica (Thou.) Lindley		New record for Pemba	RS
Disperis johnstonii Rolfe		Small terrestrial orchid. New record for Pemba	BN 4367
Eulophia s.p.			BN 4333
Nervilia umbrosa (Reichb.f.) Schltr.		Small terrestrial orchid	BN 4335
Vanilla roscheri Reichb.	Mvanila	Liana	SR
Vanilla zanzibarensis	Mvanila	Leafless creeper with aerial roots clinging on tree stems, rocks, scattered hard elliptic leaves	SR
PALMAE			
Calamus deesratus G. Mann & H. Wendl. (Its identity needs confirmation) prob. calamus	Scipionum lour.	Spiny climber. Cane for walking sticks	M – sr
Chrysalidocarpus pembanus Moore	Mpapindi	Medium-sized palm tree. Endemic to Ngezi forest. A vulnerable species.	BN 4387
Elaeis guineensis Jacq.	Mchikichi	The oil palm (occurs wild)	RMH 2662
Phoenix reclinata Jacq.	Mkindu	The wild date palm	RMH 2661
Raphia farinifera (Gaertn) Hyland [*Raphia ruffia*]	Mwale	The Raffia palm; forms stands in swamps	BN- fi
PANDANACEAE			
Pandanus kirkii Rendle	Msariaka	The beach screw pine	SR
SMILACACEAE			
Smilax anceps Willd. [S.kraussiana]	Mkekewa	Spiny climber	SR
XYRIDACEAE			
Xyris anceps Lam.		Small aquatic or swamp species in Erica bush land	BN 4338
ZINGIBERACEAE			
Aframomum angustifolium (Senn.) K.Schum.	Matunguu	Herb in moist sites	RMH 2667
Costus sarmentosus Bojer	Vitunguu dume	Herb	RS

Appendix 1b: Relative densities and relative frequency

Transect No.1 Herbs

Species name	R.D	R.F
Adenia rumicifolia	2.31	3.57
Antiaris toxicaria	5.78	1.79
Artocarpus heterophyllus	0.58	1.79
Barringtonia racemosa	2.89	1.79
Blighia unijugata	1.16	3.57
Bombax rhodognaphalon	0.58	1.79
Chassalia umbraticola	1.16	3.57
Cissus integrifolia	0.58	1.79
Cremaspora triflora	1.73	3.57
Culcasia orientalis	1.73	5.36
Cyperus renschii	2.89	3.57
Dioscorea sansibarensis	1.16	1.79
Diospyros consolatae	1.16	1.79
Elaeis farinifera	2.89	1.79
Erythrophloeum suaveolens	0.58	1.79
Flagellaria guineensis	1.73	3.57
Garcinia livingstonei	2.89	1.79
Landolfia kirkii	13.29	5.36
Mangifera indica	1.73	3.57
Olyra latifolia	0.58	1.79
Oncinotis tenuiloba	0.58	1.79
Polyscias fulva	0.58	1.79
Polysphaeria parvifolia	0.58	1.79
Pouteria brevipes	4.05	5.36
Rawsonia lucida	6.36	3.57
Smilax anceps	0.58	1.79
Sorindeia madagascariensis	1.73	1.79
Stenotaphrum dimidiatum	5.78	1.79
Strophanhus engleri	3.47	1.79
Tabernaemontana ventricosa	0.58	1.79
Thelypteris totta	5.78	5.36
Whitfieldia elongata	5.20	3.57
Zammioculas zamiifolia	13.87	8.93

Transect No.2 Herbs

Species name	R.D	R.F
Zammioculcas zamiifolia	47.31	19.23
Flagellaria guineensis	6.45	7.69
Landolfia kirkii	6.45	11.54
Adenia rumicifolia	5.38	3.85
Sansevieria conspicua	5.38	3.85
Phymatosarus scolopendria	5.38	3.85
Cremaspora triflora	5.38	3.85
Calanthe sylvatica	2.15	3.85
Haplocoelum inoploeum	2.15	7.69
Chassalia umbraticola	2.15	3.85
Terminalia boivinii	2.15	3.85
Diospyros consolatae	2.15	3.85
Gonatopus boivinii	1.08	3.85
Garcinia livingstonei	1.08	3.85
Heinsia zanzibarica	1.08	3.85
Culcasia orientalis	1.08	3.85
Vernonia hildebrandtii	1.08	3.85

Transect No.2 Shrubs

Species name	R.D	R.F
Cremaspora triflora	14.89	10
Pouteria brevipes	12.77	10
Rawsonia lucida	12.77	10
Cordia alliodora	10.64	5
Costus tomentosus	8.51	5
Salacia madagascariensis	6.38	5
Erythrophloeum suaveolens	6.36	5
Chassalia umbraticola	4.26	5
Tabernaemontana ventricosa	4.26	5
Tabebuia pentaphylla	4.26	5
Dracaena laxissima	2.13	5
Quassia undulate	2.13	5
Tetracera littoralis	2.13	5
Landolfia kirkii	2.13	5
Whitfieldia elongate	2.13	5
Antiaris toxicaria	2.13	5
Citrus aurantifolia	2.13	5

Transect No.3 Shrubs

Species name	R.D	R.F
Heinsia zanzibarica	9.76	5.77
Uvaria sp.nov.	9.76	5.77
Chassalia umbraticola	8.54	7.69
Salacia madagascariensis	7.32	7.69
Landolfia kirkii	4.88	7.69
Tarenna pavettoides	4.88	1.92
Cremaspora triflora	3.66	5.77
Psychotria sp.	3.66	1.92
Leptactina platyphylla	3.66	1.92
Polysphaeria parvifolia	3.66	1.92
Pyrostria bibracteata	3.66	1.92
Sorindeia madagascariensis	3.66	1.92
Flagellaria guineensis	2.44	3.85
Boureria petiolaris	2.44	1.92
Tetracera littoralis	1.22	1.92

Saba comorensis	1.22	1.92
Garcinia livingstonei	1.22	1.92
Annona senegalensis	1.22	1.92
Rauvolfia mombasiana	1.22	1.92
Blighia unijugata	1.22	1.92
Cissus rotundifolia	1.22	1.92
Ludia mauritiana	1.22	1.92
Maytenus senegalensis	1.22	1.92
Caesalpinia volkensii	1.22	1.92
Grewia forbesii	1.22	1.92
Strophanthus zimmermannii	1.22	1.92
Dioscorea sansibarensis	1.22	1.92
Rhoicissus sp.	1.22	1.92
Keetia zanzibarica	1.22	1.92
Flueggia virosa	1.22	1.92
Diospyros consolatae	1.22	1.92
Haplocoelum inoploeum	1.22	1.92

Transect No.3 Herbs

Species name	**R.D**	**R.F**
Asystasia gangetica	27.08	15
Phymatosorus scolopendria	19.79	10
Stenotaphrum dimidiatum	15.63	10
Rawsonia lucida	15.63	5
Terminalia boivinii	8.33	5
Diospyros mespiliformis	2.08	5
Sorindeia madagascariensis	2.08	5
Sansevieria sp	1.04	5
Cyphostemma sp	1.04	5
Barringtonia racemosa	1.04	5
Garcinia livingstonei	1.04	5
Cremaspora triflora	1.04	5
Smilax anceps	1.04	5
Sideroxylon inerme	1.04	5
Kyllinga (Cyperus) sp.	1.04	5

