SERIKALI YA MAPINDUZI ZANZIBAR

CARE TANZANIA AND DEPARTMENT OF COMMERCIAL CROPS, FRUITS AND FORESTRY

JOZANI - CHWAKA BAY PROPOSED NATIONAL PARK BIODIVERSITY INVENTORY REPORT

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Executive Summary

A biodiversity inventory of Jozani - Chwaka proposed National Park was undertaken in June/July 2002. This area is internationally recognised together with the Eastern Arc Mountains and coastal forests as part of the global biodiversity hotspots. The inventory was preceded by a reconnaissance survey involving three members of the team from 23rd to 25th June 2002, which allowed them to see the study area and determine sampling plots. This was followed by fieldwork by eight team members from 29th June to 8th July 2002. 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. For medium and large mammals foot counts on line transects, night drives 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 pitfall traps, sweep nets, banana and light traps.

At least 291 vascular plant species belonging to 83 families were recorded in the survey area of which one species, *Monanthotaxis faulknerae* (Annonaceae), a climber, was a new record for Zanzibar. Two species of plants, a tree, *Acacia mangium* (Mimosaceae), an introduced species in the forest plantations and a climber *Agelaea setulosa* (Connaraceae), a near endemic species to coastal areas of Tanga and Kenya, not listed in the Flora of Tropical East Africa (FTEA) were detected during the survey. A tree *Burttdavya nyasica* (Rubiaceae) reported by Ruffo (1992) was also detected during the survey and does not appear in the FTEA (Rubiaceae Part II). A total of 28 species found in the study area are endemic or near endemic and 21 species are known to be threatened or endangered. Five endemic and near endemic plant species are also threatened or endangered: *Coffea pseudozanguebarie* and *Psychotria alsophyla* (Rubiaceae), *Mkilua fragrans*

(Annonaceae), *Pouteria alnifolia* var. s*aclenxii* (Sapotaceae), and *Xylotheca tettensis* var. *fissistyla* (Flacourtiaceae). Ten vegetation categories and soil features were identified including the swamp forest, *Albizia* dominated forest, evergreen mixed dry forest, dry bushland thicket, derived vegetation, salt marsh swamp grassland, shrubland, cotton soil grassland, forest plantations, and marine ecosystems. There are a number of alien plant species notably a palm *Areca catechu* (Palmae) already known to suppress indigenous vegetation growth. Invasive plants, vegetation clearing, and over-exploitation are the major threats to plant biodiversity in the Jozani area.

Mammals occur in most of the ten vegetation types in the study area with primates, prosimians, bushpigs and duikers being ubiquitous. The status of the Zanzibar leopard (*Panthera pardus adersi*) remains unclear, while bushpigs, Zanzibar Red Colobus, sykes monkeys and prosimians appeared to be relatively abundant. Small mammals appeared to be relatively abundant and widely distributed, particularly elephant shrews, shrews and squirrels. A total of 30 mammal species were recorded during the survey out of 48 species known to occur on Zanzibar. One rodent *Grammomys* sp. was a new record for Zanzibar. Seven mammal species are endemic or near endemic, and out of 24 animal species which are threatened or endangered on Zanzibar 14 are mammals. All seven mammalian species which are endemic or near endemic are also threatened or endangered. Five mammal species were introduced to Zanzibar and all of them are still found on the islands. Although their effects have not been determined species like House rat (*Rattus rattus*) and Common rat (*Rattus norvegicus*) are known pests and potential vectors of disease such as plague. About 25 reptile species were encountered during the survey mostly from opportunistic sampling. At least 44 reptiles are known to occur on Zanzibar and 10 of them are threatened or endangered. Two new reptile records for Zanzibar were obtained during the survey including the Tropical Girdled Lizard (*Cordylus tropidosternum*) and the Short-tailed Pigmy Chameleon (*Rhampholeon brevicaudatus*). One snake species *Rhamphotyphlops braminus* was introduced to Zanzibar as a stowaway but its current status is not known. Amphibians were very abundant and at least 19 species were recorded during the survey out of 27 species known to occur on Zanzibar. One new amphibian species has been discovered during this inventory possibly belonging to the genus *Kassina*. Details of the new species including its ecology are being sought to be used in description and classification. Three amphibian species Mlola Forest Toad (*Stephopaedes howelli*), Mozambique Ridged frog (*Ptychadena mossambica*) and Common Squeaker (*Athroleptis stenodactylus*) were new records for Zanzibar. Six amphibian species are endemic or near endemic, four to coastal forests and two to Zanzibar. At least 157 species of fish

are reported to occur in Chwaka Bay of which 24 are threatened or endangered, no fish species is endemic. Fish production is progressively declining in the area. At least 204 specimens of Lepidoptera and Odonata were collected including 21 new records for Zanzibar and two species endemic to Tanzania. The fauna is mostly threatened by hunting/exploitation, habitat loss and fragmentation, the small and declining populations paradigms and pollution.

Immediate measures need to be taken to conserve the rare, endemic, threatened, endangered and other species occurring inside the proposed national park 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 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 park.

1.0 INTRODUCTION

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.

As part of its strategy to conserve the biological diversity on the islands the Revolutionary Government of Zanzibar is in the process of creating Jozani-Chwaka Bay National Park. The Department of Commercial Crops, Fruits, and Forestry in collaboration with CARE Zanzibar intends to enhance the protection of Jozani forest by establishing a larger conservation unit 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 proposed national park area. The main areas of interest for the survey were on vegetation, mammals, reptiles, amphibians, fish and selected groups on invertebrates (refer to ToR later).

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. Zanzibar has been separated from the mainland Tanzania for about 10,000 - 15,000 years. During this time species have been evolving separately from their mainland counterparts. This has resulted in the presence of a number of new 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). The occurrence and conservation status of a number of already known species was assessed.

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 Jozani forest in Zanzibar and Ngezi forest in Pemba 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* (1996). There is a valuable information on fisheries resources from FAO/Department of Environment, Zanzibar (1999) on the integrated management and sustainable development of Zanzibar coast. Archer *et al.* (1991) conducted a fauna survey in Jozani forest.

1.2 Brief history of Jozani area

The western area of Jozani forest known as Unguja Ukuu is reported to be the first area of Zanzibar to be settled by migrants from Kisiju in mainland Tanzania. These people settled here even before the coming of the Arabs. They then spread to other areas and cultivated mainly coconut palms because the presence of coral rag could not allow them grow other crops due to shallow soils. The local people continued to occupy and manage the Jozani area up to the 1930s. The time between 1956 - 1960 was a transition period whereby initiatives were taken towards

establishing a forest reserve. These involved negotiations with Pete villagers, most of whom occupied the area in which it was intended to establish the forest reserve. The Jozani Forest Reserve was formerly established and gazetted in 1960 and covered 194 ha. In 1965 the FR was expanded to 590 ha. A further expansion was implemented in 1980 when it was expanded to 2,512 ha. A complete ban in consumptive use of forest trees was imposed in 1992 when removal of fallen trees from the reserve was banned.

2.0 THE SURVEY AREA

2.1 Location

The study area is located on the main Zanzibar Island (Unguja) (Map 1, Map 2) some 35 kilometers from Zanzibar town. It is situated between E 39° 34', S 6° 16' (Northwest corner) and 39° 45', S 6° 28' (Southeast corner).

2.2 Scope

The area of the Proposed Jozani-Chwaka Bay National Park (PJCNP) is 57.7 sq. km. This excludes the Mapopwe Village enclave whose area is 0.7 sq.km (see Map 2, Map 4). The Proposed National Park falls within the Unguja Kusini administrative Region and includes Kati and Kusini districts. The study area is within the following Shehias (wards): Cheju, Unguja Ukuu, Charawe, Chwaka and Jozani-Pete.

2.3 Accessibility

The Proposed National Park is located between two major tarmac roads. One tarmac road from Zanzibar town to Unguja Kusini Region through Tunguu passes through the southern part of the Proposed National Park. Another tarmac road from Zanzibar town through Dunga to Chwaka Bay passes through the northern part of the proposed national park. Between the two tarmac roads, there are interconnecting gravel roads running in north-south direction. One runs from Jendele to Mpirani through Kisomanga crossing the Proposed National Park. Another road runs from Jozani to Charawe on the eastern side forming the boundary on that side. From this road, there are a few roads generally running in an east-west direction. One such road goes to Wangwani salt marshes (see Map 2, Map 4).

2.4 Topography

Altitude in the proposed National Park ranges from sea level to around 31 meters on the western side of Kitongani village and southeastern part of Mapopwe village. Jozani forest has the lowest altitude point on Zanzibar Island (see the Digital Elevation Model Map 3).

2.5 Geology

The geology of the Jozani, Chwaka and surrounding areas is predominantly limestone formed during the Quaternary, through to the Miocene. Whereas the Jozani forest area is mainly comprised of Quaternary geologic formations, the remaining areas including Chwaka, Unguja Ukuu, Ukongoroni have a mixture of Quaternary and Miocene geologic formations. The

Quaternary rocks have a mixture of tropical laterites, limestone, fish bones, sharks teeth, garnets, kyanites and tourmalines. Their maximum thickness ranges from 25-35m. The Quaternary rocks range in colour from a complex of red, chocolate, brown to white cream and grey. The Miocene rocks are mainly rhythmic fluviatile sediments of the dissected Rufiji River delta. These include limestones, sandstones, marls, sandy clays and clayey sands in 5 meter bands. They also include lenses of crystalline limestone and anhydrite frequently with local ferruginous and siliceous cementing with a maximum thickness of 2560m. Modified Miocene rocks are hard, dense, pearly white with crystalline limestone in strata and lenses. Other Miocene rocks are grey, white, opaline, coarse or angular siliceous sands, lightly cemented. These can also be thick grey-green and dense, roughly sorted chalky rocks.

2.6 Soils

Soils are closely related to the parent rocks and geomorphology. However, since the forest and most of the surrounding areas are under coral rag, the soils are shallow and in many areas the rag is emergent. In the Quaternary parent rock areas the laterites, alluvials and colluvials are predominant with some areas covered with marine, fluviatite sands and sandstone. The Miocene soils are comprised mainly of rythmic fluviatite and deltaic sediments and limestones. There are also sands, sandstones with marls, sandy clays and clayey sands.

In forested areas the soils are mostly clay loam attaining black colouration due to humus. The forest soils are mostly damp or water logged in areas with a high water table. Patches of sandy soil appear in places like Pete where the soil is brown and in Unguja Ukuu where the sandy soils are grey. In the mangroves there is fine mud clay, black in colour though the substrata could be comprised of sand. The coastline in Chwaka is sandy but some areas are muddy, especially where mangroves are present.

2.7 Climate

The climate of Jozani forest and Chwaka Bay like other East African coastal areas is determined by geographical location and seasonal changes brought by the general circulation of air over the Indian Ocean. The monsoons have the dominant influence on wind direction and strength, temperature and rainfall. The northwest monsoon (*Kaskazi*) prevails from November to February and is characterised by high air temperatures of greater than 30^0C and weaker winds. The southeast monsoon (*Kusi*) lasts from April to September and is marked by lower air temperatures, approximately 25^0C, with stronger winds. Inter monsoon periods are calm. Rainfall in the

tropics depends mainly on the movements of the air masses that cover the globe. The heavy rains from March to May are brought about when the Intertropical Convergence Zone (ITCZ) is to the north of the equator; hence Tanzania receives the convection currents causing rain. The short rains in October are due to the ITCZ moving southwards from the Tropic of Capricorn. There are no rainfall records from Jozani and only recently has a rain gauge been installed at the station, however data recording is still not satisfactory. Rainfall data from Zanzibar is presented showing mean monthly rainfall for a period of 13 years (Figure 1). Zanzibar receives rain almost all year round and no month completely lacks rainfall. East Africa coastal islands receive the highest rainfall, with Pemba receiving the highest rain (2000mm/year) while Zanzibar receive on the average 1565mm/year (UNEP, 2001). In Jozani area the locals refer to the heavy rains as "*masika*" and the short rains as "*vuli*". Unreliable rainfall between the two main seasons is known as "*chororo*.

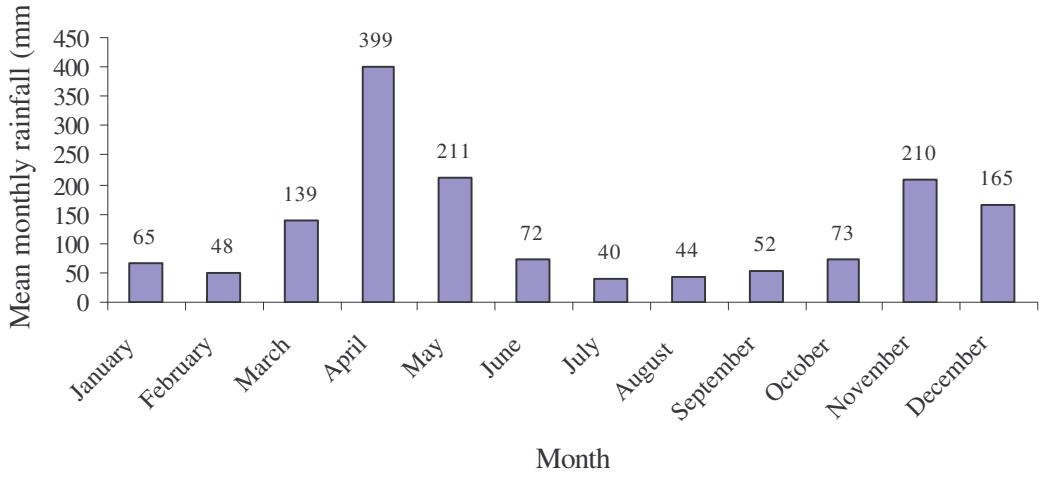

Figure 1: Mean monthly rainfall for Kisauni Airport Zanzibar for a period of 13 years (Source: TANRIC, UDSM)

2.8 Hydrology

The Quaternary geomorphology forms part of Zanzibar's corridor aquifer complex. Jozani area is reported to be the lowest in Zanzibar and the water table is generally high, often emerging above the ground surface forming springs and marshes. High water tables are also evident in areas with ground water forest. Some creeks in Charawe, Chwaka and Kichanga extend inland sometimes

joining marshes and springs. Apparently there are no rivers in the area, only drainage lines where water flows during rains. The area is generally flat and with only very gentle slopes in some areas. The average water table gradient is 0.004 whereas the annual water table recharge due to two wet seasons range from 1.67m per year in areas with Quaternary rocks to 3.27 to 7.91m per year in Miocene rock areas.

Water on the eastern coast shows increased chlorides due to wind blow sea spray and average total dissolved salts (TDS) ranges from 100 to 300mg/l. The water quality of Jozani and Cheju is slightly high with TDS ranging from 100 to 200mg/l. The limestones have little quality influence on water quality.

2.9 Vegetation

Biogeographically the flora of Zanzibar belongs to the Zanzibar-Inhambane regional centre of endemism (UNEP, 2001) which extends from Somalia to Mozambique coast. The proposed Jozani-Chwaka Bay National Park includes a wide range of discrete mappable vegetation communities with rare and endemic plant species. Ground-water forest occupies the central part enclosed by coral rag forests and bushland. Derived wooded grassland vegetation occurs in Mapopwe and Wangwani. Mangrove formations are well developed in Chwaka Bay to the north, and to a less extent in the southern end of the park.

2.10 Fauna

Because of their relatively small size compared to the mainland coastline, generally the number of species is fewer in Zanzibar and Pemba islands than on the mainland. Since their isolation from mainland Tanzania about 10,000 - 15,000 years ago a number of endemic and near endemic species and subspecies have envolved as a result of this geographical isolation. Due to the small size of the islands and habitat loss, large mammal species could not be supported. The largest mammal the Zanzibar leopard (carnivore) weights 50-82 kgs. and the red duiker (herbivore) weigh only 14 kgs. Not many biological studies have been conducted on Zanzibar and Jozani Forest in particular related to identification of species. Most of the medium to large sized animal species have been identified. So far not much has been done on identification of small terrestrial animals including mammals, reptiles and amphibians. There has been some emphasis in studying fisheries resources due to their importance in the Zanzibar economy and livelihood of the people.