Transect No.4 Herbs

Species name	**R.D**	**R.F**
Phymatosorus scolopendria	44.19	21.43
Nephrolepis biserrata	16.28	7.14
Haplocoelum inoploeum	9.30	7.14
Synaptolepis kirkii	6.98	14.29
Polysphaeria parvifolia	4.65	7.14
Garcinia livingstonei	4.65	7.14
Flagellaria guineensis	4.65	7.14
Sophora tomentosa	2.33	7.14
Ochna thomasiana	2.33	7.14
Asplenium sp.	2.33	7.14
Pyrostria bibracteata	2.33	7.14

Transect no.4 Shrubs: Relative Density & Frequence

Species name	**R.D**	**R.F**
Clerodendrum glabra	23.33	11.11
Barringtonia racemosa	20.00	5.56
Sophora tomentosa	8.33	5.56
Terminalia cattapa	6.67	5.56
Pandanus kirkii	5.00	5.56
Afzelia quanzensis	5.00	5.56
Salacia madagascariensis	5.00	5.56
Pavetta sp.	3.33	5.56

Rawsonia lucida	3.33	5.56
Allophylus pervillei	3.33	5.56
Maytenus heterophylla	3.33	5.56
Antidesma venosum	3.33	5.56
Ludia mauritiana	1.67	5.56
Lantana camara	1.67	5.56
Syzygium cuminii	3.33	5.56
Boureria petiolaris	1.67	5.56
Terminalia boivinii	1.67	5.56

Transect no.5 Herbs: Relative Density & Frequence

Species name	**R.D**	**R.F**
Asystasia gangetica	22.22	10
Cremaspora triflora	13.33	10
Ludia mauritiana	13.33	10
Phymatosorus scolopendria	11.11	10
Garcinia livingstonei	11.11	10
Haplocoelum inoploeum	8.89	10
Pandanus kirkii	6.67	10
Zammioculcas zamiifolia	6.67	20
Strychnos hemningsii	6.67	10
Salacia madagascariensis	6.67	10

Transect no.5 Shrubs: Relative Density & Frequence

Species name	**R.D**	**R.F**
Cremaspora triflora	21.21	6.25
Ludia mauritiana	15.15	6.25
Mystroxylum aethiopicum	9.09	6.25
Haplocoelum inoploeum	9.09	6.25
Manilkara sansibarensis	6.06	6.25
Suregada zanzibariensis	6.06	6.25
Pyrostria bibracteata	6.06	6.25
Rhoicissus sp.	3.03	6.25
Flagellaria guineensis	3.03	6.25
Acridocarpus zanzibaricus	3.03	6.25
Salacia madagascariensis	3.03	6.25
Uvaria ssp.nov	3.03	6.25
Keetia zanzibarica	3.03	6.25
Cissus rotundifolia	3.03	6.25
Cissus quadrangularis	3.03	6.25
Grewia sp	3.03	6.25

Transect no. 1 Plots 1 – 8: Trees Relative Density and Frequence

Species Name	**RD**	**RF**
Polyscias fulva	0.71	2.63
Bombax rhodognaphalon	5.03	5.26
Croton syslvatiens	1.07	3.94
Chrysalidocarpus pembanus	23.02	5.26
Alangium salviifoia	0.35	1.31
Pouteria brevipes	5.39	7.89
Antiaris toxicaria	6.47	5.26
Quassia undulata	8.27	5.26
Elaeis guineensis	4.67	7.89
Drypetes natalensis	0.71	1.31
Leptactina platyphylla	0.35	1.31
Tabernaemontana pachysiphon	0.71	2.63
Milicia excelsa	1.43	3.94
Rawsonia lucida	0.71	2.63
Uapaca guineensis	5.39	3.94
Artocarpus heterophyllus	0.35	1.31

Cremaspora triflora	0.71	1.31
Erythrophloeum suaveolens	4.31	3.94
Vitex doniana	1.79	2.63
Syzygium cordatum	4.31	1.31
Raphia farinifera	0.71	1.31
Parinari curattelifolia	0.35	1.31
Rauvolfia mombasiana	0.71	1.31
Sorindeia madagascariensis	1.07	2.63
Tabernaemontana ventricosa	0.71	2.63
Muivuivu	0.35	1.31
Hibiscus tiliaceus	0.35	1.31
Blighia unijugata	0.71	2.63
Macaranga capensis	1.43	2.63
Terminalia ivorensis	0.35	1.31
Pouteria msolo	1,07	1.31
Barringtonia racemosa	26.61	2.63
Funtumia africana	0.35	1.31
Lannea schweinfurthii	0.35	1.31
Garcinia livingtonii	1.07	1.31
Trema orientalis	0.71	1.31

Transect no. 2 Plots 1 – 3: Trees Relative Density and Frequence

Species Name	**RD**	**RF**
Olea woodiana	1.78	3.33
Terminalia ivorensis	4.46	3.33
Leptactina platyphylla	0.89	3.33
Artocarpus heterophyllus	0.89	3.33
Antidesma venosum	0.89	3.33
Terminalia catappa	1.78	3.33
Tabebuia pentaphylla	1.78	3.33
Chrysalidocarpus pembanus	3.57	3.33
Antiaris toxicaria	14.28	6.66
Pouteria brevipes	0.89	3.33
Alangium salviifolia	0.89	3.33
Croton sylvaticus	0.89	3.33
Quassia undulata	0.89	3.33
Milicia excelsa	2.67	10.0
Cordia alliodora	38.39	6.66
Tectona grandis	3.57	3.33
Mangifera indica	0.89	3.33
Quassia undulata	8.03	3.33
Polyscias fulva	0.89	3.33
Rauvolfia mombasiana	0.89	3.33
Elaeis guineensis	0.89	3.33
Tabernaemonta ventricosa	1.78	3.33
Sorindera madagascariensis	0.89	3.33
Cordia aliodora	4.46	3.33
Cedrella mexicana	3.57	3.33

T3 P1

Species Name	**RD**	**RF**
Bridelia micrantha	2.36	2.56
Terminalia catappa	1.55	5.12
Calophyllum inophyllum	3.14	5.12
Syzygium cuminii	1.55	2.56
Afzelia quanzensis	10.23	2.56
Haplocoelum inoploeum	16.53	10.25
Cussonia zimmermannii	14.57	5.12
Milicia excelsa	1.57	5.12
Erythrophloeum suavelens	3.93	5.12
Blighia unijugata	0.78	2.56

Chrysalidocarpus pembanus	16.53	5.12
Lannea schweinfurthii	1.57	5.12
Cremaspora triflora	0.78	2.56
Bourreria petiolaris	0.78	2.56
Pouteria brevipes	3.93	2.56
Blighia unijugata	0.78	2.56
Croton sylvaticus	0.78	2.56
Elaeis guineensis	0.78	2.56
Sorindeia madagascariensis	2.36	5.12
Antiaris toxicaria	0.78	2.56
Diosypyros consolatae	3.93	2.56
Adansonia digitata	1.57	2.56
Voacanga africana	0.78	2.56
Ficus lutea	0.78	2.56
Terminalia boivinii	0.78	2.56
Manilkara sulcata	1.57	2.56

T5P1 Dry coastal forest on sandy soils

Species Name	**RD**	**RF**
Afzelia quanzensis	13.3	9.8
Ficus lutea	0.74	1.96
Casuarina equisetifolia	2.96	3.92
Sideroxylon inerme	12.59	5.88
Mwingajini	0.74	1.96
Sorindeia madagascariensis	1.48	3.92
Diospyros consolatae	0.74	1.96
Ludia mauritiana	0.74	1.96
Pndanus kirikii	3.70	1.96
Barringtonia racemosa	2.22	1.96
Terminalia catappa	0.74	1.96
Bourreria petiolaris	0.74	1.96
Ficus lutea	0.74	1.96
Psychotria sp.	5.92	3.92
Drypetes natalensis	3.70	3.92
Lannea schweinfurthii	2.22	3.92
Terminalia boivinii	0.74	1.96
Manilkara sansibarensis	17.03	7.84
Brexia madagascariensis	0.74	1.96
Vitex doniana	0.74	1.96
Syzygium cordatum	6.66	7.84
Chrysalidocarpus pembanus	8.88	3.92
Olea woodiana	1.48	3.92
Sp.x	0.74	1.96
Ficus scasselatii	1.48	3.92
Diospyros consolatae	2.96	3.92
Rauvolfia mombasiana	0.74	1.96
Vitex ferruginea	0.74	1.96
Casearia gladiiformis	2.96	3.92
Pandus kirikii	0.74	1.96
Maytenus senegalensis	0.74	1.96

T6 P1 Chokaani

Species Name	**RD**	**RF**
Voacanga africana	4.0	11.11
Haplocoelum inoploeum	18.0	11.11
Terminalia boivinii	8.0	5.55
Manilkara sansibarensis	8.0	5.55
Adansonia digitata	4.0	5.55
Bourreria petilaris	4.0	11.11
Manilkara sulcata	2.0	5.55
Cussonia zimmermannii	6.0	11.11

Diospyros consolatae	8.0	11.11
Sorindeia madagascariensis	30.0	5.55
Pandanus kirkii	2.0	5.55
Allophylus pervillei	4.0	5.55
Syzygium cordatum	2.0	5.55

Appendix 2: Reported plant species and their main uses in the studied villages around Ngezi forest, Pemba

S/N	Local name	Scientific name	FREQUENCY OF USE							FREQUENCY OF TISSUE USED					
			Timber proeuction	Fooe eg juice, fruits	Builеing materials	Fuel wooe	medicine	hanecrafts e.g baskets, mikeka na makawa	construction of fishing vessels	fruit	stem	roots	leaves	branches	seeds
1	Mbambakofi	**Afzelia quanzensis**	38	4	2	54	0	0	4	2	54	0	1	34	0
2	Mbungo	*Saba comorensis*	1	59	0	0	1	0	1	0	1	0	0	0	0
3	Mbugu														
4	Mchekundu		0	0	3	1	1	0	0	1	3	0	0	0	0
5	Mchenza mwitu	*Kapaca guineensis*	10	3	6	30	2	1	0	2	25	0	3	21	1
6	Mchi		0	0	2	0	0	1	0	1	3	0	0	0	0
7	Mchikichi		4	4	32	2	1	3	1	0	7	1	22	13	4
8	Mchocha		9	22	10	42	1	4	3	26	42	1	1	31	2
9	Mchongoma	*Flocourtia indica*	0	0	0	0	1	0	0	0	0	1	0	0	0
10	Mdalidali		0	0	0	0	2	0	0	0	1	1	0	0	0
11	Mdamdam	*Harungana madagasariensis*	1	0	1	4	0	0	0	0	3	0	1	2	0
12	Mfenesi	*Artocarpus hetorophyllus*	45	58	1	24	0	0	3	58	55	0	2	20	0
13	Mfuu	*Vitex doniana*	17	8	2	19	0	0	0	9	20	0	0	6	2
14	Mgomba tumbili	*Musa acuminata*	0	0	0	0	1	0	0	1	0	0	0	0	0
15	Mgulele	*Antiaris toxicaria*	2	0	0	3	0	0	1	0	3	0	0	1	0
16	Mibale		0	0	2	0	0	1	0	0	0	0	3	0	0
17	Mibungo		0	12	1	0	1	0	0	70	4	0	0	0	2
18	Mibura	*Pasinani curatellifolia*	0	3	2	9	2	0	0	3	9	2	0	3	0
19	Mikali		1	4	0	1	0	0	0	4	2	0	0	0	0
20	Mikanja	*Cremaspora trifolia*	1	1	17	21	4	0	0	1	37	1	1	21	0
21	Mipo		2	19	0	0	0	0	0	16	3	0	0	0	1

S/N	Local name	Scientific name	FREQUENCY OF USE							FREQUENCY OF TISSUE USED					
			Timber proeuction	Fooe eg juice, fruits	Buileing materials	Fuel wooe	medicine	hanecrafts e.g baskets, mikeka na makawa	construction of fishing vessels	fruit	stem	roots	leaves	branches	seeds
22	Mivinje	**Casuarina equisetifolia**	2	0	6	11	2	0	1	0	1	0	0	0	0
23	Mjafari	*Drypetes natalensis*	0	0	0	0	62	0	1	1	1	2	0	1	0
24	Mkandaa		3	1	13	53	5	0	0	2	66	0	2	40	1
25	Mkarati	*Bridelia micrantha*	23	1	1	22	0	0	2	1	29	0	0	8	0
26	Mkindu		0	0	9	0	0	63	0	1	2	1	70	2	0
27	Mkoko		0	0	1	2	4	0	0	2	5	1	1	1	0
28	Mkorosho	*Anacardium occidentales*	2	2	2	2	0	0	0	2	2	0	0	0	0
29	Mkungu	*Terminalia catappa*	45	41	4	50	0	1	1	42	59	0	1	28	1
30	Mkuu kilemba		5	0	5	21	0	0	0	0	14	0	0	16	0
31	Mkwamba	*Margaritaria discoidea*	0	0	0	1	0	0	0	0	1	0	0	0	0
32	Mlimau	*Citrus limonn*	0	2	0	4	0	0	0	1	3	0	0	2	0
33	Mnamia maji		0	0	0	1	4	0	0	0	0	0	4	0	0
34	Mnanasi mwitu		0	1	0	0	0	0	0	1	0	0	0	0	0
35	Mninga	*Pterocarpus angolensis*	1	0	0	1	0	0	0	0	2	0	0	0	0
36	Mnyungwa-tambuu		0	0	0	0	2	0	0	0	0	1	0	0	0
37	Mpera Mwitu	*Racosonia indica*	0	4	0	5	1	0	0	4	4	0	1	3	0
38	Mpilipili	*Lorindeia madagascariensis*	0	1	0	6	0	0	0	0	1	0	0	6	0
39	Mpopoo		0	0	1	0	0	0	0	1	0	0	1	0	0
40	Mranga makele		0	0	0	2	0	0	0	0	1	0	1	1	0
41	Msaji	*Tectona grandis*	2	0	0	2	0	0	0	0	3	0	0	1	0
42	Msasa	*Ficus exasperata*	1	0	0	0	0	0	1	0	1	0	0	0	0
43	Mshubili-mwitu		0	0	0	0	9	0	0	0	0	7	1	1	0
44	Msikundazi		2	0	1	2	0	0	1	0	1	0	0	1	0
45	Msinduzi	*Croton sylvaticus*	0	0	0	2	78	0	0	0	75	38	1	0	0