2.11 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. Table 1 summarises the land use / habitat types in the proposed national park and surrounding areas. Most of the land in the survey area is used for forestry and wildlife conservation. Forestry includes both the natural forest and forest plantations. The protected area is also used for photographic tourism, nature trails and conservation activities. The Mapopwe enclave is used for settlement and agriculture as are most of the areas surrounding the Jozani forest reserve. Crops grown include coconuts, mangoes, oranges, lemons, cassava, potatoes and bananas. There are a number of activities including forest products exploitation, hunting, beekeeping and grazing some of them illegally conducted inside the forest. In Chwaka Bay fishing is the main activity, but seagrass farming and marine invertebrates collection is practiced. Harvesting of mangroves is observed in the coastal areas of Charawe, Ukongoroni and Chwaka.

The proposed Jozani-Chwaka National Park (Map 4) is dominated by bush lands (32.6 %). The western part, found at a higher altitude, is dominated by lower bushes (19.6) with few or no big trees. On the other hand, the eastern part is dominated by bushes with emergent trees (13 %). The area between bush lands forms a valley with mangroves (13.1 %) on the northern and southern parts. Between the mangroves are: *Diospyros* Forest (12.4 %), Ground Water Forest (9.6) and Salt Marshes (1.7). The area under cultivation (3.3 % i.e. palms, mango trees etc.) is located between Kitogani and Kaebona villages.

2.12 Human demography

There has been no census conducted since 1988 and most of the figures available are probably underestimates. The 1988 census indicated that population rate of increase in Zanzibar was 3.0% while human population density was 226 people/km^2 in Unguja and 269 people /km^2 in Pemba. The average household size was 4.7 people per household. Map 5a and Map 5b Show the human population density in the survey area by *Shehias* for 1988 and 2007 years respectively. Human densities for the year 2007 have been extrapolated based on 1988 population figures. Table 2

provides human population in villages surrounding the forest reserve in 1988 and projected to the year 2007.

Table 1: Area Statement: Proposed Jozani - Chwaka National Park, Zanzibar

Vegetation Type	Area		%
	sq.m	sq.km	
Albizia Dominated Forest	9,211,759	9.21	16.8
Bushland with Emergent Trees	7,100,182	7.10	13.0
Bushland	10,735,027	10.74	19.6
Derived Vegetation: Bracken Bush	778,770	0.78	1.4
Derived Vegetation: Wooded Grassland	1,137,127	1.14	2.1
Diospyros Forest	6,808,538	6.81	12.4
Ground Water Forest	5,261,116	5.26	9.6
Lake	6,562	0.01	0.0
Mixed Cropping	1,826,738	1.83	3.3
Mangrove	7,192,622	7.19	13.1
Ocean	3,332,920	3.33	6.1
Plantation	335,616	0.34	0.6
Sand Dunes	86,536	0.09	0.2
Salt Marshes	946,902	0.95	1.7
	54,760,415	**54.76**	**100.0**

Table 2: Human population from 1988 census and data projected to the year 2007 in villages surrounding Jozani - Chwaka proposed National Park, Zanzibar

Village	Human population	
	1988	**2007**
Bwejuu	2139	3005
Charawe	531	861
Cheju	596	710
Chwaka	1897	2765
Kibigiji	1817	2132
Marumbi	744	1203
Michamvi	501	704
Muungoni	1722	2708
Paje	1089	1487
Pete	543	812
Ukongoroni	596	937
Unguja Ukuu	2370	3228
Uroa	1551	2415
Uzi Ng'ambwa	2021	3020

3.0 METHODS

3.1 Vegetation sampling

Botanical assessment of Jozani-Chwaka Bay proposed National Park ecosystem was carried out in order to produce information relevant to the environment impacts. The study involved identification of vegetation types and the species diversity comprising the flora of the area. This procedure enables to expose the threatened and rare species of the area, and suggestions of any conservation measures for the rare and endangered species. The floristic survey at the study area adopted three approaches:

- Reconnaissance
- Sampling intensity comprising of vegetation data collection and structured questionnaires.
- Literature survey relevant to Jozani-Chwaka Bay proposed National Park.

3.1.1 Reconnaissance

This was carried out for 2 days (see also section 3.3.1) in order to identify different vegetation types and sites at which to establish sampling transects. Vegetation classification was based on the concepts of Greenway (1973) as modified by White (1983), Herlocker (1999) and Beentje (1994). This classification combines physiognomic and floristic criteria including the dominant species of the dominant stratum of the vegetation as follows:

Category	Life form	Height	Woody canopy cover	Herb cover	Vertical stratification
Forest	Trees	5 - 40 m	Closed, >80%	nil	1 - 2 storeys
Bushland and thickets	Shrubs with few emergent trees	Emergent trees 10 - 20 m	> 20% to closed	Little or nil	single or shrub layered
Wooded grassland	Stunted or dwarf trees	< 5 m except in clustered thickets		>80%	single
	Grasses - perennial - annual	25 - 100 cm < 10 cm			
Shrubland	Shrubs or dwarf shrubs to 2 m or clustred bushes	1 – 2m with emergent trees < 5m high.	Bushes >20% Open area <20%	Little or > 50%	Shrub entangled with lianas or climbers
Salt marsh	Grasses - perennial	< 50 cm	> 20%	> 90%	Homogenous cover
Mangrove formation	Trees and bushes on shores periodically flooded	5 – 25 m	> 20%	nil	1 - 2 storeys

This basic information was used to assess the different vegetation communities that were classified into 10 vegetation types as indicated in Table 1 in the results section.

3.1.2 Vegetation data collection

The classification and mapping of vegetation communities are the initial phases of ecological inventory. Sources of information include observations on, and measurements of species abundance, heights and diameter at breast height (DBH) for trees, how these attributes are influenced by the natural environment and by different types and intensities of land use practices. Eleven vegetation communities were recognized in this study area. Mangrove vegetation community was studied separately in another study.

During sampling at least one transect line was established for each vegetation community that was identified during reconnaissance except for grassland, mangrove vegetation, shrubland and marine vegetation. Shrubland and grassland were not studied quantitatively but their species compositions were enumerated on various randomly selected sites. The mangrove vegetation and marine vegetation (algae and seagrasses) were not quantitatively assesed because they have already been separately studied in other studies (Shunula, 1997; Mohammed, 1999). The data were collected using a Nested Quadrat Method (Stohlgren *et al,* 1995; Crawley, 1997). Along each transect, sample plots were fixed at 100m intervals and each rectangular plot of 50m x 20m dimensions contained sub-plots for sampling shrubs and herbs as indicated below.

Life Form	Fixed plot area	Length	Width	Definition
Herbs	$2.0m^2$	2.0m	0.5m	All forbs and grasses under 1.5m & all annuals
Shrubs	$10.0m^2$	5.0m	2.0m	Woody plants higher than 1.5m with dbh <10cm
Trees	$1000.0m^2$	50.0m	20.0m	Woody plants higher than 5.0m with dbh. $\geq$10cm

GPS readings were taken at each sample point but in the forest readings for some points could not be obtained due to forest shade and for such cases a gap or opening closest to the point was chosen where there was sufficient light.

All herbs and shrubs that occur within the sub-plots were recorded and the number of individuals for each species was counted. Trees were recorded and measurements included height and DBH for each individual. Where individual trees were multi-stemmed from below the breast height, each stem was measured as a separate individual.

Where new species encountered did not fall into the plots and subplot being sampled, the respective species were recorded for addition to the plant chek-list. Land-use and condition of the habitat were noted. Human threats to the forest reserve were assessed by noting fire incidences, tree felling, ring barking, root collections for medicinal use and foot paths leading to the forest. Plant specimens were collected and taken to herbarium of the Botany Department, University of Dar es Salaam for verification of names. They will serve as voucher specimens for future references. Mounted duplicates will be returned to Jozani museum.

Review of past botanical reports include Ruffo (1992), Mohammed (1999) and Pikkarainen (1991). Species concept of vascular plants follow Milne-Redhead, Polhill, Beentje *et al* (1952…). Consistence of vernacular names was confirmed with the field identifications and literature relevant to the flora (Ruffo, 1992; Williams, 1949).

3.1.3 Structured questionnaires and interviews

Information on the various uses of resources from the study area were collected by a structured questionnaire (Appendix IV) distributed to six villages surrounding the Jozani Forest Reserve. The villages included Unguja kuu, Charawe, Kitongani, Ukongoroni and the two conflict villages of Mapopwe and Pete. For some reasons the Ukongoroni village did not respond to the questionnaire. Further information was gathered during botanical field survey and through unstructured interviews with field guides who were among our key sources of information. Indigenous knowledge is useful in the planning for conservation and managemenr of the proposed national park. Actual field observations were useful in determining wood supplies to the villages and lorries carrying both building materials and fuelwood to urban areas were observed.

3.2 Vegetation 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.

3.3 Fauna inventory

3.3.1 Reconnaissance survey

A reconnaissance survey was undertaken from 23rd to 25th June 2002 as a preliminary site visit and scoping exercise. Three team members Dr. C. Nahonyo, Dr. C. Msuya and Mr. B Mwasumbi pariticipated in the survey. This enabled the team to familiarize with the area and identify the major vegetation types and decide on where and how many transects to establish. The area was traversed in all directions and was found to be relatively large. It was decided that transects would be established in the major habitats and vegetation types so as to be as representative of the area as possible. Logistical arrangements for the survey were also dealt with.

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. Due to the

large study area and time constraints transects were spaced to cater for both habitat and spatial distribution. Also due to a large gap in the knowledge of small mammals, amphibians and invertebrates in the study area the survey team concentrated much of its effort on the currently least known taxa and species. For the large and medium sized mammals which have been studied before and/or there is a substantial amount of information, the existing literature was used to provide information. Species diversity was calculated using the Shannon Weaver Index H' :

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

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 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, 1996).

Table 3: Description of transects used to sample plants, small mammals, reptiles, amphibians and invertebrates in Jozani - Chwaka proposed National Park, Zanzibar. GPS coordinates (using Garmin GPS 12x) for each transect were taken for future reference

Transect		GPS	Description
SN	Name		
1	Wangwani (Evergreen scrub forest/Coastal coral rag forest)	S 06° 13.552' E 039° 24.642'	Natural forest close to salt marshes, tall trees up to 10-25m high. Canopy cover c.60-100% in some areas with strata. Dry leaf litter cover 60-100%. No signs of harvesting. Soils fairly deep, dark brown. Coral rag conspicuous in some areas.
	Salt marsh grassland		Open salt resistant grassland with almost 100% cover and few emergent shrubs. *Typha* and mangroves downstream. High water table, black sandy-loam on top of rocks and in some places the sub surface is composed of sand
2	Wangwani (wooded grassland)	S 06° 13.563' E 039° 24.765'	*Annona senegalensis* bushes predominant c.4-4m high. Grass cover 85% wood vegetation cover 10-15%. Coral rag emergent common and conspicuous. Soil dark brown fairly deep mixed with coral rag

Transect		GPS	Description
SN	Name		
3	Bondeni (Evergreen scrub forest)	S 06° 15.017' E 039° 25.625'	Dry thicket/bushland canopy cover 50-100%, and dry leaf litter cover 20-90%. *Pandanus* dominant with lianes, climbers. Soil black brown loam, shallow to deep, mixed with coral rag. Trees and shrubs 5-12m high.
4	Jozani (Ground water forest plantation)	S 06° 16.273' E 039° 25.102'	Tall trees of *Callophylum inophyllum*, *Casuarina equesetifolia Eucalyptus* sp. up to 45m high with undergrowth of ferns. There are also *Pandanus rabaiensis* and *Raphia farinifera* and *Vites doniana* in some areas. High water table in usually brown-black sediment soil. Coral rag emergent in some places
5	Tovu/Mnazi Mmoja (Ground water natural forest)	S 06° 16.381' E 039° 25.355'	Tall trees some up to 50m high, dominated by *Pandanus, Raphia, Vitex, Elaeis* and *Anthrocleista*. Canopy cover 10-90% with layers. Leaf litter cover 50-100%. Some coral rag conspicuous, rocky sub surface, high water table, deep soil, black humid loam.
6	Unguja Ukuu (Forest plantation)	S 06° 15.422' E 039° 23.075'	*Casuarina* and *Acacia* spp. 15m high, with some natural vegetation regeneration. Dry leaf litter cover c.100%. Fairly deep brown loam soil. Coral rag not very conspicuous. Harvesting of poles and fuelwood
7	Mapopwe (Legume dominant natural forest)	S 06° 12.509' E 039° 23.403'	Dominated by *Albizia adianthifolia* and *Senna petersiana* with intermediate layers of *Mallotus.* Forest with layers, lianes and climbers, trees 15-50m high, canopy cover 50-90%. Dry leaf litter cover almost 100%. Coral rag prominent and highly conspicuous. Shallow soil of black loam. No signs of harvesting. Stone walls sign of past human presence.
8	Kichanga (Bushland and thicket)	S 06° 16' 38.5" E 039° 25' 36.3"	Thicket/bushland 5-10m high on mangrove forest edge. Thorny shrubs lianes and climbers. Coral rag emergent in some places. Soils top black loam, bottom brown loam fairly deep but with gravel, pebbles, no sign of harvesting.

3.3.2.1 Mammals

Large mammals were censused using foot counts on line transects selected from a baseline (Map 7). Animals encountered along the transects during censusing were counted and recorded. The perpendicular distance from the transect line was estimated. Since 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.

Night drives were also conducted to record presence of nocturnal animals which are difficult to sight during daytime. A total of 4 transects totaling 58km were surveyed from Jozani forest headquarters to Wangwani, Tovu and Unguja Ukuu. Animals sighted during the night drive were recorded.

3.3.2.2 Small mammals

The trapping of small mammals was done in all 8 transects (Table 3) described above. Specimen collection was done using three types of traps: bucket pitfalls, snap traps and live traps (Sherman 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 15 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 traps. Baits were replaced each day during trap inspection. Traps were inspected every morning during sampling time from around 7.00am to 11.00am since traplines were far spaced, all specimens found in the traps were identified and recorded. Specimens not able to be identified immediately were collected for later identification. The traps were also used to collect certain reptile species (see section 3.3.3) and amphibians (see section 3.3.4). Collected specimens were preserved in 70% alcohol, 10% formalin or skinned and sun dried. Specimens found alive during trap inspection and which could be identified were released near the place they were captured.

3.3.2.3 Reptiles

Due to the very low number of captures opportunistic sampling was used to obtain further information of species which were available in Jozani. Sightings of the reptiles were also recorded to give clues of occurrence and distribution in the area.

3.3.2.4 Amphibians

Most amphibian specimens were collected using bucket pitfall traps (see Section 3.3.2 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. Photographs of specimens were taken for identification.

3.3.2.5 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 Chwaka and the Fisheries Department in Zanzibar town. Some fishermen were interviewed and provided valuable information on fish, fishing gear, fish spawning areas and fish marketing.

3.3.2.6 Invertebrates

Butterflies and moths (Order Lepidoptera), and dragonflies and damselflies (Order Odonata) were sampled using three methods: (1) sweep nets, (2) light traps at night using a 11-Watt bulb and a white screen, and (3) a "Banana trap" for Butterflies. Sampling was done systematically so that the samples were comparable and therefore could be used for comparison of relative abundance. Sweeping during daylight and collecting at night were timed (5 minutes per sample for general sweeping, and 40 minutes per sample for butterflies and Odonata. Collecting at night took 50 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) Salt-water marsh (SM), (2) Natural Forest (NF) -S06^{0}13'25''E39^{0}24'35'', (3) Wooded grassland (WG) – S06^{0}13'32''E39^{0}24'43'', (4) Ground-water Forest Plantation (GFP) -S06^{0}16'02"E39^{0}25'10", (5) Ground-water Natural Forest (GFN) –S06^{0}15'02''E39^{0}24'42'', and (6) Thicket (THI) – S06^{0}16'11''E39^{0}24'24''. At each site a 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).