S/N	Local name	Scientific name	FREQUENCY OF USE							FREQUENCY OF TISSUE USED					
			Timber proeuction	Fooe eg juice, fruits	Buileing materials	Fuel wooe	medicine	hanecrafts e.g baskets, mikeka na makawa	construction of fishing vessels	fruit	stem	roots	leaves	branches	seeds
46	Msisi	*Tiliacora funifera*	11	1	0	15	1	0	0	0	14	0	2	11	0
47	Msoo	*Scutia myntina*	4	1	1	0	37	0	1	0	0	38	0	0	0
48	Msufi	*Ceiba petandra*	0	0	0	1	0	2	1	1	1	1	0	0	1
49	Mtanda-kaanga		0	0	0	0	2	0	0	1	1	0	0	0	0
50	Mti maziwa		0	0	0	1	0	0	0	0	0	0	0	1	0
51	Mtondoo	*Calophyllum inophyllum*	37	0	3	29	0	0	8	2	40	0	0	20	2
52	Mtonga	*Funtumia africana*	21	4	1	38	36	0	0	45	31	1	1	37	3
53	Mtoria		0	2	1	0	1	0	0	2	1	0	0	0	0
54	Muale	*Raphia faninifera*	0	0	6	2	0	8	1	0	5	0	9	3	0
55	Muhina-mwitu		0	0	0	0	2	0	0	0	0	2	0	0	0
56	Muivuivu		0	0	1	3	0	1	0	1	5	0	0	1	0
57	**Muuje**	***Strychnos angolensis***	0	0	0	0	2	0	0	0	0	0	1	1	0
58	Mvinje	*Casuarina equisitifolia*	2	0	1	0	1	0	0						
59	Mvule	*Milicia excelsa*	42	0	0	16	0	0	0	5	41	0	0	9	1
60	Mvunja shoka	*Dicrostachys cinerea*	1	1	0	3	3	0	0	0	5	0	2	1	0
61	Mwambo		2	2	2	5	0	0	0	2	8	0	0	4	0
62	Mwarobaini	*Azadarachta indica*	2	0	0	5	32	0	0	0	41	12	14	6	1
63	Mwavi		41	1	0	40	1	0	0	1	42	0	0	28	0
64	Mwembe	*Mangifera indica*	322	572	4	1263	147	251	414	87	77	0	1	40	2
65	Mwembe mwitu		7	2	10	17	0	0	1	1	20	0	1	9	2
66	Mwezi upande		0	0	0	0	1	0	0	0	0	1	1	0	0
67	Mzambarau	*Sygygium cuminii*	46	48	1	67	0	0	2	54	70	0	4	31	3
68	Mzambarau samli		3	8	0	6	2	0	0	5	8	0	0	7	0
69	mziwaziwa	*Euphobia hirta*	0	0	0	1	0	0	0	0	1	0	0	1	0
70	Ndaamba		0	0	0	1	0	0	0						

Appendix 3: A checklist of mammals recorded at Ngezi forest reserve and the surroundings, Pemba

Family/Species	Common name	Previous records	Present study	Status
Soricidae				
Crocidura fuscomurina	Zanzibar Tiny Musk Shrew	x	-	
Crocidura sp.			x	
Pteropodidae				
Eidolon helvum	Straw-coloured Fruit Bat	x	-	
Epomophorus wahlbergi	Wahlberg's Epauletted Fruit Bat	x	-	
Pteropus voeltzkowi	Pemba Flying Fox	x	x	Endemic
Rousettus aegyptiacus	Egyptian Fruit Bat	x	x	
Emballonuridae				
Coleura afra	African Sheath-tailed Bat	x	-	
Hipposideridae				
Hipposideros commersoni	Giant African Leaf-nosed Bat	x	x	
Hipposideros rubber	Noack's Leaf-nosed Bat	x	x	
Molossidae				
Chaerephon pumila	Little Free-tailed Bat	x	-	
Mops brachypterus	Peter's Free-tailed Bat	x	-	
Chaerephon limbatus		x		
Nycteridae				
Nycteris grandis	Large Slit-faced Bat	x	-	
Rhinolophidae				
Rhinolophus hildebrandti eloguens		x		
Rhinolophus deckeni	Decken's Horseshoe Bat???	x		
Rhinolophus swinnyi	Swinny's Horseshoe Bat	x		
Vespertilionidae				
Pipistrellus nanus	Banana Bat	x	-	
Scotophilus dinganii	African Yellow House Bat	x	x	
Cercopithecidae				
Cercopithecus aethiops	Pemba green monkey	x	x	

Family/Species	Common name	Previous records	Present study	Status
Cercopithecidae				
Otolemur garnettii	Small-eared Greater Galago	x	x	
Colobus badius kirkii	Zanzibar red colobus	x	x	Introduced
Herpestidae				
Atilax paludinosus	Marsh (Water) Mongoose	x	x	
Viverridae				
Viverricula indica	Small Indian Civet	x	-	Introduced species
Mustelidae				
Aonyx capensis	Cape Clawless Otter	-	x	New record for Pemba
Procaviidae				
Dendrohyrax validus	East African Tree Hyrax	x	x	*D. v. neumanni* endemic to Z,P
Bovidae				
Cephalophus harveyi	Harvey's (Red Forest) Duiker	x		
Cephalophus monticola	Blue Duiker	x	x	*C. monticola pembae* endemic to P
Sus scrofa	Wild Boar	x	-	Introduced Feral animals reported to breed
Muridae				
Mus musculus	Common House Mouse	x	-	Introduced
Rattus rattus	Black Rat	x	x	Introduced

Appendix 4: A checklist of birds recorded at Ngezi Forest Reserve and the surroundings, Pemba Island. Legend: Vag. = Vagarant species, M. = Migratory species (based on Pakenham, 1979), x = presence, - = not recorded during the survey.

Family/Species	Common name	Previuos record	Present study	Status
SULIDAE				
Morus capensis	Cape Gannet	x	-	Vag
PHALACROCORACIDAE				
Phalacrocorax africanus	Long-tailed Cormorant	x	x	Vag
Family/Species	**Common name**	**Previous records**	**Present study**	**Status**
ARDEIDAE				
Ixobrychus minutus	Little Bittern	x	-	
Gorsachius leuconotus	White-backed Night Heron	x	-	M
Ardeola ralloides	Squacco Heron	x	-	M
Ardeola idea	Madagascar Squacco Heron	x	-	Vag
Bubulcus ibis	Cattle Egret	x	x	
Butorides striatus	Green-backed Heron	x	-	
Egretta alba	Great White Egret	x	-	
Ardea purpurea	Purple Heron	x	x	
Ardea cinerea	Grey Heron	x	x	
Ardea melanocephala	Black-headed Heron	x	x	
CICONIIDAE				
Anastomus lamelligeus	Open-billed Stork	x		Vag
Ciconia episcopus	Woolly-necked Stork	x	-	
THRESKIORNITHIDAE				
Bostrychia hagedash	Hadada Ibis	x	x	
PHOENICOPTERIDAE				
Phoenicopterus ruber	Greater Flamingo	x	-	Vag
ANATIDAE				
Dendrocygna viduata	White-faced Whistling Duck	x	x	Vag
Thalassornis leuconotus	White-backed Duck	x	-	
Nettapus auritus	Pygmy Goose	x	x	
ACCIPITRIDAE				
Macheiramphus alcinus	Bat Hawk	x	-	
Elanus caeruleus	Black-shouldered Kite			
Milvus migrans	Black Kite (y billed)	x	-	
Haliaeetus vocifer	Fish Eagle	x	-	
Gypohierax angolensis	Palm-nut Vulture	x	x	
Polyboroides radiatus	Gymnogene	x	x	
Circus aeruginosus	Eurasian Marsh Harrier	x	x	Vag
Circus macrourus	Pallid Harrier	x	-	Vag
Circus pygargus	Montagu's Harrier	x	-	Vag
Accipiter melanoleucus	Great Sparrowhawk	x	-	

Accipiter tachiro	African Goshawk	x	x	
PANDIONIDAE				
Pandion haliaetus	Osprey	x	-	M
FALCONIDAE				
Falco naumanni	Lesser Kestrel	x	-	Vag
Falco tinnunculus	Common Kestrel	x	-	
Family/Species	**Common name**	**Previous records**	**Present study**	**Status**
Falco dickinsoni	Dickinson's Kestrel	x	x	Endemic
Falco amurensis	Amur Falcon	x	-	Vag
PHASIANIDAE				
Coturnix delegorguei	Harlequin Quail	x	-	Vag
Coturnix adansonii	Blue Quail	x	-	
NUMIDIDAE				
Numida meleagris	Helmeted Guineafowl	x	x	
TURNICIDAE				
Turnix sylvatica	Common Button-quail	x	-	
RALLIDAE				
Sarothrura elegans	Buff-spotted Flufftail	x	-	
Sarothrura rufa	Red-chested Flufftail	x	-	
Amaurornis flavirostra	Black Crake	x	x	
Gallinula chloropus	Common Moorhen	x	x	
JACANIDAE				
Actophilornis africanus	Jacana	x	x	
ROSTRATULIDAE				
Rostratula benghalensis	Painted Snipe	x	-	Vag
HAEMATOPODIDAE				
Haematopus ostralegus	Euasian Oystercatcher	x	-	M
DROMADIDAE				
Dromas ardeola	Crab-plover	x	-	M
BURHINIDAE				
Burhinus vermiculatus	Water Thicknee	x	x	
CHARADRIIDAE				
Charadrius hiaticula	Ringed Plover	x	-	M
Charadrius leschenaultii	Greater Sandplover	x	-	M
Pluvialis squatorola	Grey Plover	x	-	M

Vanellus lugubris	Senegal Plover			
SCOLOPACIDAE				
Gallinago media	Great Snipe	x	-	M
Numenius phaeopus	Whimbrel	x	-	M
Family/Species	**Common name**	**Previous records**	**Present study**	**Status**
Numenius arquata	Eurasian Curlew	x	-	M
Tringa nebularia	Common Greenshank	x	-	M
Tringa ochropus	Green Sandpiper	x	-	M
Tringa glareola	Wood Sandpiper	x	-	M
Xenus cinereus	Terek Sandpiper	x	-	M
Actitis hypoleucos	Common Sandpiper	x	-	M
Arenaria interpres	Turnstone	x	-	M
Calidris alba	Sanderling	x	-	M
Calidris minuta	Little Stint	x	-	M
Calidris ferruginea	Curlew Sandpiper	x	-	M
LARIDAE				
Larus hemprichii	Sooty Gull	x	x	M
Larus fuscus	Lesser Black-backed Gull	x		M
Sterna bergii	Greater Crested Tern	x	x	Vag
Sterna bengalensis	Lesser Crested Tern	x	--	M
Sterna dougallii	Roseate Tern	x	-	Vag
Sterna fuscata	Sooty Tern	x	-	Vag
COLUMBIDAE				
Streptopelia semitorquata	Red-eyed Dove	x	x	
Turtur chalcospilos	Emerald-spotted Wood Dove	x	x	
Turtur afer	Blue-spotted Wood Dove	x	-	
Turtur tympanistria	Tambourine Dove	x	x	
Treron pembaensis	Pemba Green Pigeon	x	x	
PSITTACIDAE				
Poicephalus cryptoxanthus	Brown-headed Parrot	x	x	
CUCULIDAE				
Chrysococcyx caprius	Didric Cuckoo	x	x	
Ceuthmochares aereus	Yellowbill	x		
Centropus superciliosus	White-browed Coucal	x	x	
TYTONIDAE				
Tyto alba	Barn Owl	x	x	
STRIGIDAE				
Otus pembae	Pemba scops Owl	x	x	
CAPRIMULGIDAE				
Caprimulgus fossii	Gabon Nightjar	x	x	

APODIDAE				
Cypsiurus parvus	Palm Swift	x	x	
Apus affinis	Little Swift	x	x	
Family/Species	**Common name**	**Previous records**	**Present study**	**Status**
ALCEDINIDAE				
Corythornis cristata	Malachite Kingfisher	x	x	
Ceyx picta	Pygmy Kingfisher	x	x	
Halcyon leucocephala	Chestnut-bellied Kingfisher	x	-	Vag
Halcyon senegaloides	Mangrove Kingfisher	x	x	
Ceryle rudis	Pied Kingfisher	x	x	
MEROPIDAE				
Merops superciliosus	Madagascar Bee-eater	x	-	
Merops persicus	Blue-cheeked Bee-eater	x	x	M
CORACIIDAE				
Coracias caudata	Lilac-breasted Roller	x	-	
Eurystomus glacurus	Broad-billed Roller	x	x	M
UPUPIDAE				
Upupa africana	African Hoopoe	x	-	M
BUCEROTIDAE				
Tockus alboterminatus	Crowned Hornbill	x	x	
HIRUNDINIDAE				
Phedina borbonica	Mascarene Martin	x	-	vag
Hirundo abyssinica	Lesser Striped Swallow	x	x	
Hirundo smithii	Wire-tailed Swallow	x	x	
MOTACILLIDAE				
Motacilla flava	Yellow Wagtail	x	-	M
Motacilla aguimp	African Pied Wagtail	x	x	Vag
Anthus cinnamomeus	African Pipit	x	x	
TURDIDAE				
Oenanthe isabellina	Isabelline Wheatear	x	-	Vag
SYLVIIDAE				
Acrocephalus arundinaceus	Great Reed Warbler	x	-	Vag
Acrocephalus Boeticatus	African Reed Warbler	x	-	
Acrocephalus gracilirostris	Lesser Swamp Warbler	x	-	
Acrocephalus rufescens	Greater Swamp Warbler	x	-	
Cisticola juncidis	Zitting Cisticola	x	-	