3.3.3 Legend to threatened and endangered species of flora and fauna

The IUCN redlist updated in 2000 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 Major habitat types and dominant species

The description of different vegetation units that were classified into 10 vegetation types or habitats is presented in Table 4. A general description of grassland, shrubland, marine (algae and seagrasses) and mangrove vegetation types are given though these were not quantitatively studied. Pikkarainen (1991) attempted to classify the Jozani vegetation into 8 vegetation types namely forest plantations, natural forest unexploited, secondary forest (following previous commercial harvesting), natural high forest (no longer used for commercial cutting), coastal evergreen thickets, salt marsh grassland, low forest and magrove forest. This classification system does not make clear distinctions especially as regards to what is a forest or bushland or thicket and completely omits wooded grassland and ground water forest. The concept used to define low forest and high forest is also not clear. Mohammed (1999) classifies the vegetation of Jozani-Chwaka bay proposed National Park in 7 vegetation types including groundwater forest, coastal evergreen thickets, mangrove forests, saline grasslands, algae and seagrass beds and forest plantations. This is an appropriate classification although no details are given as to what criteria were used to arrive at the categories. In this study we applied abundance scales and physiognomic concepts of Greenway (1973) and White (1983) in the determination of vegetation types of Jozani-Chwaka Bay proposed National Park. In our study the mangrove and algae/seagrass bed formations were not sampled but their floristic compositions are briefly described. We have treated bushland and thickets as one vegetation type (Burgess and Clarke, 2000) and the wooded grassland and the shrublands as separate units (Table 4).

Table 4: The units of vegetation classification as were observed in Jozani-Chwaka Bay proposed National Park

VEGETATION CATEGORIES AND MAIN EDAPHIC FEATURES	SPECIFICATIONS AND DEFINITIONS
1. Swamp forest (freshwater swamp forest of White, 1983) in permanently moist truncated valley bottom (Plates 1, 3, 16). Rock basement surface covered with a deep layer of decayed litter with high water table.	This topography is frequently interspersed with large and key emergent species. They are *Pandanus*, *Elaeis, Eugenia* and scattered trees of *Vitex*, *Anthocleista* and *Ficus* species. These species have trees 25 -35 m in height that constitute the canopy cover. *Ficus* species and *Vitex doniana* with largest dbh ranges dominate for trees and the shrub layer is dense in some spots while the ferns *Stenochlaena* and *Phymatodes* form the herb layer. Monodominant stands of *Pandanus rabaiensis* are causing some concern for conservation as the species is deemed to invade and suppress regeneration of other species (personal communication with Thabit). Another monocotyledonous tree of Jozani is *Raphia farinifera*. (White 1983, Greenway 1973).

VEGETATION CATEGORIES AND MAIN EDAPHIC FEATURES	SPECIFICATIONS AND DEFINITIONS
2. *Albizia* dominated forest, greater part covered by coral rock (Legume dominated forest of Burgess and Clarke 2000)	Closed canopy formation dominated by *Albizia adhianthifolia* with trees 30 - 35m high. Intermediate species include *Blighia unijugata,*and *Senna* species. The Caesalpinioideae dominated dry forest suggests relicts of the former Pan-african lowland forest shown to be stable with healthy understorey regeneration (Burgess and Clarke, 2000). *Mallotus opposifolia* is the most dominant middle canopy tree with density of about 47.5 stems.ha^{-1}. The habitat is the most vulnerable to fires, farming, hunting and grazing. The surface is moist, but leaf litter is thin. There are indications of former plot farms within the forest marked by ruins of long walls made of coral rocks. These were meant to prevent vermin (wild pigs) from entering the farms. It is considered a separate vegetation unit because the stands completely exclude other canopy dominant species in the next category. Many members of Caesalpinioideae produce seeds of short viability which do not tolerate dessication and are not dispersed by wind or birds (Burgess and Clarke, 2000). Clearance of such a forest affects regeneration potential.
3. Evergreen mixed dry forest or Mixed evergreen scrub forest of Burgess and Clarke, 2000 (Plates 23, 24).	Relatively moist surface (surface limestone developed on coral rock), represented by a mixed dominance of a few species which include *Diospyros consolatae* (most dominant), *Terminalia boivinii*, *Rapanea melanophloeus*, *Olea woodiana*, *Apodytes dimidiata*, *Mystroxylon aethiopicum*, *Maytenus mossambicensis*, *Ozoroa obovata* and *Sideroxylon inerme*. In shallow valley bottoms *Ficus sur* is common. Canopy height is 10-25m with few emergent trees. The structure is intermediate between the bushland and thicket category (below) with trees below 10m tall and forest canopy over 25m. White (1983) recognizes that scrub forest occurs as a narrow band separating Zanzibar-Inhambane forest from the Somali-Masai regional centre of endemism. Lianas are scarce or rare.
4. Dry bushland and thicket (Gillmann 1949, White, 1983)(Plates 4, 5).	This category is transitional to scrub forest and represents a dwarf bushland with clustered bushes on more xeric coral rock basement. The dominant species are the same as above, but the structure is different. It is dominated by shrubs with emergent trees to 10m. Thickets are well developed in shallow valley depressions with a thin layer of litter. *Afzelia quanzensis* occurs in this type of thickets. There are some indications of previous farming, thus representing secondary vegetation. Common emergent trees include *Maytenus mossambicensis*, *Mystroxylon aethiopicum*, *Apodytes dimidiata*, and *Diospyros consolatae*. All of these species occur in the previous category except that the trees are of smaller sizes (<10m high and DBH<10cm) and shrubs including *Diospyros*, *Polysphaeria, Pyrostria,* and *Maytenus* dominate over trees.
5.0 Derived vegetation	This includes derived woodland vegetation and fire induced barcken bush.
5.1 Derived wooded grassland. This is indicated as open gaps on topographic maps (Plates 7, 13)	This is secondary vegetation derived from previously fire-devastated vegetation. It is characterized by grouped tree and shrub bushes where *Bridelia micrantha* becomes widespread. In open grassland *Annona senegalensis* and *Ozoroa obovata* are widespread woody species, while *Hyparrhenia rufa* is the dominant grass. Elsewhere *Hyparrhenia* and the woody species of *Annona* and *Ozoroa* are absent but thicket bushes are dominated by *Psiadia arabica* and *Dodonea viscosa*.

VEGETATION CATEGORIES AND MAIN EDAPHIC FEATURES	SPECIFICATIONS AND DEFINITIONS
5.2. Fire induced bracken bush	This represents early successional stages of fire influences on vegetation. It is represented by a thick impenetrable bush cover of *Pteridium equilinum* which is a pioneer species with few emergents of *Bridelia micrantha* and *Ficus* species.The bracken acts as a pioneer in areas where the previous vegetation has been destroyed by fire. It produces toxins which retard seed germination of other plants but this obstacle breaks down later in the succession.
6. Salt marsh swamp grassland (Plates 6, 9)	*Paspalum vaginatum* forms dense cover to the exclusion of other grasses and herbs. A few woody species such as *Ficus sp* and *Pluchea dioscoridis* occur on scattered rocks covered with think soil mantles. Edges of the salt marsh are dominated by *Acrostichum aureum*, *Pluchea soridida* and scattered *Aframomum sp, Syzygium cumini, Pandanus kirkii* and *Phoenix reclinata*.
7. Shrubland (Plate 17)	It is located between Cheju and forest boundary on a higher elevation than the rest of the area. This vegetaion type was not quantitatively sampled but its species composition was enumerated on various randomly selected sites. The vegetation type is characterized by dwarf bushes with open spaces or clustered thickets. There are few emergent trees which include *Euclea racemosa* ssp *schimperii*, *Rapanea melanophloeos*, *Manilkara sansibarensis Bersama* sp. and *Diospyros consolatae*. There are also shrubs or small trees <4m high and these include *Annona senegalensis, Ozoroa obovata, Turraea floribunda*, *Dodonea angustifolia, Psiadia punctulata* and *Albizia pertersian.* Branched shrubs include *Rhus natalensis*, *Rhus vulgaris*, *Dichrostachys cinerea, Maytenus mossambicensis, Sideroxylon inerme*. The bushes are generally interwoven with climbers, lianas and twiners. These include *Synaptolepis, Jasminum fluminense*, *Rhoicissus revoilii, Ancylobotrys petersiana, Paulinia pinnata* and the twiners *Cassytha filiformis*.
8. Cotton soil grassland (Plate 21)	This spreads over in Cheju village outside the proposed national Park boundary. The land is relatively flat and fertile and crops include *Mangifera indica, Cocos nucifera, Carica papaya, Citrus aurantium*, *Manihot esculentap* and *Ipomea batata*. The flood plains are important for paddy. Natural land is covered with grass and scattered *Borassus aethiopicum*. There are patches of riverine forest. Cheju grassland is an important ecosystem for the existence of the proposed National Park. Many families who were living in Mapopwe village have moved to Cheju after Government ordered them not to perform any further activity in Mapopwe which was the source of charcoal, building poles, and grazing
9. Forest plantation	This includes forest plantations in the groundwater valley and on dry coral rock habitats.
9.1 *Calophyllum* plantation in groundwater valley (Plates 11, 12)	The *Calophyllum* plantation was established in 1950's and is found in groundwater valley, moister than surrounding slopes and ridge tops. The plantation was introduced to supply valuable trees of *Calophyllum inophyllum* with mixed trees of *Eucalyptus* and *Casuarina* sp. The tree canopy is 25-35m high without a medium canopy layer, but shrubs are represented by indigenous species of *Psychotria goetzei* and *Apodytes dimidiata*. The ground layer is covered with epiphytic *Polypodium scolopendria* and *Stenochlaena tennifolia*.
9.2 *Acacia* plantations (Plates 14, 15)	These plantations form almost pure stands with *Acacia mangium* and *A. auriculiformis* dominating the areas. Most trees have heights ranging between 5 and 10m. Isolated individuals of other trees such as *Bridelia micrantha, Annona senegalensis, Casuarina equisetifolia and Fius sur* are found mixed with *Acacia.*

VEGETATION CATEGORIES AND MAIN EDAPHIC FEATURES	SPECIFICATIONS AND DEFINITIONS
9.3 *Gmelina* plantation	The plantation is a dominated by *Gmelina arborea.* In some places a few individuals of *Rapanea melanophloes, Calophyllum inophylum, Apodytes dimidiata* and *Eucalyptus sp* are present**.**
9.4 *Casuarina* plantation (Plates 14, 15)	These are pure stands of *Casuarina equisetifolia* with individuals reaching a height of about 10m.
10. Marine ecosystem	This include mangrove formation, algae and seagrasses, open water body
10.1 Mangrove formation (Plates 18, 19, 20)	The mangrove ecosystem is confined on shores where the vigour of the surf is broken by sand bars or coral reefs, being most extensively developed on the deltas of large rivers such as Rufiji delta in the mainland or small bays such as Chwaka Bay. The mangrove flora of East Africa has a high diversity compared to the mangrove flora of West Africa. There are 9 mangrove species which include *Avicennia marina (*Family Avicenniaceae)*, Bruguiera gymnorrhiza* Family Rhizophoraceae) *Ceriops tagal* Family Rhizophoraceae) *Rhizophora mucronata* (Family Rhizophoraceae), *Sonneratia alba* (Family Sonneratiaceae), *Lumnitzera racemosa* (Family Combretaceae), *Hertiera littoralis* (Family Sterculiaceae) *Xylocarpus granatum* (Family Meliaceae) and *Xylocarpus moluscaensis* (Family Meliaceae). Associates of mangrove species occur at high water mark and these include *Barringtonia sp* and *Brexia madagascariensis* in Chwaka Bay. Landward the mangrove formation gradually fades into barren sand-flat where *Shaeda monoica* intermingles with *Arthrocnemum indicum*, *Salicornia sp* and grasses like *Sporobolus viriginius*, *Paspalum vaginatum*. All the above basic information applies also to Jozani-Chwaka Bay proposed National Park. *Paspalum vaginatum* for instance, forms a dense cover in Wangwani salt marsh. The details of this ecosystem have been dealt with under a separate study.
10.2 Algae and seegrasses	There are varieties of algae and seagrass species occurring in Chwaka Bay area. About 23 species of algae and 10 species of seagrass (Appendix VI) have been reported in Mohammed (1999).

The survey results show that habitat diversity in the proposed park is relatively high and probably higher compared to areas of similar size on the mainland coastal forests. Vegetation communities on Zanzibar are similar to those found in the coastal areas on the mainland at the same latitude. Zanzibar was separated from the mainland during the ice-age but the short distance separating the two areas can still allow dispersal of certain plant species (Moreau and Pakenham, 1941). The island communities have habitat suitability favouring species pre-adaptation (Begon *et al*, 1996). This is a genetic selection of the ancestors, which have a genetic fitness to survive under stress and different climatic conditions. The species pre-adaptation also involves the modification of the plant parts induced by the external conditions to suit the existing environment. However, due to the relatively short separation time, Zanzibar has not developed many endemic plant species. The diversified ecological habitats harbour genetic reservoir for numerous plants and unique habitats for the rare and endemic animal species such as the Zanzibar red colobus. For Zanzibar, the

Jozani forest is the only large remaining natural rainforest and its units are vital for *in situ* conservation of plant diversity in order to support and preserve a potentially useful gene pool and maintain ecosystem ecological stability. Different habitats will tend to have different threats hence zoning the park will be necessary, as different zones might need different management and conservation approaches due to the different biotic communities and physical characteristics present. A diversity of habitats also gives opportunity to have a broad range of ecotourism uses.

4.1.2 Floristic diversity and species list

A total of 291 plant species belonging to 83 families were recorded in Jozani-Chwaka Bay proposed National Park area (Appendix I). This is not an exhaustive species list due to time constraint which prevented a more detailed botanical survey. However, the figure gives an indication of the high floristic diversity possessed in the study area. The vascular plant groups are reprented as follows:

(i) Dicotyledons: 66 families, 187 genera and 248 species.

(ii) Monocotyledons: 9 families, 26 genera and 35 species.

(iii) Pteridophytes (ferns): 8 families, 8 genera and 8 species.

Out of the 291 vascular plant species recorded during the survey one species *Monanthotaxis faulknerae* (Annonaceae) a climber was a new record for Zanzibar. A tree *Acacia mangium* (Mimosaceae) an introduced species in the forest plantations and a climber *Agelaea setulosa* (Connaraceae) a near endemic species to coastal areas of Tanga and Kenya, are documented for the first time for Zanzibar as they do not appear in the Flora of Tropical East Africa (FTEA). A tree *Burttdavya nyasica* (Rubiaceae) was reported by Ruffo (1992) and during this survey was found in the groundwater forest but does not appear in the FTEA (Rubiaceae Part II).

Some factors influencing species richness on Zanzibar includes invasion of communities by pre-adaptive species (*Diospyros-Terminalia-Euclea-Manilkara-Encephalartus* associations) that evolved elsewhere on the mainland. The flora is limited to those types having ancestors that managed to disperse to the island (Begon *et al*., 1996).

The species richness and diversity at each site was assessed by the number of species in each growth form. The number of species in the herb layer was lowest (4 species) in the *Callophylum* plantation followed closely by the vegetation at the edge of mangrove, the two sites in the ground water forest and the salt marsh grassland (Appendix II). Each of the five sites had less than 10

herb species. The rest of the habitats showed a relatively high diversity with the highest number (16 species) recorded in the evergreen scrub forest, *Gmelina* plantation and the *Syzigium–Elaeis* dominant ground water forest. The low diversity in the herb layer of *Callophylum* plantation and similar habitats can be explained by lack of enough light at the floor of such vegetation resulting in dominance of shade loving species such as *Stenochlaena* and *Phymatodes* as was observed in most habitats with closed canopy. The *Albizia* dominated forest showed the highest number of species in the shrub layer followed by the scrub forest whereas the lowest number was recorded in the salt marsh swamp grassland and wooded grassland. The habitats with high number of shrubs may indicate a high regeneration process of the forest. The evergreen forest had highest diversity (24 species) of three species (Appendix III) and only tree species in the *Casuarina* plantation. This may imply that *Casuarina equisetifolia* has a suppressing effect on other species and is probably affecting the indigenous species.