Family/Species	Common name	Previous records	Present study	Status
MUSCICAPIDAE				
Muscicapa striata	Spotted Flycatcher	x	x	M
Terpsiphone viridis	Paradise Flycatcher	x	x	
TIMALIIDAE				
Trichastoma rufipennis	Pale-breasted Illadopsis	x	-	
NECTARINIIDAE				
Nectarinia olivacea	Olive Sunbird	x	x	
Nectarinia senegalensis	Scarlet-chested Sunbird	x	x	
Nectarinia pembae	Pemba Sunbird	x	x	
ZOSTEROPIDAE				
Zosterops vaughani	Pemba White-eye	x	x	Endemic
ORIOLIDAE				
Oriolus oriolus	Golden Oriole	x	-	M
Oriolus larvatus	Black-headed Oriole	x	x	M
LANIIDAE				
Lanius collurio	Red-backed Shrike	x	-	M
DICRURIDAE				
Dicrurus adsimilis	Fork-tailed Drongo	x	x	
CORVIDAE				
Corvus albus	Pied Crow	x	x	
STURNIDAE				
Cinnyricinclus leucogaster	Violet-backed Starling	-	x	New record
Lamprotornis corruscus	Black-breasted Glossy Starling	x	x	
PLOCEIDAE				
Passer griseus	Grey-headed Sparrow	x	-	
Euplectes hordeaceus	Black-winged Red Bishop	x	-	
Anomalospiza imberbis	Parasitic Weaver	x	-	
Ambylospiza albifrons	Grosbeak Weaver	x	-	
ESTRILDIDAE				
Mandingoa nitidula	Green-backed Twinspot	x	-	
Amandava subflava	Zebra Waxbill	x	-	
Lonchura cucullata	Bronze Mannikin	x	x	
Family/Species	**Common name**	**Previous records**	**Present study**	**Status**

Lonchura bicolor	Black & White Mannikin	x	x	
Lonchura fringilloides	Magpie Mannikin		-	
Lonchura oryzivora	Java Sparrow	x	-	

Appendix 5: A checklist of reptiles recorded at Ngezi Forest Reserve and the surroundings, Pemba

Species	Common name	Previuos records	Present study	Status
Cheloniidae				
Chelonia mydas	Green Turtle	x	-	
Eretmochelys imbricata	Hawksbill Turtle	x	-	
Dermochelyidae				
Dermochelys coriacea	Leatherback Turtle	x	-	
Pelomudusidae				
Pelusios castanoides	Yellow-bellied Hinged Terrapin	x	x	
Gekkonidae				
Hemidactylus mabouia	Tropical House Gecko	x	x	
Hemidactylus platycephalus	Tree Gecko	x	-	
Lygodactylus capensis	Cape Dwarf Gecko	x	x	
Lygodactylus viscatus	Copal Dwarf Gecko	x	x	
Phelsuma abbotti	Pemba Day Gecko	x	x	Endemic
Scincidae				
Cryptoblepharus boutonii	Coral Rag Skink	x	x	
Lygosoma pembanum	Pemba Island Writhing Skink	x	x	Endemic
Mabuya albotaeniata	Pemba Island Skink	x	x	Endemic
Mabuya striata	Striped Skink	x	x	
Panaspis sp.	Lizard		x	New record
Chamaeleonidae				
Chamaeleo dilepis	Flap-necked Chameleon	x	-	
Typhlopidae				
Ramphotyphlops braminus	Flower-pot Blind Snake	x	-	
Rhinotyphlops pallidus	Zanzibar Blind Snake	x	-	
Leptotyphlopidae				
Leptotyphlops pembae	Pemba Worm Snake	x	x	Endemic
Leptotyphlops emini	Emin Pasha's Worm Snake	x	-	
Colubridae				
Dispholidus typus	Boomslang	x	x	
Lamprophis fuliginosus	Brown House Snake	x	x	
Lycophidion pembanum	Pemba Wolf Snake	x	-	Endemic
Natriciteres pembana	Pemba Marsh Snake	x	x	Endemic
Philothamnus semivariegatus	Spotted Bush Snake	x	x	
Elapidae				
Naja mossambica	Mozambique Spitting Cobra	x	x	

Appendix 6: A checklist of amphibians recorded at Ngezi forest reserve and the surroundings, Pemba

Species	Common Name	Previuos records	Present study	Status
ARTHROLEPTIDAE				
Schoutedenella xenodactyloides		-	x	New record
BUFONIDAE				
Bufo gutturalis	Guttural toad	x	x	
HYPEROLIIDAE				
Afrixalus fornasini	Fornasini's spiny reed frog	x	x	
Hyperolius sp.		-	x	New record
RANIDAE				
Amnirana galamensis	Galam white-lipped frog	x	x	
Phrynobatrachus acridoides	East African puddle frog	x	-	
Phrynobatrachus sp "*pakenhami*"?		x	x	Endemic
Ptychadena anchietae	Anchieta's ridged frog	x	x	
Ptychadena sp.		x	-	

Appendix 7a: Marine fish recorded in nine villages around Ngezi forest (4th January to 12th January 2005)

FAO Name	Family	Scientific name
Baelama Anchovy	Engraulidae	*Thryssa baelama*
Barlai flathead	Platycephalidae	*Platycephalus insidiator*
Barracuda	Sphyraenidae	*Sphyraena jello*
Big eye	Priacanthidae	*Priacanthus hamrur*
Big eye trevally	Carangidae	*Caranx sexfasciatus*
Black edged conger	Congridae	*Conger cinereus cinereus*
Black Marlin	Istiophoridae	*Makaira indica*
Blotch eye Soldier fish	Holocentridae	*Myrpristis murdjan*
Blue fin trevally	Carangidae	*Caranx melampygus*
Blue & Gold fusilier	Caesionidae	*Caesio caerulaureus*
Sharp tooth Cardinal	Apogonidae	*Cheilodipterus quinqueilineatus*
Stripped eel Catfish	Plotosidae	*Plotosus lineatus*
Cigar wrasse	Labridae	*Cheilio inermis*
Common dolphin	Coryphaenidae	*Coryphaena hippurus*
Cow fish	Ostraciidae	*Lactoria cornuta*
Croakers	Scianidae	*Johnnius dussumieri*
FAO Name	**Family**	**Scientific name**
Daisy parrotfish	Scaridae	*Scarus sordidus*
Dash dot got fish	Mullidae	*Parupeneus barberinus*
Devis anchovy	Engraulidae	*Stelephorus indicus*
Spotted Eagle Ray	Myliobatidae	*Aetobatus narinari*
Variegated Emperor	Lethrinidae	*Lethrinus variegatus*
Flora moray	Muraenidae	*Echidna nebulosa*
Frigate tuna	Scombridae	*Auxis thazard*
Butterfly Goby	Gobiidae	*Amblygobius albimaculatus*
Golden cardinal	Apogonidae	*Apogon aureus*
Great barracuda	Sphyraenidae	*Sphyraena barracuda*
Grouper	Serranidae	Cephalopholis miniata
Halfbeak	Hemiramphidae	*Hemiraphus far*
Half-moon triger fish	Monacanthidae	*Cantherhines melanopterus*
Hamphead wrasse	Labridae	*Cheillinus undulatus*
Hound needle	Belonidae	*Tylosurus crodilus crocodiuse*
Indian Mackerel	Scombridae	*Rastreliger kanagurta*
Jackfish	Carangidae	*Seriola revoliana*
Cutlassfish	Trichiuridae	*Trichiurus lepturus*
Leopard flounder	Bothidae	*Bothus pantherinus*