4.1.3 Indicator species and tools to diagnose ecological condition

A forest is sound when it is able to sustain its structure in the face of regular and incidental natural disturbance. The main criterion for forest integrity is the occurrence of all species of organisms and age classes of all organisms in a particular proportion of social organization (Herlocker, 1999). The loss of a particular species is a symptom of poor forest condition. Fluctuating climatic conditions also affect the ecological condition and inflict vegetation changes. Results from this study shows that some species have declined or disappeared through harvesting such as *Croton sylvaticus* and *Burttdavya nyasica*. Decline in these species is of great concern for conservation especially of timber trees.

Indigenous timber tree species of *Milicia excelsa* and others have been reported from Jozani Forest, but the majority were not encountered during this study. *Callophylum inophyllum* was introduced to replenish timber production.

The species inventory and population composition are not adequate to evaluate ecological integrity (condition) for planning and management. It is laborious to make exhaustive inventory of species diversity and their relative population composition in order to evaluate ecological integrity for planning and management. For convenience, it is preferable to adopt new approaches, which rapidly assess forest integrity without detailed inventories of all major groups of forest species. However, this is a hypothesized approach to use rapid simple measurement of the appropriate set of indicators resulting in standardized approach techniques (Koop *et al*.,

1994). Ecological indicators are useful tools to appraise forest condition. There are three groups of ecological indicators to be considered:

i. Structural indicators

Natural vegetation is considered structurally stable when it is undisturbed. When a forest is disturbed through activities such as timber harvesting the condition of the forest integrity is also affected (Budowski, 1965). Forest structure indicators, therefore, define the reduced eclogical integrity of the habitat:

a) Basal area: The numbers of counted trees and their basal areas are indicated in Table 2. These values are relatively low in Jozani compared to the coastal forests on the mainland for most surveyed habitats except in ground water forest and in forest plantations. For example in the coastal forests on the mainland the average DBH (cm) and basal area (m^2/ha., in brackets) were 10-20 (0.118), 20-50 (0.528), and >50 (0.728) (Burgess and Clarke, 2001) respectively.

b) Tree diameter: The presence of large trees is taken as an indicator of mature forest. In this study trees with a diameter greater than 40cm were considered as relatively large and were recorded in transect 8 (ground water forest: *Pandanus-Elaeis* dominant), transect 9 (*Callophylum* plantation), transect 7 (ground water forest: *Areca catechu* dominant) transect 10 (edge of mangrove vegetation), transect 13 (ground water forest: *Syzigium & Eugenia* dominant), transect 17 (*Gmelina* plantation) and in transect 4 (evergreen scrub forest). Transects 11, 12 and 14 each had 1 tree with diameter over 40cm. However, among these trees only a few had diameters greater than 50cm, categorised by Smiet (1989) as big trees. This is relevant for Jozani because the forest has trees with DBH category of > 50 cm hence the concern for conservation and monitoring.

c) Tree height: Tree heights were estimated in 5 metre classes and the maximum height class was composed of trees with height greater than 25 m. Tall trees constituted 166 stems (7.6%) out of the sampled 2,170 trees. Most of these trees occurred in transects 9 (40%) and transect 7 (17.5%).

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 Jozani forest examples were sighted at Mapopwe and Unguja Ukuu areas where ruins of past

stone walls were seen indicating previous forest disturbance. The secondary forest in these areas was usually two layered.

e) Characteristic diameter distributions (Koop, 1989): Diameter distribution patterns in secondary forest (e.g. Figure 3 and in Table 2), tend to display a reverse J-shaped curve shown by the undisturbed forest. In Jozani the relationship of overall density to DBH follows the L - shaped curve whereby the lowest DBH class has the highest number of species, and the high DBH class has the lowest number of species, except for transect 9 a forest plantation under the monospecific genus *Callophyllum*. The diameter distribution of this transect shows a normal J - shaped curve suggesting that there is no forest stratification. In this forest plantation old individuals continue to increase in size and dominate the forest while few seedlings are recruited.

ii. Light indicator species

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

a) Indicative groups of pioneer tree species found in the gap formations: The indicative groups of pioneer tree species found in the study area include *Trema guineensis*, *Macaranga capensis* and *Mallotus opposifolia.*
b) Light demanding species: These include *Panicum trichocladum*, *Aframomum angustifolium* (ginger group), *Stenochlaena tenuifolium*, *Nephrolepis biserrata*, and *Phymatodes scolopendria.* The latter three belong to the fern group.

iii. Atmospheric moisture indicators

This indicator group refers to families of species indicating high atmospheric humidity e.g. the hanging *Usnea*, the epiphytic orchids of *Aerangis hologlotis* and *Microcoelia exilis* in bushland and thicket. No quantitative sampling was undertaken for these indicator groups.

Other direct ecological indicators are those of disturbance. These include cut stumps of trees, fire incidences, presence of footpaths leading to areas of destruction (pole cutting), burnt stumps and logs, exotic trees e.g. *Mangifera indica,* C*ocos nucifera* which indicate development stages of farming and settlements. Some species serve as ecological indicators for certain habitat

conditions. *Acrostichum aureum* and *Paspalum vaginatum* are indictors of saline conditions often associated with salt marsh. The percentage of canopy gaps is reflected by the frequency of light indicators. Mostly the gaps created in old growth are colonised by light indicators which eventually dominate.

4.1.4 Vegetation condition, quantitative description and assessment of species abundance

i) Trees basal area, density and dominance

The basal area calculated for each vegetation type separately (Table 5 & Fig. 2) showed the highest basal area (53.49 $m^2.ha^{-1}$) in transect 7 representing ground-water forest, the *Areca catechu* dominant stand, followed by transect 9 which represents *Callophylum* plantation (49.06 $m^2.ha^{-1}$), transect 17 representing *Gmelina* plantation (36.57 $m^2.ha^{-1}$), and transect 8 in the ground-water forest, the *Pandanus-Elaies* dominant stand (22.35 $m^2.ha^{-1}$). Some vegetation communities showed an intermediate range of basal areas. These include the *Syzigium* and *Eugenia* dominant stand in the ground water forest (transect 13), the vegetation at the edge of mangrove (transect 10) and the *Albizia* dominated forest (transect 6) which had 17.01 $m^2.ha^{-1}$, 16.98 $m^2.ha^{-1}$ and 16.3 $m^2.ha^{-1}$ respectively. The rest of transects had low basal area values less than 10.0 $m^2.ha^{-1}$. The lowest values were recorded in salt marsh swamp (transect 1), wooded grassland (transect 3) and in dry bushland and thickets (transect 5).

The density (Table 5), expressed as the number of stems per hactare for the sampled trees showed a nearly similar pattern as that observed in basal area with highest values in ground water forest, the *Areca catechu* dominant stand (1097.5 $stems.ha^{-1}$) followed by *Gmelina* plantation (530.0 $stems.ha^{-1}$). Next to this plantation were evergreen scrub forest (transect 4) and the *Pandanus-Elaies* stand in the ground water forest having 475 $stems.ha^{-1}$ each and the *Acacia* plantations (440 $stem.ha^{-1}$). These five forest stands had density over 400 stems per hectare which is substantially high figure. Again the lowest values were recorded in the salt marsh swamp grassland and wooded grassland. These big differences in tree basal area and density for different transects explains the big differences existing within the study area for micro-habitat conditions ranging from the permanently wet habitats to very dry rocky ones.

Tree dominance for each transect was calculated separately and the species dominance values are presented in Appendix III. There was a high variation in dominance among transects. Based on ranks assigned to each species, *Diospyros consolatae* had highest dominance in the evergreen scrub forest (transects 2 & 4) and in transect 14 while *Annona senegalensis* and *Bridelia*

micrantha contribute equally high in dominance in the wooded grassland. *Rapanea melanophloeos* and *Albizia adianthifolia.* ranked highest in transect 5 and transect 6 respectively whereas *Callophylum inophyllum* dominated in transects 8, 9 and 17. In transect 7 the highest dominance was recorded in *Vitex doniana* and *Syzigium cumini* dominated in transects 10 and 13. In transect 11 and transect 12 the dominating species were *Olea woodiana* and *Bourreria petiolaris* respectively. *Acacia auriculiformis* dominated the *Acacia* plantations and *Casuarina equisetifolia* ranked highest in transect 16. This observation whereby a certain species or group of species change in dominance from one area to another confirms that the Jozani-Chwaka Bay is heterogeneous with different habitats and vegetation types. Every type survives and performs better in the environment to which it is most adapted and most suited.

ii) Shrub and Herb layer

Relative densities (R.D.) and relative frequencies (R.F.) of herb and shrub species assessed for various transects are presented in Appendix II. The R.D. and R.F. values for different species varied from one community type to another depending on micro-habitat conditions operating at different scales. In the salt marsh grassland *Paspalum vaginatum* showed the highest dominance (R.D. > 80%) because this species is adapted to salty conditions.

In transect 2 and 4, the seedlings and saplings of *Olea woodiana*, *Macphersonia gracilis* and *Diospyros consolatae* had highest relative density and frequency in the herb and shrub layers. High abundance of these three species in the shrub and herb layers is an indication of high regeneration potential under the prevailing conditions. In the wooded grassland *Heteropogon contortus*, *Tephrosia pilosa* and *Hyparrhenia rufa* were the dominant species in terms of R.D. and R.F. while the shrub layer was dominated by *Annona senegalensis*. This observation is due to the fact that following fire that destroyed the previous vegetation, the area is now exposed to light and many species of grasses, herbs and forbs are favoured. Many plants of *Annona senegalensis* in the woody layer indicates that the habitat represents secondary succession following a previous catatrophic event of fire and if no further disturbanceoccurs it may develop to a forest again. Generally, the herb and shrub layers in many vegetation types were dominated by the seedlings and saplings of the dominating trees mixed with other understorey species. This is important since presence of seedlings, saplings and the shrubs of the dominating species indicates a high regeneration potential of the habitat. This was true for all habitat types except in *Callophylum* and *Casuarina plantation* where the shrub layer was poorly represented and the herb layer was dominated by ferns.

Table 5: Summarized tree data for different transects representing different vegetation types in Jozani-Chwaka Bay proposed National Park

Attributes		Transects																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Density (stems.ha^{-1})		20.0	302.5	37.5	475.0	110.0	310.0	1097.5	475.0	345.0	157.5	230.0	157.5	315.0	237.5	440.0	202.5	530.0	320.1
Basal area (m^2.ha^{-1})		0.02	8.43	1.2	4.89	1.37	16.3	53.49	22.35	49.06	16.98	4.75	4.09	17.01	5.23	6.32	3.29	36.57	14.79
Height ranges (m)	5.0 - 9.9	1	22	13	31	41	31	141	55	7	32	77	40	62	73	110	30	99	865
	10.0 - 14.9	0	33	2	67	3	45	91	43	19	11	13	11	32	15	66	30	69	550
	15.0 - 19.9	0	41	0	71	0	24	95	43	25	12	2	7	14	5	0	21	20	380
	20 - 24.9	0	14	0	19	0	8	83	31	19	6	0	2	11	2	0	0	14	209
	>25.0	0	11	0	2	0	16	29	18	68	2	0	3	7	0	0	0	10	166
DBH ranges (cm)	10.0 - 14.9	1	49	5	61	39	51	240	18	7	20	59	29	64	55	105	58	50	911
	15.0 - 19.9	0	34	5	53	5	31	35	19	11	6	18	22	21	24	64	17	68	433
	20.0 - 24.9	0	22	3	43	0	11	59	38	13	3	10	7	9	11	5	6	20	260
	25.0 - 29.9	0	14	2	22	0	31	12	21	19	3	3	2	10	3	1	0	20	163
	30.0 - 34.9	0	0	0	4	0	0	23	11	11	10	1	1	5	1	1	0	24	92
	35.0 - 39.9	0	2	0	4	0	0	31	20	27	3	0	1	7	0	0	0	21	116
	>40.0	0	0	0	3	0	0	39	63	50	18	1	1	10	1	0	0	9	195
Total number of stems sampled		1	121	15	190	44	124	439	190	138	63	92	63	126	95	176	81	212	2170

Key:

Transect 1: Salt mash swamp

Transect 2 & 4: Evergreen scrub forest

Transect 3: Wooded grassland

Transect 5: Dry bushland and thicket

Transect 6: Albizia dominated forest

Transect 7: Ground water forest: *Areca catechu* (Mipopoo) dominant

Transect 8: Ground water forest: *Pandanus-Elaeis* dominant

Transect 9: *Calophyllum* plantation

Transect 10: Edge of mangrove vegetation

Transect 11: *Diospyros* dominated bushland and thickets

Transect 12: Forest to bushland/thicket profile

Transect 13: Ground water forest: *Syzigium* & *Eugenia* dominant

Transect 14: Fire induced vegetation

Transect 15: *Acacia* plantations

Transect 16: *Casuarina* plantations

Transect 17: *Gmelina* plantation

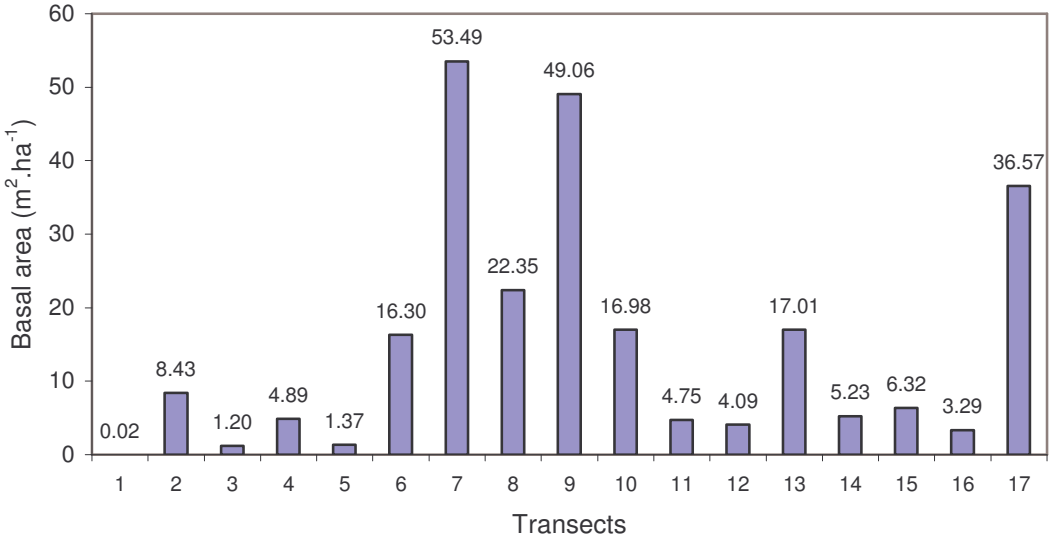

Figure 2: Basal area in different transects representing various vegetation types in Jozani-Chwaka Bay proposed National Park, Zanzibar

iii) DBH and height distribution

One way of assessing forest structure is by looking at the way individuals of different sizes (height and stem diameter) are represented in that community. The height frequency distribution is presented in Fig. 3 & Table 5 while DBH frequency distribution for various transects representing different vegetation types is shown in Fig. 4 and Table 5. For all trees sampled in each transect there was highest number of plants in the lowest DBH class (i.e.10.0-14.9cm) and the lowest number in the largest DBH class except for transect 8 (ground water forest: *Pandanus –Elaeis* dominant) and transect 9 (*Callophylum* plantation) in which the opposite pattern was observed. Again with exception of transects 8 and 9 there was a consistent decrease of number of individual per class as DBH increased. This dominance of trees in the lower DBH classes as observed in this study is a good indication of active forest regeneration since many tree populations have small newly recruited individuals differing in size and age. The opposite trend observed in transects 8 and 9 where many individuals are found in the largest class is an indicator of low or lack of forest regeneration process. This observation shows that there is not much regeneration taking place in the *Callophylum* plantation nor in *Pandanus-Elaies* stand in the

ground water forest. It may also mean that no much harvesting of big individuals from these sites is taking place. Normally, the trees included in above 40cm DBH class are tall; they are also canopy trees. The height frequency distribution of the trees shows that there was highest number of trees with height <10m in all transects except in transect 9 (*Callophylum* plantation), in transect 2 and in transect 4 which both represent the evergreen scrub forest. The evergreen scrub forest (transects 2 & 4) showed maximum number of trees in the third height class (i.e. 15.0-19.9m) whereas the *Callophylum* plantation had maximum number of trees in the largest height class (i.e. ≥25m).

Trees ≥ 15m in height were missing in transects 1 (salt marsh swamp), 3 (wooded grassland), 5 (dry bushland and thicket) and 15 (*Acacia* plantations) and those with height ≥20m were missing transect 11 (*Diospyro*s dominated bushland and thickets) and transect 16 (*Casuarina* plantation). There was no tree ≥25m in transect 14 (fire induced vegetation). The remaining transects had all five height classes represented by at least 2 trees. The observed pattern where most individuals are found in the smaller height class and where they decrease in number progressively towards bigger size class suggest the presence of stratified forest where many trees form the understorey and few form the canopy and emergent trees.

4.1.5 Socially, economically and ecologically important species

4.1.5.1 Medicinal plants

Plant species are an important source of human and veterinary medicines, although less information is available about veterinary uses. Williams (1949) and Ruffo (1992) provided a list of some plants species with medicinal uses in Zanzibar. Active compounds of some species in Tanzania have been investigated (Nkunya, *et al* 1990).

Dichrostachys inerme is a species the bark of which is used to make an anthelmintic (for killing or ejecting intestinal worms). The roots are used to treat snakebites, scorpion's stings, venereal diseases and to make expectorants and purgatives. Different parts of *Antidesma venosum* provide cures for coughs, colds, schistosomiasis, scabies, constipation, diarrhea and dysentry.

There are many plants found in Jozani forest which are known for their traditional medicinal uses in Jozani but which have not yet been chemically investigated. With sufficient investment in research and development these plants could contribute significantly to advances in the

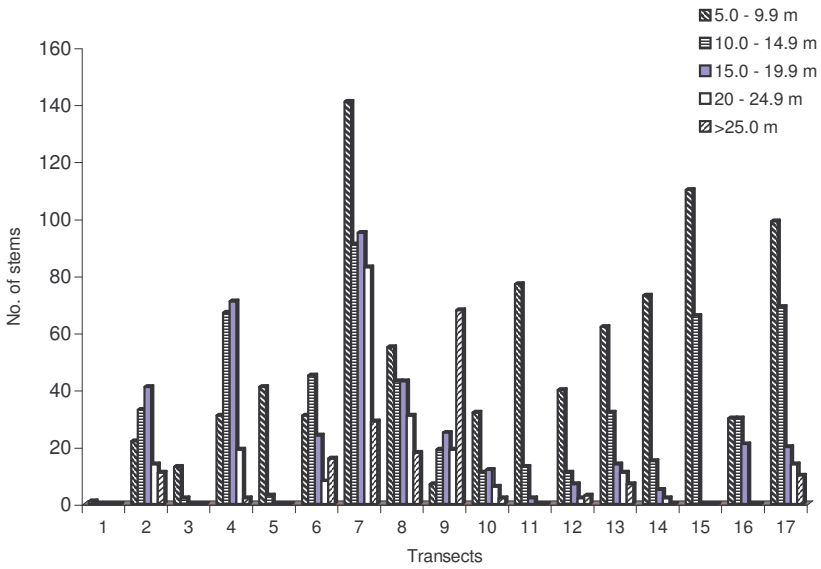

Figure 3: Distribution of tree heights in Jozani-Chwaka Bay proposed national Park, Zanzibar

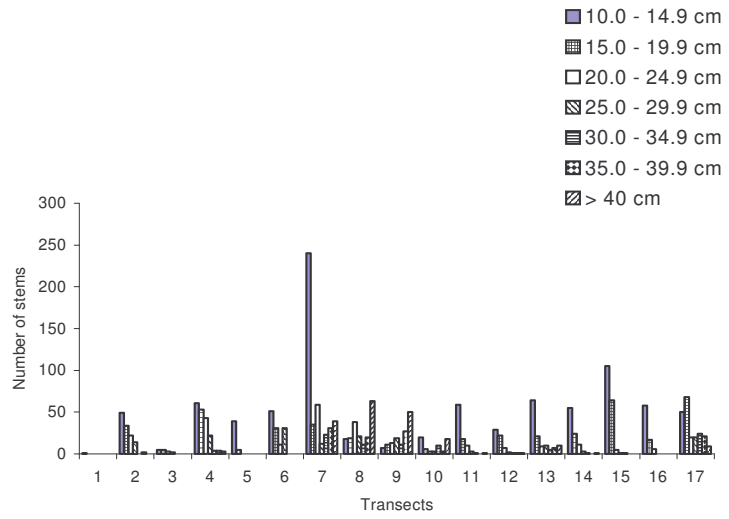

Figure 4: DBH distribution in various transects representing different vegetation types in Jozani-Chwaka Bay proposed National Park, Zanzibar

production of conventional medicines (Herlocker, 1999). Over collection of some species for medicinal uses also needs further investigation. For example, *Croton sylvaticus* (*Msinduzi*) is becoming exceedingly rare because it is being over exploited for its medicinal uses. Its phytochemical constituents are being undertaken at University of Dar es Salaam, Department of Chemistry. Other species that have been investigated are known from Jozani and Pemba are listed in Table 6 below.

Table 6: Some species investigated or under investigation at Chemistry Department, University of Dar es Salaam for phytochemical constituents with medicinal values (Nkunya *et al*, 1990)

Species	Family	Places of observation	Part investigated	Constituents	Biological acitivitiy
Mkilua fragrans	Annonaceae	Pemba, Zanzibar town	Fruits, stem, root bark	Aporphinoids acetylenic acetogenins	Antifungal, antibackerial, cytotoxic
Uvaria acuminata	Annonaceae	Mapopwe	Stem & root barm	C-benzyhydrochaicones sesquiterpenes	Antimalarial
Hoslundia opposita	Lamiaceae	Jozani	Arial parts, roots, fruits	Under investigation	Antimalarial
Croton sylvaticus	Euphorbiaceae	Jozani	Roots	Under investigation	

Apart from the species under investigation and those with known chemical contituents several others medicinal plants are known. A list of potential medicinally important plant species found in Jozani-Chwaka Bay area is presented in Table 7.

Table 7: Potential medicinally important plant species in Jozani-Chwaka Bay proposed National Park, Zanzibar

Botanical name	Vernacular name	Disease treated	Part used
Achyranthes aspera L.		➢ An emetic for pains in the chest not due to cough	Roots
Adansonia digitata	Mbuyu	➢ Dysentery remedy ➢ Malaria treatment ➢ Antidote against strophanthus poisoning to tree eye-pains	Fruits Leaves and barks Under leaves

Botanical name	Vernacular name	Disease treated	Part used
Albizia adianthifolia	Mgelenge Mkenge	➢ To cure scabies and skin diseases ➢ As a bronchitis remedy ➢ Snake bite and for keeping evil sprits away	Bark and roots
Albizia zygia.	Mgunga	➢ To cure skin eruptive fevers and as a dressing on yawns	Bark & roots
Anacardium occidentale	Mkorosho	➢ Preventing abortion	Roots
Annona senegalensis	Mtopetope	➢ Head-ache ➢ Stomach ache ➢ Kirambi ➢ Liver, abdominal pains	Roots
Antidesma venosum	Mtimagoa msisimizi	➢ Liver, abdominal pains, coughs, schistosomiasis, scabies, fits, diarrhoea dysentery and constipation	Seeds, Fruits, leaves, Twig
Asparagus falcatus		➢ Veneral diseases	Roots
Blighia unijugata	Mtikiza Mkulukilemba	➢ Epilepsy ➢ Hernia	Roots
Bridelia micrantha (Hochst)	Mkaratu Mututututu	➢ To treat liver complains against dysentery in children	Roots Barks
Caesalpinia volkensii	Mkomwe	➢ Tracoma	Seeds
Cassytha filiformis	Mlangamia	➢ Hedache	Leaves
Clausena anisata	Mfusho	➢ Fever, dementia	Leaves
Clerodendrum sp.	Kipepe	➢ Convulsions	Leaves
Croton sylvaticus	Mshinduzi	➢ Swellings Hernia	Bark-powder
Dichrostachys cinerea	Msigino	➢ Snake bites ➢ Wounds and Boils ➢ Stomach-ache	Leaves, Roots
Dodonaea viscosa	Mkeng'eta	➢ Impotence	Roots
Elaeis guineensis Jacq	Mchikichi	➢ Culnery	Fruits
Eucalyptus sp.	Mkaratus	➢ Nasal drops, Vermin repellant	Seeds
Euclea racemosa ssp. schimperi	Mdaa	➢ Swelling, chest pains ancylostomiasis, syphilis	Roots, barks
Euclea natalensis	Msiliza	➢ Constipation	Roots
Euphorbia hirta L.	Mziwaziwa	➢ Gonorrhoea, stomach-ache, dysenteries, snake bite, bronchitis asthma.	Whole plant and Roots
Ficus exasperata	Msasa	➢ Pneumonia	Roots

Botanical name	Vernacular name	Disease treated	Part used
Ficus sycomorus L.	Mkuyu	➢ Chest, Antidiarrhoea, Flow of milk to the cow	Stem, Leaves, Fruit, Roots
Flagellaria guineensis	Mpepa, Mtebi	➢ Treatment of venereal disease	Fruits
Flueggea virosa	Mkwamba	➢ Promote fertility among women, to cure chest pains insect-repelent	Leaves/roots Roots, Leaves
Grewia sp.	Mkole	➢ Fumigation	Roots, Bark, Leaves
Harrisonia abyssinica	Mdakakomba	➢ Fever, Dementia, snake bites stomach-ache	Leaves, Roots
Hoslundia opposita	Mlashore	➢ Fever	Leaves
Launaea cornuta	Mchunga	➢ Malaria	Leaves
Lippia javanica	Mpambauke	➢ Anaemia, Madness fever	Leaves
Macaranga capensis	Mkalanga	➢ Allergy	Leaves
Mallotus oppositifolius	Mtandutundu	➢ Stomach-ache, chest	Roots
Mangifera indica	Mwembe	➢ Stomach-ache, Diarrhoea	Leaves
Markhania obtusifolia sprague		➢ Convulsion & barrenness	Leaves, fruits
Ocimum suave	Vumbasis	➢ Asthma stomach-ache, fever, mosquito repellent dementia	Leaves
Pandanus kirkii	Mkadi	➢ Aphrodisiac	Roots
Ozorora obovata	Mng'ombe	➢ Stomach-ache	Roots
Ozorora obovata	Mng'ombe	➢ Stomach-ache, to treat fever	Roots
Phyllanthus sp.	Mtambaa na penu	➢ Gonorrhoea, bubanic plague, dressing to abscesses	Leaves, Fruits, Roots
Piper umbellatum	Mnamia-panga Mtambuu mwitu	➢ Ring worm	Whole plant or stem.
Pittosporum viridiflorum	Mpande	➢ To prevent Abortion, Anaemia	Bark
Pluchea sordidas	Mwingambu	➢ Dementia	Leaves
Psiadia punctulata	Mkeneta	➢ Rashes	Leaves
Psidium gujava L.		➢ Deep cuts, spraius, diarrhoea, ulcers, instestinal haemorhages, cholera	Leaves, flowers, Bark & Roots.
Rapanea melanophloeos Mez	Mkangalashamba	➢ Expectrorant and emetic, astringent, anthelmintic	Bark, Leaves, Fruits
Rauvolfia mombasiana	Mwengechaa	➢ Stomach-ache ➢ Primary stages of diabetes	Roots 5 pieces of twigs per dose
Rhus longipes	Mchengule	➢ Stomach-ache ➢ Tooth-ache	Roots Leaves

Botanical name	Vernacular name	Disease treated	Part used
Rhus natalensis	Mkumba	➢ Wounds, infertility, pains in menstruation period	Roots
Senna petersiana	Mpingawaume	➢ Hernia, impotence	Roots
Solanum incanum	Mtula	➢ Hernia, constipation,	Roots
Sorideia madagascariensis	Mtikiza/Mpilipili doria	➢ Bleeding of women, also women's pains while in monthly periods	Roots
Strychnos innocua	Mtonga	➢ Hernia	Roots
Synaptolepis kirkii	Mbibikiu	➢ Vomiting, Impotence	Roots
Tabernaemontana ventricosa	Pumbu ya kima	➢ To heal wounds	Milk sap from stems, fruits
Tacca leontopetaloids	Uwangajike	➢ Ear-ach, Diarrhoea	Tuber
Tamarindus indica	Mkwaju	➢ Lakative	Seeds
Tarenna pavettoides	Mlashore	➢ Fever,	
Terminalia catapa L.	Mkungu	➢ Catarrh, Diarrhoea, Dysenteries, Skin diseases, asthma	Bark, Leaves
Turraea floribunda	Mtamagoa	➢ Stomach-ache	Roots
Psychotria goetzei	Mtimafuta	➢ Antiseptic for fresh wounds	Squeeze juice from warmed twigs
Euclea racemosa ssp. *schimperii*	Mdaa	➢ Purgative/laxactive (aperient)tamagoa	Roots

4.1.5.2 Species with multiple uses as sources of plant products essential to society

Eastern African countries harbour many plant species with multiple economic uses. Many are sources of food. These species help to alleviate problems of food shortage and nutritional requirements in fragile ecosystems. Zanzibar is highly populated, yet with little value in agricultural terms the study area is a source of many forest resources including fruits, vegetables, fuelwood, charcoal and medicine (Table 8; Appendix V). Mbuya *et al*. (1994) lists 37 different species of uses for trees, shrubs and liana. Proper conservation and the utilization and marketing of plant products from such species could to a large extent provide economic base for the rural areas. Some of the uses are not known from Zanzibar but known from other sources including literature. Table 8 below indicates plant species with multiple uses in Jozani-Chwaka Bay proposed National Park.

ii) Forest plantations

Jozani groundwater forest has been logged for timber since the 1940s and was made a forest reserve in the early 1960s. The history of forest plantations in Zanzibar goes back to 1930's with the introduction of *Callophylum inophyllum* in the Jozani swamp forest. This was intended to meet timber demand after the indigenous timber trees had been depleted. Subsequently the

government of Zanzibar realized that apart from timber shortage the fast growing population needed forest resources including marketable building poles, firewood and charcoal. Plantations of fuel-wood and pole-producing species were introduced (Plates 27, 28). The plantations contain hard wood species of *Casuarina*, two *Acacia* species and *Gmeliana arborea*. These species were introduced because they are fast growing and adaptable to soil and climatic conditions. The performances of these exotic species are presented together with other species in Appendix III, Table 5 & Figures 2 &3.

There are no reports of enrichment plantations of the depleted indigenous timber trees of *Milicia excelsa* and *Afzelia quanzensis*. Hard wood planting of *Milicia excelsa* in Pugu Forest Reserve did not succeed due to insect infestation, but that doesn't mean the same problem would be encountered if this approach was applied in the Jozani Forest Reserve.

Thus the present approach of establishing hard wood plantations to meet local demands of fuelwood, charcoal and building poles is an appropriate method of conservation to reduce dependence on forest resources. Besides government plantations, local people have also been encouraged to establish their own hardwood plantations especially of *Casuarina equisetifolia*. It has been observed that wood supplies from government plantations are obtained at a lower marketable price compared to wood supplies from private sources (Mwinyimkuu, personal communication.). Government policy of financial considerations to local people's rights on the forest resources has had a positive impact on deforestation. Management of forest plantations has gradually deteriorated since 1980's to 1990's due to financial problems, and because FINIDA, which was financing the Jozani Project, has ceased supporting it. This has resulted in the poor performances of plantations and unplanned forest harvesting (Plate 30). *Casuarina* plantations do not regenerate from coppices where the *Acacia* species respond well. The *Callophylum inophyllum*, *Casuarina equesitifolia* and *Eucalyplus sp* plantations in the groundwater habitat are performing well by attaining largest DBH classes and tree heights. However, *Casuarina*, especially, has been subjected to wind blow creating big gaps.