Lobster	Palinuridae	*Palinurus delagoae*
Lobster	Palinuridae	*Panulirus homarus*
Lemon shark	Carcharhinidae	*Negaprion acutidens*
Mackerel/Kawakawa	Scombridae	*Euthynnus affinis*
Mangrove Red snapper	Lutjanidae	*Lutjanus argentimaculatus*
Manta Ray	Mobulidae	*Manta birostris*
Sailfish	Istiophoridae	*Istiophorus platypterus*
Moorish Idol	Zanclidae	*Zanclus canescens*
Flathead Mullet	Mugilidae	*Mugil cephalus*
Blue spot Mullets	Mugilidae	*Valamugil seheli*
Octopus	Octopodidae	*Octopus macropus*
Queen coris	Labriidae	*Coris formosa*
Queen fish	Carangidae	*Scomberoides tol*
Rabbit fish	Siganidae	*Siganus sutor*
Red cornet fish	Fistulariidae	*Fistularia petimba*
Reef shark	Carcharhinidae	*Triaenodon obesus*
Round herring	Clupeidae	*Spratelloides gracilis*
FAO Name	**Family**	**Scientific name**
Sail fin Flying fish	Exocoetidae	*Parexocoetus brachypterus brachypterus*
Sardines	Clupeidae	*Sardinella gibbosa*
Sea grass parrot fish	Scaridae	*Leptoscarus vaigiensis*
Sea turtle	Cheloniidae	*curetta curetta*
Shrimps	Hippolytidae	*Exhippolysmata ensirostris*
Sickle fish	Drepanidae	*Drepane punctata*
Siderial moray	Muraenidae	*Siderea picta*
Silver biddy	Gerreidae	*Gerres oyena*
Silver moony	Monodactylidae	*Monodactylus argenteus*
Skipjack	Scombridae	*Katsuwonus pelamis*
Blue emperor	Lethrinidae	*Lethinus nebulosus*
Squids	Loliginidae	*Loligo duvaucelli*
Squids	Sepiidae	*Sepia pharaonis*
Sting ray	Dasyatidae	*Himantura uarnak*
Stone fish	Synanceiinae	*Synanceia verrucosa*
Sulfur goatfish	Mullidae	*Upenaus sulphureus*
Surgeonfish	Acanthuridae	*Ctenochaetus striatus*
Sweeper	Pempheridae	*Pempheris mangula*
Terrapins	Teraponidae	*Terapon jarbua*
Thin tail Thresher shark	Alopiidae	*Alopias vulpinus*
Black spot emperor	Lethinidae	*Lethrinus harak*
Tooth pony	Leognathidae	*Gazza minuta*

Black bar Trigger fish	Balistidae	*Rhinecanthus aculeatus*
Tropical Halfbeak	Hemirhaphidae	*Hyporhamphus affinis*
Turkey moray	Muraenidae	*Gmnothorax meleagris*
Unicorn fish	Acanthuridae	*Nasso brevirostris*
Vagabond butterfly fish	Chaetodontidae	*Chaetodon vegabundus*
Wahoo fish	Scombridae	*Acathocybium solandri*
White spot grouper	Serranidae	*Epinephelus caeruleopunctatus*
Yellow fin tuna	Scombridae	*Thunnus albacares*

Appendix 7b: Freshwater fishes around Ngezi forest

FAO Name	**Family**	**Scientific name**
African Catfish	Clariidae	*Clarias gariepinus*
Bonefish	Albulidae	*Albula vulpes*
Fresh water eel	Anguilidae	*Anguilla bicolor bicolor*
Sleepers	Gobiidae	*Eleostris fusca*
Ladyfish	Elopidae	*Elops machnata*

Appendix 8a: Butterflies sampled in six transects in Ngezi forest, Pemba

Species / Transect	T1	T2	T3	T4	T5	T6	Total
Family Acraeidae							
Acraea egina pembanus Kielland	1	0	0	0	0	1	2
Acraea encedon Linnaeus	1	5	0	0	0	3	9
Acraea natalica Boisduval	6	1	0	1	0	0	8
Acraea pseudolycia Butler	2	0	1	0	0	9	12
Family Danaidae							
Amauris niavius dominicus Linnaeus	0	0	0	0	1	1	2
Danaus chrysippus Linnaeus	0	2	0	0	0	0	2
Family Hesperiidae							
Spialia diomus Hopffer	0	0	0	0	0	1	1
Family Lycaenidae							
Leptotes sp.	0	1	0	0	0	0	1
Zizeeria knysna Trimen	3	5	0	1	1	0	10
Family Nymphalidae							
Bebearia orientis insularis Kielland	0	0	0	0	0	2	2
Byblia anvatara acheloia Boisduval	1	0	0	0	0	2	3
Charaxes varanes vologeses Mabille	0	0	0	1	0	0	1
Charaxes jahlusa Trimen	0	0	1	0	0	0	1
Cymothoe coranus Grose-Smith	4	0	1	9	9	0	23
Euphaedra neophron rydoni Howarth	0	0	0	0	2	0	2
Eurytela dryope Cramer	0	0	0	0	2	0	2
Euxanthe wakefieldi Ward	0	0	0	0	1	0	1
Hypolimnas misippus Linnaeus	1	0	0	0	0	0	1
Junonia oenone oenone Linnaeus	0	5	0	0	0	7	12
Lachnoptera iole ayresi Trimen	0	0	0	1	1	0	2
Phalanta phalanta aethiopica (Rothschild and Jordan)	0	0	0	0	0	1	1
Pseudacraea boisduvali pemba Kielland	0	0	0	0	0	2	2
Pseudacraea lucretia Cramer	1	0	0	0	0	3	4

Family Papilionidae							
Papilio demodocus Esper	0	0	0	0	0	1	1
Species / Transect	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**Total**
Princeps dardanus Brown	0	0	0	0	0	1	1
Family Pieridae							
Belenois thysa Hopffer	0	0	0	1	0	0	1
*Catopsilia florella*Fabricius	0	1	0	0	0	0	1
Colotis evippe Linnaeus	0	0	0	3	0	0	3
Eurema brigitta Cramer	2	0	0	1	0	0	3
Eurema hapale Mabille	7	0	0	4	2	0	13
Family Satyridae							
Bicyclus anynana anynana Butler	0	1	0	0	1	0	2
Bicyclus campinus Aurivillius	0	0	0	0	1	0	1
Melanitis leda africana Fruhstorfer	*0*	0	2	1	1	0	4
Ypthima rhodesiana Carcasson	*0*	0	0	0	0	1	1
Ypthima sp.	1	0	0	0	0	0	1
Total	**30**	**21**	**5**	**23**	**22**	**35**	**136**