4.1.6 Conservation status and endemism of plant species

i) Conservation status

Conservation efforts at Jozani are confronted by political, economical and habitat degradation issues arising from the surrounding villages (see interview responses in Appendix V). Major

Table 8: Plants with multiple uses in Jozani-Chwaka Bay proposed National Park

Species name	Medicinal	Firewood	Charcoal	Timber	Poles	Baskets & mats	Fibres & ropes	Fodder	Tools handle	Boats	Fruits, seeds, roots	Vegetables	Others
Anacardium occidentale											*		*
Annona senegalensis	*										*		*
Afzelia quanzensis				*									
Hoslundia opposita	*										*		*
Croton sylvaticus	*			*									
Calophyllum inophyllum	*	*			*								*
Carica papaya	*										*	*	*
Areca catechu	*										*		
Borassus aethiopicum					*				*	*			*
Brexia madagascariensis	*										*		
Bridelia micrantha	*							*		*			
Bruguera gymnorhiza		*			*								
Capsicum frutescens											*		*
Senna petersiana	*				*								
Casuarina equisetifolia		*			*				*				
Ceiba pentandra				*							*		*
Milicia excelsa				*							*		*
Citrus aurantiifolia							*				*		*
Cocos nucifera					*		*				*		*
Encephalartos hildebrandtii											*	*	
Tabernaemontano ventricosa	*												*
Ficus sur	*								*		*		
Flacourtia indica					*						*		
Flagellaria guinensis					*								
Flueggea virosa	*		*			*					*		*
Hyparrhenia rufa						*		*					*
Panicum trichocladum													
Psidium guajava	*												
Tamarindus indica	*	*	*	*	*			*					*
Markhamia zanzibarica	*	*			*				*				

Species name	Medicinal	Firewood	Charcoal	Timber	Poles	Baslets & mats	Fibres & ropes	Fodder	Tools handle	Boat			
Maytenus mossambicensis	*	*	*										
Launaea cornuta	*											*	
Adansonia digitata	*						*			*			
Ipomoea aquatica								*					
Antidesma venosum	*									*			
Ozoroa obovata	*	*											
Olea woodiana		*		*						*			
Trema orientalis		*									*		
Rauvolfia Mombasiana	*												
Suregada madagascariensis	*						*				*		
Saba comorensis							*				*		
Flueggea virosa	*	*	*			*							*
Apodytes dimidiata		*	*		*								
Diospyros consolatae		*	*		*								
Phoenix reclinata						*							
Pandanus kirkii	*												
Rhus longipes	*												
Euclea racemosa ssp. *schimperii*	*												
Terminalia catapa	*			*									

Species which possess multiple medicinal values may be the subject of further biochemical investigation and threats. Stripping of bark for medicinal uses succumbs the individual tree to disease threats. Others include recreational, shade etc.

issues include agricultural encroachment, illegal charcoal production and cutting trees for fire wood, building poles. Other uses including low income sources by villagers with farms close to the forest reserve to the issue of relocation. Some species found in the study area are known to be threatened or endangered and appear in the check-list of CITES species and in the Red list of endangered & threatened species (Table 9). Endangered wild species include plants that are directly overharvested in the wild for medicine, timber or forage plants. They also include populations used as sources of genetic variation for wild relatives of field crops and species which are crucial for the well-being of an ecosystem including dominant or keystone species and food plants of animals aof major concern (Frankel *et al,* 1995).

Table 9: Threatened and endangered species and their conservation status

Species	Family	Conservation status
Eulophia volkensis	Orchidaceae	Appendix II of CITES
Vanilla roscheri	Orchidaceae	Appendix II of CITES
Vanilla zanzibarica	Orchidaceae	Appendix II of CITES
Aerangis hologrottis	Orchidaceae	Appendix II of CITES
Microcoelia exilis	Orchidaceae	Appendix II of CITES
Nervilia umbrosa	Orchidaceae	Appendix II of CITES
Encephalartos hildebrandtii Var. *hildebrandtii*	Zamiaceae (Cycads)	Appendix I of CITES
Coffea pseudozanguebariae	Rubiaceae	Red list summary report 2000, VU B1+2b
Milicia excelsa	Moraceae	Red list summary report 2000, LR/nt
Afzelia quanzensis	Caesalpiniaceae	Not specified
Croton sylvaticus	Euphorbiaceae	Not specified
Dalbergia melanoxyforn	Fabaceae	Red list summary report 2000, LR/nt
Euphorbia nyikae	Euphorbiaceae	Appendix II of CITES
Mkilua fragans	Annonaceae	Red list summary report 2000, VU B1+2b
Pouteria alnifolia var. saclenxii	Sapotaceae	Red list, summary report 2000, VU B1+2c
Psychotria goetzei var. goetzeiplatyphylla	Rubiaceae	Red list, summary report 2000, VU B1+2b
Psychotria alsophyla	Rubiaceae	Red list, summary report 2000, VU B1+2b
Mallotus oppositifolius var. lindius	Rubiaceae	Red list, summary report 2000, VU B1+2b
Mildbraedii carpinifolia	Rubiaceae	Red list, summary report 2000, VU B1+2b
Xylotheca tettensis var. fissistyla	Flacourtiaceae	Red list, summary report 2000, VU B1+2c

Key: LR = Lower risk; VU = Vulnerable

ii) Endemic and near endemic species

Endemism describes species that are native to a particular geographic area or continent. In conservation view two aspects are of importance that is endemism and number of species. Polhill (1968) realized the paucity of plant species endemism in the Jozani area. Jozani is ranked among the 25 high-priority sites for long-term conservation due to its importance for

the endangered red colobus monkey. The number of tourists visiting Jozani forest is rapidly increasing and thus an increasing forest income resulting into a revenue-sharing scheme among the surrounding villages. The forest also attracts local schools and it will in future form a centre for scientific research.

Jozani-Chwaka Bay Proposed National Park possesses many near endemic species which have linkages with the Zanzibar-Inhambane regional centre of endemism. One of the arguments is the location of Zanzibar Island on a continental shelf close to the coastal mainland of Tanzania that lies in this phytochorion. The endemic and near endemic species are listed in Table 10 below.

Table 10: Endemic and near endemic plant species of Jozani-Chwaka Bay proposed National Park and their distribution outside Jozani

Family	Species name	Distribution	Remarks
Annonaceae	*Mkilua fragrans* Verdc.	K_7, T_3, 6,8, Z, P.	In RLSR
	Monanthotaxis faulknerae Verdc.	K_7, T_3	In RLSR
	Monanthotaxis fornicata (Baill.) Verdc	K_7, T_3, 6, Z	Not known elsewhere
	Mononthotaxis trichocarpa (Eng. & Diels) Verdc.	K_7, T_3, 6, 8, Z	Not known elsewhere
	Uvaria kirkii Hook. f.	K_7, T_3, 6, 8, Z & P.	
Apocynaceae	*Rauvolfia mombasiana* Stapf	K_7, T_3, 6, 8, Z & P	
Convolvulaceae	*Ipomoea shupangensis* Bak.	T_1, 3, 6, 8 & Z	
	Ipomea zanzibarica Verdc.	K7 & Z	Not known elsewhere
Celastraceae	*Maytenus mossambicensis* (Koltz.) Blakelock, var. *ambonensis* (Loes) N. Robson	K_7, T_3, 6 & Z	Not known elsewhere
Flacourtaceae	*Grandidiera boivinii* Jaub. *Xylotheca tettensis* var. *kirkii* (Oliv.)	K_7, T_3, 6, 8 & Z K_7, T_3, 6, 8 & Z	
Myrtaceae	*Eugenia capensis* (Eckl. & Zeyh.) Sond. ssp. *multiflora* Verdc.	K_7, T_3, 6, 8 ,Z & P.	
Ochnaceae	*Ochna atropurpurea*	T_3, 6, 8 & Z	
Oleaceae	*Olea woodiana*	Z	
Pandanaceae	*Pandanus rabaiensis* Rendle	K_7, T_3, 6, 7, Z &P.	Not known elsewhere
Rubiaceae	*Burttdavya nyasica* Hoyle	T_3, 6, 8 & Z	Rare in Jozani
	Coffea pseudozangueriae Bridson	K_7, T_3, 6, & Z.	
	Chassalia umbraficola Vatke ssp. *umbraticola*	K_7, T_3, 6, 8, Z &P.	
	Canthium mombazense Baillon	K_7, T_3, 6, 8, Z & P	Not in FTEA for Zanzibar
	Heinsia zanzibarica (Bojer.)Verdc.	K_7, T_3, 6, 8 & Z	

Family	Species name	Distribution	Remarks
	Psychotria alsophila K. Schum.		New for FTEA records
	Trianolepis africana Hook. f. ssp. *hildebrandtii* (Vatke) Verdc.	K_7, T_3, 6, Z & P.	
	Tricalysia microphylla Hiern	K_7, T_3, & Z	Not known elsewhere
	Tarenna littoralis (Hiern) Bridson	K_7, T_3, 6, Z, P & M	
Sapotaceae	*Manilkara sulcata* (Engl.) Dubard	K_1, T_3, 6, Z & P	Not known elsewhere
	Pouteria alnifolia (Baker)Pierre var. *sacleuxii* (Loconte) J.H. Hensl.	Z	Apparently restricted to Zanzibar Island
Thymelaceae	*Synaptolepis kirkii* Oliv.	T_3, K_7, T_3, 6, 8, Z, & P	

T = Tanzania; K = Kenya; Z = Zanzibar; P = Pemba.

4.2 Fauna

4.2.1 Mammal occurrence and distribution

Most of the species of large mammals reported to be present in Jozani from previous surveys and studies were encountered during the survey (Appendix VII) either through direct observation or signs. The exception was the Zanzibar Leopard (*Panthera pardus adersi*) whose presence was difficult to establish. Leopards are notoriuosly difficult to observe (Kingdon, 1997) and their presence is difficult to establish without use of techniques like camera trapping or baiting. Mammals tended to occur in all forest areas though the distribution was influenced by habitat types and human interference. Certain species were sometimes absent in seemingly potentially ideal habitats. Some of the large mammals sighted physically during the survey included the Red Duiker (*Cephalophus adersi*) blue duiker (*Cephalophus monticola sundevalli*) Red Colobus (*Piliocolobus kirkii*), Sykes Monkey (*Cercopithecus mitis*). Most other species were recorded from signs such as Suni, Galagos, Bushpigs, Genets and Civets. The distribution of most species was widespread within the forest and their occurrence outside the forest reserve was not common. This suggests that the distribution of most of these species is continuing to shrink compared to the previous reports (Williams *et al* 1996). Hunting, farming, settlement and human disturbances have restricted the range of most large mammals on Zanzibar. Ukongoroni area within which most of the Jozani forest is located remains the most important area for most large mammals. Below is a synopsis of the large mammal species of Jozani - Chwaka proposed National Park.

Zanzibar Leopard (*Panthera pardus adersi*)

This is a subspecies endemic to Zanzibar. Reports indicate that it was abundant in Jozani forest and surrounding areas before 1964. Potential habitat includes forests and thickets in Wangwani, Tovu, Bondeni (Jozani HQ), Unguja Ukuu and Mapopwe to Cheju. Many leopards were killed after 1964 when it was presumed that they posed a threat to human life and property. This resulted in a severe decline in their number. No indication of leopard was found during our survey. In 1992, C. Ruffo (per comm.) reported hearing a leopard roar at night while camped at Unguja Ukuu forest station. In 2001 Ali Mwinyi (pers. comm.) a wildlife officer, collected dung in Jozani forest presumed to belong to a leopard but no voucher specimen was retained. The wildlife officer also heard an animal, which was not physically sighted but assumed to be a leopard. Villagers of Cheju north of Jozani reported that leopards are still present in Jozani but that they are scarce. They reported one or two sightings over one or two years. Leopards are probably still present in Jozani but their numbers are certainly low and possibly not a viable population. Application of infra red camera trapping technique may be necessary to establish whether there are still some individuals remaining in the forest.

Zanzibar Red Colobus (*Piliocolobus kirkii*)

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 - 13kgs. and exhibits diverse dietary habits, sometimes reported as crop pest. Its preferred habitat includes the ground water, coral rag, deep soil and mangrove forests. Occurrence in cultivated and areas under fallow is reported to be due to loss of preferred habitat. The Red Colobus was the most commonly observed mammal in the survey area, it occupies most forested areas from Mapopwe in the north down to Cheju, Unguja Ukuu, Pete, Jozani, Bondeni, Tovu, to Wangwani. Jozani forest and surroundings harbour the largest population of the colobus while Uzi Island has a small population. There are minor colobus populations in south Jozani, coral rag forest and Masingini. In Jozani, 9 groups are recognised and are under constant monitoring. Some groups at Jozani are habituated. 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. Unlike the leopard the conservation of the red colobus was unaffected after 1964. Since 1995 local community support has been sought in the conservation of the colobus. However, despite the conservation efforts the population of the red colobus (Table 11) is reported to be declining or rather fluctuating due to habitat loss, fragmentation and hunting. The different population figures are due to different counting techniques. Half of the current population of Red Colobus is reported to occur outside of the protected areas (Masoud *et al*, 2001). One of the main conservation difficulties for the species is its low reproduction rate. Due to its ecological, conservation and socio-economic importance, a population and habitat viability analysis (including a sensitivity test) is recommended to obtain the necessary information needed for planning the long term species conservation strategy.

Table 11: Population trends of the Zanzibar Red Colobus (*Piliocolobus kirkii*) in Zanzibar (Source: Hedberg and Hedberg, 1966; Masoud *et al*, 2001)

Date	Population size	Area	Source	Method
1868	"rare"		Sir John Kirk (Hedberg and Hedberg, 1966)	Estimate
1966	200	Jozani	Herdbeg (Hedberg and Hedberg, 1966)	Estimate
1981	1469	Zanzibar	Silkiluwasha, 1981	Estimate
1991	1000-1500	Zanzibar	Struhsaker, 1991	Estimate
1996	1500-2000	Zanzibar	Struhsaker & Siex, 1996	Estimate
1997	2400	Zanzibar	Othman & Rijali, 1997	Census
1998	1500-2000	Zanzibar	Struhsaker & Siex, 1996	Estimate
1999	<2500	Zanzibar	Siex, 1999 (memo to CNR)	Estimate
1996	183-191	Uzi Island	Snyder, 1996	Census
1997	c.200	Uzi Island	Othman & Rijali, 1997	Census
1998	23	Uzi Island	Stewart, 1998	Census
2001	95	Uzi Island	Aylward, 2001 (SIT student)	Census

Aders' Duiker (*Cephalophus adersi*)

This is rare, endemic, and confined to coastal forests of East Africa. It shows a disjunct distribution occurring in Jozani forest and Arabuku-Sokoke forest in Kenya. However, the duiker was last seen in Arabuko–sokoke in 1995. It is found in many areas of Jozani forest

including secondary thicket. The duikers tend to avoid wet ground and salt marshes hence there were more signs of them in dry thickets than in ground water forest. It is the largest herbivore in the forest and is hunted for its meat. The distribution of Aders' Duiker is currently largely limited to Jozani forest. Its range has been declining progressively from 1983 (Swai, 1983a, 1983b) through the mid-nineties (Williams *et al*., 1996). Recent observations indicate they also remain in Kiwengwa forest in east-central and possibly Mtende forest to the south. By 1995 the range of Aders' Duiker in surveyed areas had shrunk by approximately 60% from that of 1983 (i.e 12 years). On the average the Aders' duiker range declined by 5% annually from 1983. The greatest decline occurred in unprotected areas. The breeding programme for this species was initiated. This breeding programme would be more successful if effective protection of animals released to the wild is practiced.

Blue duiker (*Cephalophus monticola sundevalli*)

This is the most widespread duiker in Africa and it displays a broad variation in coat colour and morphological aspects. In Zanzibar two different races occur one on Unguja and another on Pemba. On Unguja the preferred habitat is coral rag thickets. In Jozani forest the duiker occurs in dry thickets and forest in Wangwani, Charawe, Tovu, Unguja Ukuu, Cheju to Mapopwe in the north. Like the Aders' Duiker the range of the Blue Duiker has declined for the past two decades by approximately half. The remaining populations are concentrated in Ukongoroni (Jozani forest) and lesser populations in Kiwengwa in central-east and Mtende forest to the south. Hunting for meat and habitat loss are the major factors leading to decline in populations though this duiker is not listed on the threatened species list. An assessment is necessary to establish its conservation status.

Suni (*Neotragus moschatus moschatus*)

The suni is reported to have the widest distribution of the Zanzibar antelopes. It occupies coastal forests thickets and may be found in mountain forests up to 2,700m. In Zanzibar it occupies the coral rag thickets and forested areas, but is also found in disturbed habitats. It is known to occupy areas previously cultivated but left fallow for some years. In Jozani forest and surrounding areas it occurs in a range of habitats except the salt marshes and very wet areas. Its ability to utilise fallow areas enables it to extend its range and hence the only major threat to the species is over hunting. It is reported to be the most easily caught in drive nets and accounts for over 80% of antelope meat sold in Zanzibar town. In contrast to the other antelopes the range of suni was reported to have remained stable or increased slightly in the

past two decades. This has been possible due to its ability to utilise fallow and abandoned cultivated areas. The suni range has extended to the east of Jozani an area which they were not reported to occur in 1983 (Williams *et al*., 1996). Their ability to tolerate certain levels of human disturbance provides them with some survival advantage.

Prosimians (galagos)

Three species of galagos occur in Zanzibar and they include the Lesser bushbaby (*Galago senegalensis*), Zanzibar galago (*Galagoides zanzibaricus*) and Greater galago (*Otolemur garnettii*). The last two are threatened. 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. The Garnett's galago occurs in coastal forests of Eastern Africa including Pemba and Zanzibar. The Zanzibar Galago is a locally abundant species in Jozani forest and other areas. It is confined to coastal forests and thickets and the Eastern Arc Mountains. There are possibly other species in southern Tanzania and Rondo plateau. Both species were identified during the survey using vocalisation at the headquarters and during opportunistic sampling and night drives. Habitat loss is possibly the greatest potential threat to galagos.

Javan Civet (*Viverricula indica*)

This is an exotic species introduced to Pemba and Zanzibar at an early date but it is not exactly known when. Since its introduction the civet has coexisted with the African civet *Viverra civetta*. No negative impact has been established 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. Shrews, elephant shrews, squirrels, rodents and mongooses were distributed throughout the forest though their occurrence was clustered depending on habitat. Shrews were the most common in the forest and thicket

habitats. The elephant shrews though not very frequently trapped occur more in the forested areas especially the *Albizia* forests of Mapopwe in the north of Jozani forest. The rodents also occurred more in forest areas and the catch rate of shrews and rodents was low in wooded grassland habitat.

Shrews

Shrews of East Africa are not well known, their distribution is restricted and do not commonly occur in all. Generic and species diversity in coastal forests is lower than in the Eastern Arc Mountain forests (Burgess and Clarke, 2000). Zanzibar shrew diversity is comparatively high in relation to most coastal forests on the mainland with 2 genera and 4 species occurring on Zanzibar 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). Shrews were the most common small mammals captured in all types of traps (see Appendix VIII).

Elephant-shrews

Two species occur in Zanzibar, the Four-toed Elephant Shrew (*Petrodomus tetradactylus*) and Black and Rufous Elephant Shrew (*Rhynchocyon petersi adersi*) and during the survey both species were sighted opportunistically and during night drive transects. Both species appear to be ubiquitous in the forest and thicket habitats in the survey area. The Four toed Elephant Shrew was also captured on a snap trap. The other species *Rhynchocyon petersi adersi* a sub species of *R. petersi*, belongs to a genus which is considered primitive and an ancient relict in the forests. The subspecies *R. petersi adersi* is an endangered species and occurs only on Zanzibar. The species *R. petersi* is widespread in coastal forests of East Africa.

Squirrels (Sciuridae)

Two species occur in Zanzibar: the Red-legged Sun Squirrel (*Heliosciurus rufobranchium*) and the Red Bush Squirrel (*Paraxerus palliatus*). The latter was the most common sighted during the survey particularly in the forests and thickets in Mapopwe and Wangwani areas. *P. palliatus* is registered in the IUCN redlist as a vulnerable species.

Rodents (Muridae)

At least five species of rats occur in Zanzibar and three of them including the Giant rat (*Cricetomys gambianus*), the introduced House rat (*Rattus rattus*) and *Grammomys* sp. were observed during the survey. The last species was a new record for Zanzibar. The specimen is yet to be classified to species level. Two specimens of *Grammomys* sp. were collected in Wangwani and another in Tovu area, both forest habitats.

Bats

At least 20 species occur in Zanzibar and 9 of them were observed during the survey. Bats are abundant in Jozani and surrounding areas occupying a variety of habitats. Two bat species occurring in Zanzibar are threatened, including the Heart-nose Big eared Bat (*Cardioderma cor*) which is at lower risk and Decken's Horse-shoe Bat (*Rhinolophus deckeni*) which is considered threatened though there is data deficiency is establishing its actual conservation status.

4.2 2 Relative abundance of vertebrates

Overall mammals appeared to be widely distributed in the study area though individual species or groups tended to occur more in certain habitats than others although when the catch rate of all species combined in each of the 8 transects was tested there was no sigficant difference (KW = 3.294, df = 7, P > 0.05). However, when the different animal groups are examined (Table 12, Figure 5, 6 and 7) a clear difference appears as some animal groups occurred more abundantly in certain areas than others. Few mammals were physically seen in the three transects covered during the animal foot count census to warrant any meaningful density calculation. In the fisrt transect (2.3km) one blue monkey was sighted but a number of animal signs (dung, vocalisation, trails, footprints) were observed. In the second transect (2.6km) one group of red colobus was encountered but could not be counted due to poor visibility. Many animal signs and other small animals and invertebrates were observed. In the third transect (3.9km) 2 groups of black monkeys and one of red colobus (29 individuals) were encountered. However, animal signs suggested the presence of a number of species in the survey area. Dung count along the transects recorded an average of 1.3 dung piles /km of transect for Aders Duiker, 0.8 dung piles/km for Blue Duiker and 0.3 dung piles /km for suni respectively. Bushpigs appeared to be the most common species with signs appearing frequently in all three transects. Duiker signs were mostly seen in thickets and forested areas which are relatively dry.

Four night drive transects ran from Jozani-Tovu (13 x 2 km) and from Jozani-Wangwani (16 x 2 km). Only three animals were recorded; 2 elephant shrews in the Jozani-Tovu transect and one galago at Wangwani. None of the nocturnal species was sighted during the night drives.

The relative abundance of some mammals is summarized in Table 13 below. Factors including occurrence and distribution, population numbers, rarity and endemism have been taken into account.

Table 12: Total number of mammal specimens captured in traps (bucket pitfalls, snaps, shermans) in Jozani forest Zanzibar (June-July 2002)

Transect	Animal group				Total
	Shrews	Squirrels	Rodents	Mongooses	
1. Wangwani (F)	3	1	1	1	6
2. Wangwani (WG)	0	0	0	0	0
3. Bondeni (SF)	0	1	0	0	1
4. Jozani (GWFP)	5	0	0	0	5
5. Tovu (GWF)	2	0	1	0	3
6. Unguja Ukuu (FP)	2	0	0	0	2
7. Mapopwe (CRF)	2	4	0	0	6
8. Kichanga (BT)	0	1	0	0	1
Total	14	7	2	1	24

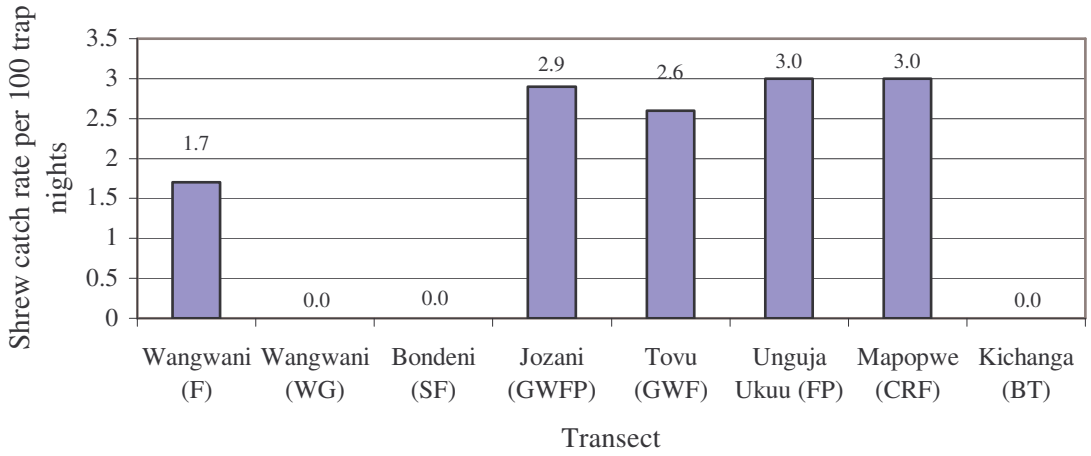

Figure 5: Catch rate of shrews (x/100 trap nights) in Jozani - Chwaka proposed National Park, Zanzibar (June-July 2002)

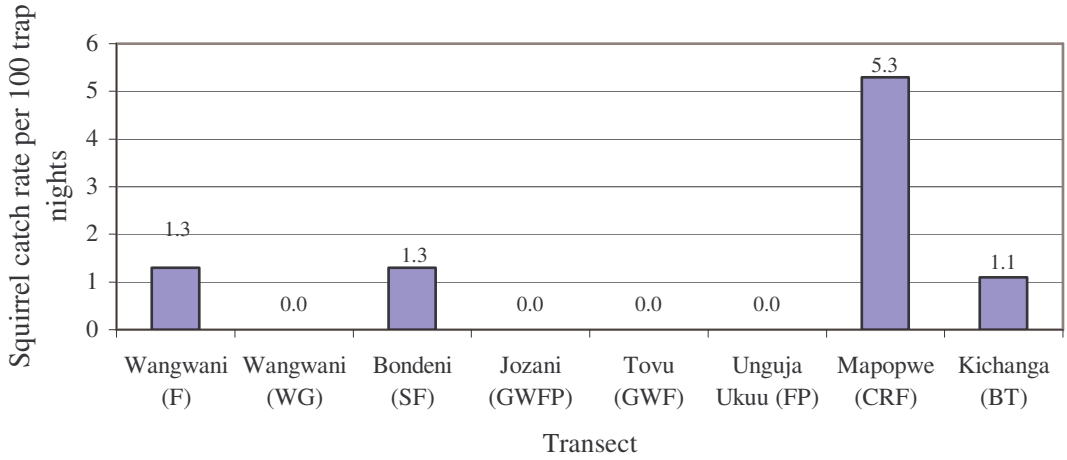

Figure 6: Squirrel catch rate (x/100 trap nights) in Jozani - Chwaka proposed National Park, Zanzibar (June-July 2002)

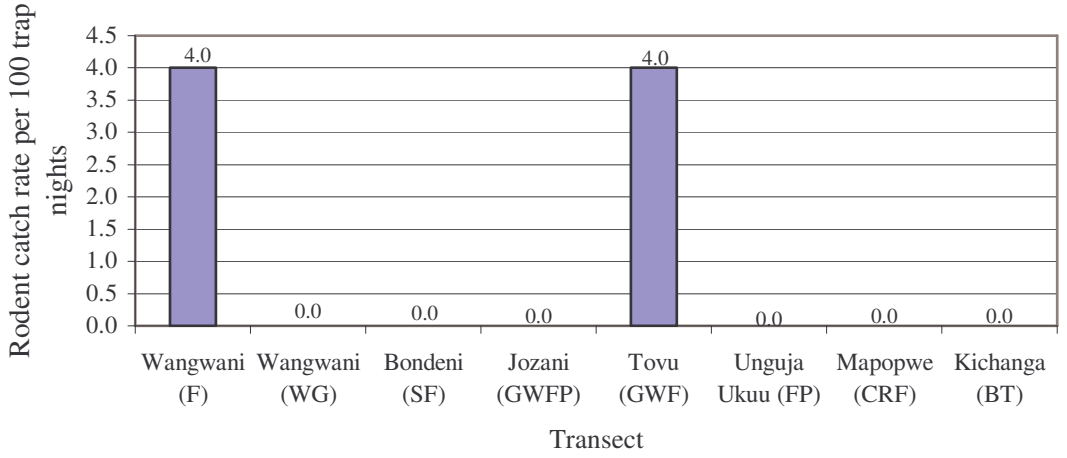

Figure 7: Rodent catch rate (x/100 trap nights) in Jozani - Chwaka proposed National Park, Zanzibar (June-July 2002)

Table 13: Relative abundance of some vertebrate groups and species in Jozani-Chwaka Bay proposed National Park, Zanzibar (Source: This survey; various sources)

Animal group	Species	Relative abundance
Mammals	Zanzibar Leopard	Rare
	Aders Duiker	Moderate
	Blue Duiker	Moderate
	Suni	Abundant
	Elephant Shrews	Abundant
	Shrews	Abundant
	Galagos	Moderate
	Sykes Monkey	Abundant
	Zanzibar Red Colobus	Abundant
	Bats	Abundant
	Vervet Monkeys	Moderate
	Bushpigs	very abundant
	Rodents	Abundant
	Squirrels	Moderate
	Civets	Moderate
Reptiles	Snakes	Moderate
	Chameleons	Moderate
Amphibians		Very abundant

4.2.3 Animal species 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. The highest species diversity was observed in Jozani forest plantation and Wangwani and Tovu forests (Table 14). The wet forested areas showed a high species diversity. Bondeni natural forest and Unguja Ukuu forest plantation showed the lowest species diversity. Figure 8 indicates the number of species for different animal groups found on Zanzibar.

4.2.4 Important habitats for animals

Different animal groups occur in different habitat types (Table 15). 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

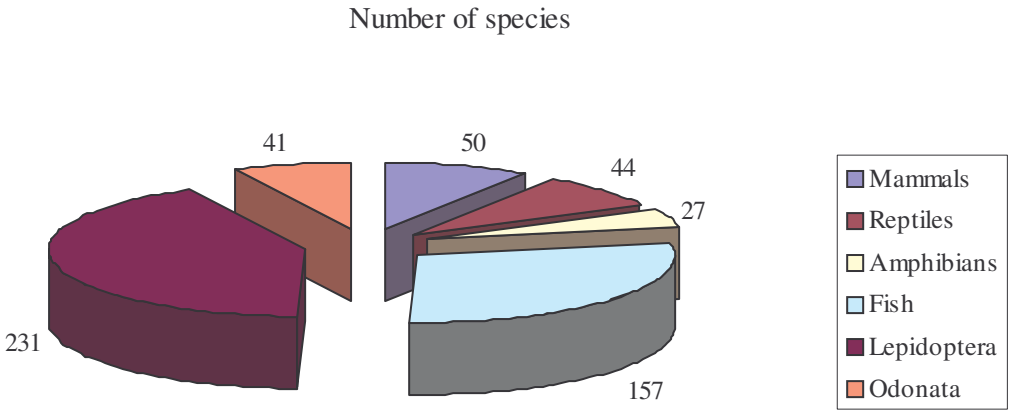

Figure 8: Number of species for various animal groups occurring in Zanzibar. Most of these species are recorded in Jozani Forest and surrounding areas. Fish records are from Chwaka Bay only (Source: variuos sources including Moreau and Pakenham 1941; Pakenham, 1984; FAO, 1984a, 1984b, 1984c, 1984d; Archer *et al*, 1991 and this survey)

Table 14: Shannon Weaver diversity index (H') for all species captured in traps in the 8 sampled transects in Jozani Forest, Zanzibar (H'_{max} = 1.2553)

Transect	H'
1 Wangwani (forest)	0.7445
2 Wangwani (wooded grassland)	0.5796
3 Bondeni (forest)	0.3305
4 Jozani (ground water forest plantation)	0.8335
5 Tovu (ground water forest)	0.7553
6 Unguja Ukuu (forest plantation)	0.3360
7 Mapopwe (coral rag forest)	0.6734
8 Kichanga (Bushland thicket on mangrove forest edge)	0.3756

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, shrews, elephant shrews, bats, amphibians and invertebrates. The forest is the habitat which 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 15: Distribution of different habitats in Jozani - Chwaka Bay proposed National Park, Zanzibar

Species	F	WG	GWF	FP	BT	TF	SM	MF
Red Colobus	*		*	*	*	*		*
Aders Duiker	*			*		*		
Blue Duiker	*			*	*	*		
Suni	*	*		*	*	*		
Bushpigs	*	*	*	*	*	*		
Galagos	*		*	*		*		
Elephant shrews	*		*		*	*		
Shrews	*	*	*	*	*	*	*	
Bats	*		*	*		*	*	*
Sykes Monkey	*		*	*	*	*		
Amphibians	*	*	*	*	*	*	*	*
Molluscs	*	*	*	*	*	*	*	*
Lepidoptera	*	*	*	*	*	*	*	*
Odonata	*	*	*	*	*	*	*	*
Orthoptera	*	*	*	*	*	*	*	*

Legend: F = forest, WG = wooded grassland, GWF = ground water forest, FP = forest plantation, BT = bushland thicket on mangrove forest edge, TF = thicket and forest, SM = salt marsh, MF = mangrove forest

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. Daily, short term movements are exhibited by some animals in search of food and shelter or water. 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. No specific movement routes for the animals were reported by the local people.