Appendix 8b: Moths sampled in six transects in Ngezi forest, Pemba

Family / Transect	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**Total**
Arctiidae	12	6	0	4	7	20	49
Gelechiidae	0	0	0	0	1	0	1
Geometridae	4	9	4	5	5	5	32
Lasiocampidae	3	0	0	0	0	0	3
Noctuidae	31	13	9	4	2	10	69
Oecophoridae	0	0	0	0	2	1	3
Psychidae	0	0	0	1	0	0	1
Pterophoridae	0	0	1	0	0	0	1
Pyralidae	1	0	0	0	0	10	11
Sphingidae	1	0	0	0	0	1	2
Tineidae	0	0	0	0	1	0	1
Tortricidae	1	3	2	6	1	1	14
Zygaenidae	0	1	0	6	0	1	8
Total	**53**	**32**	**16**	**26**	**19**	**49**	**195**

Appendix 8c: Odonata sampled in six transects in Ngezi forest, Pemba

Species	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**Total**
Family Calopterygidae							
Phaon sp.	1	0	0	0	0	0	1
Family Coenagrionidae							
Enallagna sp.	4	17	10	4	4	2	41
Pseudagrion sp.	1	2	0	0	0	1	4
Family Libellulidae							
Notiothermis jonesi	1	0	0	0	0	0	1
Orthetrum julia	0	1	0	0	0	0	1
Palpopleura lucia	9	1	0	2	0	21	33
Tetrathermis sp.	0	1	0	0	0	4	5
Trithermis annulata	1	0	0	0	0	0	1
Zygonyx sp.	3	2	22	6	1	5	39
Unidentified Libellulidae	2	5	2	2	2	7	20
Total	**22**	**29**	**34**	**14**	**7**	**40**	**146**

Appendix 9a: Checklist of Lepidoptera (butterflies and Moths) from Ngezi Forest Reserve, Pemba (Key: * = First record in Pemba, ** = Endemic to Pemba, * = Endemic to Pemba and Zanzibar, f = forest-dependent species).**

ORDER LEPIDOPTERA

Family Acraeidae

Acraea egina pembanus Kielland***
Acraea encedon Linnaeus*
Acraea natalica Boisduval
Acraea pseudolycia Butler*

Family Danaidae

Amauris niavius dominicus Linnaeus[f]
Danaus chrysippus Linnaeus

Family Hesperiidae

Spialia diomus Hopffer*

Family Lycaenidae

Leptotes sp.
Zizeeria knysna Trimen*

Family Nymphalidae

Bebearia orientis insularis Kielland**[f]
Byblia anvatara acheloia Boisduval*
Charaxes varanes vologeses Mabille*
Charaxes jahlusa Trimen[f]
Cymothoe coranus Grose-Smith[f]
Euphaedra neophron rydoni Howarth**,[f]
Eurytela dryope Cramer[f]
Euxanthe wakefieldi Ward
Hypolimnas misippus Linnaeus
Junonia oenone oenone Linnaeus*
Lachnoptera iole ayresi Trimen[f]
Phalanta phalanta aethiopica (Rothschild and Jordan)
Pseudacraea boisduvali pemba Kielland**[f]
Pseudacraea lucretia Cramer[f]

Family Papilionidae

Papilio demodocus Esper
Princeps dardanus Brown[f]

Family Pieridae

Belenois thysa Hopffer
Catopsilia florella Fabricius
Colotis evippe Linnaeus
Eurema brigitta Cramer
Eurema hapale Mabille*

Family Satyridae

Bicyclus anynana anynana Butler*[f]
Bicyclus campinus Aurivillius*[f]
Melanitis leda africana Fruhstorfer
Ypthima rhodesiana Carcasson*
Ypthima sp.

Appendic 9b: Checklist of Odonata (Dragonflies and Damselflies) sampled from Ngezi forest, Pemba

Family Calopterygidae

Phaon sp.

Family Coenagrionidae

Enallagna sp.
Pseudagrion sp.

Family Libellulidae

Notiothermis jonesi
Orthetrum julia
Palpopleura lucia
Tetrathermis sp.
Trithermis annulata
Zygonyx sp.
Unidentified Libellulidae

Appendix 9c: Reported use of some animals and birds from Ngezi forest, Pemba

Local name	English name	Scientific name	Use
Bata maji	Ducks		Food
Popo wa Pemba	Pemba flying fox	*Pteropus voeltzkowi*	Food
Popo	Bats		Food
Chechele	Grey headed Paradise Flycatcher	*Terpsiphone viridis plumbeiceps*	Food
Chechele	Red winged Paradise Flycatcher	*Terpsiphone viridis ungujaensis*	Food
Chekea mwezi			none
Chonjwe	Marsh mongoose	*Atilax paludinosus rubescens*	Food
Chore	Broad-billed Roller	*Eurystomus glaucurus*	Food and Medicine
Chozi	Sunbird		Food
Fufu	White browed coucal	*Centropus superciliousus*	Food
Kanga mwitu	Guinea fowl		Food
Kifaumu			Food
Kima	Monkey		none
Kimapunju	Zanzibar red colobus	*Colobus badius kirkii*	Food
Kipanga	Kite		none
Kisharifu			none
Kituitui			none
Kobe	Brown terrapin	*Pelusios cataneus*	none
Koho/Bata mchikichi	Palm nut vulture	*Gypohierax angolensis*	Food
Komba	Greater bushbaby	*Otolemur garnettii*	Food

Kong'ho			Food
Korongo			Food
Kuku ziwa	Little grebe	*Tachybaptus ruficollis*	Food
Kunguru	Pied crow		Food
Kwarara	Hadada ibis	*Bostrychia hagedash*	Food
Kwau	Brown headed parrot	*Poicephalus cryptoxonthus*	Food
Kwembe	Crowned Hornbill	*Tockus alboterminatus*	Food
Manja	Pemba white eye	*Zosterops vaughani*	Food
Miramba	Starling		Food
Ngawa	Javan Civet	*Viverricula indica*	Food
Nguruwe	Wild boar	*Sus scrofa*	Food
Ninga	Green pigeon	*Treron pembaensis*	Food
Njiwa	Pigeon		Food
Nyoka	Snake		none
Paa/chesi	Pemba blue Duiker	*Cephalophus monticola pembae*	Food
Panya	Rat		none
Pelele	Zanzibar tree Hyrax	*Dendrohyrax validus neumanni*	Food and Medicine
Pugi	Tambourine dove	*Turtur tymphanistria*	Food
Salile			Food
Local name	**English name**	**Scientific name**	**Use**
Sauti			Food
Sorohombi			Food
Tumbili	Pemba Vervet monkey	*Cercopithscus aethiops*	Food and Medicine
Vihodi	Pemba scops owl	*Otus pembae*	Food
Vijimbi Msitu	Mangrove kingfisher	*Halcyon senegaloides*	Food