4.2 6 Reptiles

Reptiles were the most difficult species to find. Forest Cobras (*Naja melanoleuca*) and White-lipped Snake (*Crotaphopeltis hotamboeia*) were the most frequently observed species during the survey period. A Short-tailed Chamaeleon (*Rhamphoeleon brevicaudatus*) and Tropical Girdled Lizard (*Cordylus tropidosternum*) were recorded for the first time on Zanzibar Island. *R. brevicaudatus* was found on leaf litter in dense coral-rag forest at Mapopwe and *C. tropidosternum* was found in tree holes in forest surrounding Wangwani salt marshes. Literature survey and observations suggest the reptile community on the island to be composed of species known from coastal forests and woddland. Reptile occurrence in Jozani forest was an indication of diversity and suitability of microhabitats that are important for the survival of the group.

4.2.7 Amphibians

Almost all species of the amphibians recorded in Jozani –Chwaka proposed National Park (Figure 9, Table 16) during the survey and reported from previous works (Pakenham, 1984) are common in Tanzania mainland coastal areas. Amphibians were captured in all 8 sampled transects though catch rates differed slightly between areas (Figure 10, 11).

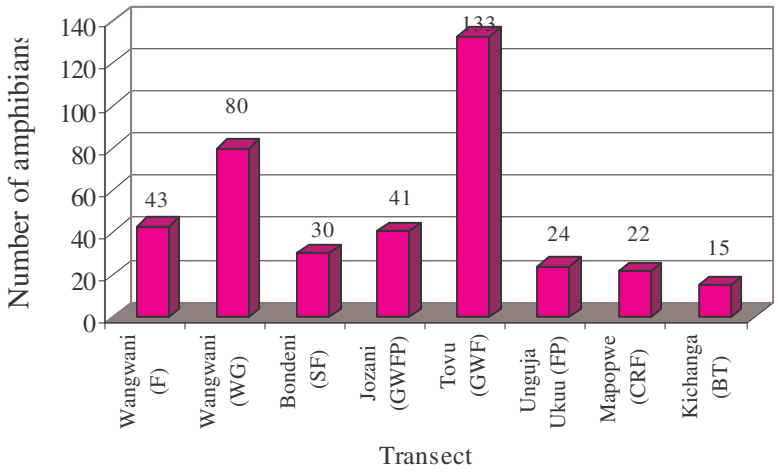

Figure 9: Number of amphibians caught in bucket pitfall traps in Jozani - Chwaka proposed National Park, Zanzibar (June-July 2002)

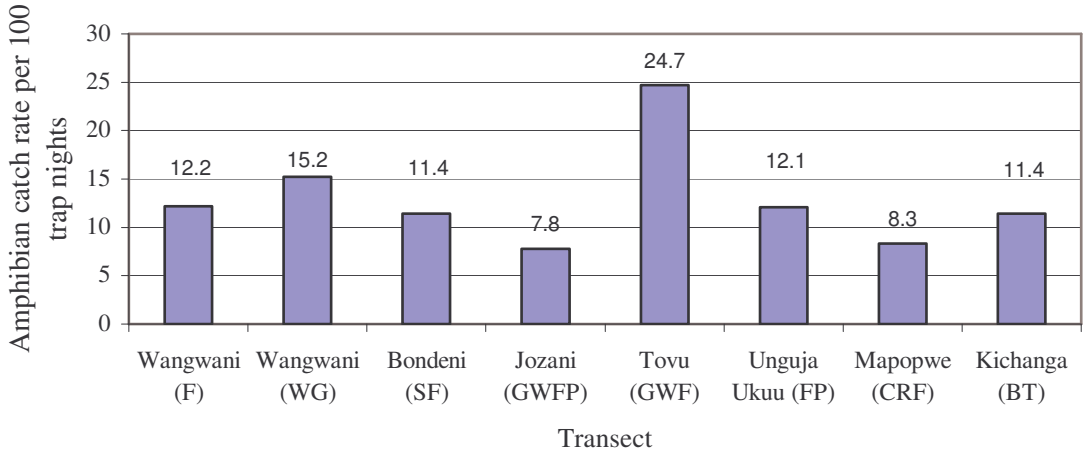

Figure 10: Catch rate of amphibians (x/100 trap nights) from bucket pitfall traps in Jozani - Chwaka Bay proposed National Park, Zanzibar (June-July 2002)

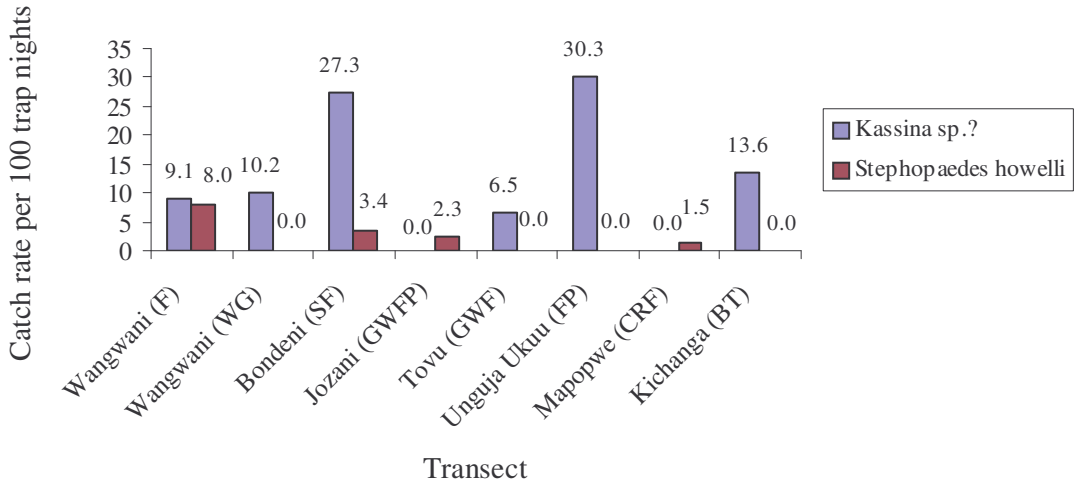

Figure 11: Catch rate (x/100 trap nights) of two species of amphibians a possible new species of "*Kassina*" and Mlola Forest Toad (*Stephopaedes howelli*) in Jozani - Chwaka Bay proposed National Park, Zanzibar (June-July 2002). The latter is endemic to coastal forests on Mafia and Zanzibar.

The *Xenopus muelleri* is a species restricted to freshwater pools and can move from one water body to another on wet days. It has a wide distribution south of the Sahara. In Jozani-Chwaka National Park it was found in ground water forest areas. Three members of the family Bufonidae are reported on Zanzibar Island. *Bufo gutturalis* although common in Zanzibar, was not recorded in the park area. The population of this species in Jozani may be very low. *Mertensophryne micranotis* and *Stephopaedes howelli* are among the known coastal forest endemic species. *Stephopaedes howelli* (Plate 34) is reported for the first time on Zanzibar Island. *Mertensophryne micranotis* was recorded once in plantation forest around Unguja Kuu during the survey. Both species prefer areas with leaf litter and breeding takes place in water trapped in snail shells, coral rag and in tree holes.

Members of the Tree Frogs (*Hyperoliidae, Lepipelis, Afrixalus* and *Hyperolius*) reported on Zanzibar are common species. *Afrixalus stuhlmanni* although not recorded during the survey, its type locality is on Zanzibar Island and may be considered as endemic to Zanzibar. *Hyperolius parkeri* and *Leptopelis flavomaculatus* are coastal forest endemics. Most animals were recorded in areas near forest edge and in patches of grassland. *Kassina maculata*, a species common in fresh water ponds and known to occur on Zanzibar Island was not recorded inside the park area during the survey. A possibly new species of *Kassina* was found (Plate 35). The highest abundance of this species was recorded in forest plantation around Unguja Ukuu. More ecological studies are needed while the description process is underway. The family Rhacophoridae, (Foam-nest Tree frogs) is represented by only a single species on Zanzibar, *Chinomantes xerompelina*.

Eight species of Ranids have been reported for Zanzibar and all are common in the adjacent mainland coastal areas with the exception of *Phrynobatrachus pakenhami* and *Phrynobatrachus minutus*. *P. pakenhami* type locality is near Wete, Pemba and seems to be endemic to Zanzibar and Pemba Islands. Taxonomically, the species may be confused with *P. acridoides,* which is most abundant in rice cultivation outside the park area.

Arthroleptis stenodactylus was reported on Zanzibar for the first time. The species is widely distributed in East Africa to South Africa. However, two types (forest and woodland types) have been reported and can be separated by their characteristic calls (Msuya, 2001). The forest type which was recorded in Jozani forest is restricted to closed and mature forest habitat.

Table 16: Shannon Weaver Diversity indices (H') for amphibians captured in the 8 sampled transects in Jozani-Chwaka Proposed National Park, Zanzibar (H'_{max} = 1.2788)

Transect	H'
1 Wangwani (forest)	0.5699
2 Wangwani (wooded grassland)	0.5796
3 Bondeni (forest)	0.2775
4 Jozani (ground water forest plantation)	0.7174
5 Tovu (ground water forest)	0.7054
6 Unguja Ukuu (forest plantation)	0.2364
7 Mapopwe (coral rag forest)	0.4729
8 Kichanga (secondary forest/mangrove forest edge)	0.0371

4.2.8 Endemic species of animals

Many species on Zanzibar and Pemba 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 6 mammal species are known to be endemic to Zanzibar (Table 17).

Table 17: Endemic and near endemic animal species and sub species on Zanzibar (Source: Moreau and Pakenham, 1941; Pakenham, 1984; Kingdon, 1997; Burgess and Clarke, 2000)

Animal group	Common name	Scientific name	Status
Felidae	Zanzibar leopard	*Panthera pardus adersi*	Endemic to Zanzibar
Cercopithecidae	Zanzibar Red Colobus	*Piliocolobus kirkii*	Endemic to Zanzibar
Bovidae	Zanzibar Red Duiker	*Cephalophus adersi*	Endemic to East African coastal forests, Arabuko-Sokoke forest in Kenya
	Blue Duiker	*Cephalophus monticola monticola*	Near endemic (two different races, one on Pemba and one on Zanzibar; Kingdon, 1997)
Galagonidae	Garnetts Galago	*Otolemur garnettii*	East African coastal forests endemic
	Zanzibar Galago	*Galagoides zanzibaricus*	East African coastal forests endemic
Soricidae	Black and Rufous Elephant Shrew	*Rhynchocyon petersi adersi*	Endemic to Zanzibar

4.2.9 Threatened and endangered animal species

A number of animal species found in the survey area and surroundings are threatened. These include 14 mammals and 14 reptiles (see Table 18). 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 18: Threatened and endangered animal species listed in IUCN redlist, and species listed in CITES Appendices found in Jozani - Chwaka Bay proposed National Park and other areas in Zanzibar (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
Macroscelididae (elephant shrews)	Black and rufous Elephant shrew	*Rhynchocyon petersi adersi*	EN. B1 + 2c	
Megadermatidae (Bats)	Heart-nose Big-eared Bat	*Cardioderma cor*	LR. Nt	
Rhinolophidae (bats)	Decken's Horse-shoe Bat	*Rhinolophus deckeni*	DD	
Galagonidae (bushbabys)	Zanzibar galago	*Galagoides zanzibaricus*	LR, nt	
	Greater galago	*Otolemur garnettii*	LR, nt	
Cercopithecidae (monkeys)	Sykes monkey	*Cercopithecus mitis*	DD	II
	Zanzibar Red Colobus	*Piliocolobus kirkii*	EN, B1a	II
Viverridae (mongooses and civets)	Zanzibar slender mongoose	*Herpestes sanguineus*	EN, B1 + 2c	
Felidae (cats)	Zanzibar leopard	*Panthera pardus adersi*	?	I
Procaviidae (hyraxes)	Eastern Tree hyrax	*Dendrohyrax validus*	VU. B1 + 2c	
Bovidae	Zanzibar Red Duiker	*Cephalophus adersi*	EN, C1	
	Suni	*Neotragus moschatus moschatus*	LR, cd	
	Blue Duiker	*Cephalophus monticola*		II
Sciuridae (squirrels)	Red Bush Squirrel	*Paraxerus palliatus*	VU, A1c	
Dermochelyidae (turtles)	Leatherback turtle	*Dermochelys coriacea*		I
Chelonidae (turtles)	Green Turtle	*Chelonia mydas*	EN, A1 abd	I
	Hawksbill Turtle	*Eretmochelys imbricata*	CR, A1, abd, 2bcd	I
Testudinidae (tortoises)	Aldabra Giant Tortoise	*Geochelone gigantea*	VU, D2	II
	Bell's Hinged Tortoise	*Kinixys belliana*		II
Gekkonidae (geckos)	Dull-Green day Gecko	*Phelsuma dubia*		II

Animal group	Common name	Scientific name	Conservation status	
			IUCN Redlist	CITES Appendices
Chamaeleonidae (chameleons)	Flap-necked Chameleon	*Chamaeleo dilepis*		II
Cordylidae (lizards)	Tropical Girdled Lizard	*Cordylus trypidosternum*		II
Varanidae (monitor lizards)	Nile Monitor	*Varanus niloticus*		II
Boidae (pythons)	Rock Python	*Python sebae*	VU	II

4.2.10 Introduced species of animals

Islands like Zanzibar are often affected by introduction of alien species by variuos dispersal agents including humans (Table 19). 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).

Table 19: Some animal species introduced to Zanzibar and Pemba

Common name	Scientific name	Area introduced	Agency	Introduction date	Current status
Wild boar/Black pig	*Sus scrofa*	Zanzibar and Pemba	Portuguese	16th century	Present
Musk-shrew	*Suncus caeruleus*	Zanzibar	Stowaway	Unknown	?
Javan civet	*Viverricula indica*	Zanzibar and Pemba	Indian community	Unknown	Present
House rat	*Rattus rattus*	Zanzibar	Stowaway	Unknown	Present
Common rat	*Rattus norvegicus*	Zanzibar	Stowaway	Unknown	Present
Snake	*Rhamphotyphlops braminus*	Zanzibar	Stowaway on soil of plant cuttings	Unknown	Not known

4.2.11 Fish

Chwaka Bay

Chwaka Bay is located within 6.13-6.25°S and 39.37-39.58°E on the East Coast of Unguja Island, about 34 km east of Zanzibar town. Large intertidal flats partly covered with mixed assemblages of algae and seagrass beds characterize the bay. On the landward side of its

mouth, the bay is fringed by a dense mangrove forest, which is drained by a number of tidal creeks, the largest of which is Mapopwe Creek, the main water exchange route between the forest and the bay. A modest fragmented coral reef occurs at the entrance of the bay, which is part of the extensive reef that fringes the east of Unguja Island.

4.2.11.1 Fisheries resources

Fisheries resources found on Zanzibar include fish, prawns, sea cucumbers, seaweeds and lobsters. These are mainly exported but fin fishes are used for local consumption. All these resources are also available in Chwaka Bay. Other marine resources like prawns, lobsters, and sea-shells 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 molluscs and cockles) are used domestically since their production is low (FAO/Department of Environment Zanzibar, 1999).

4.2.11.2 Fish species occurrence, endemism and diversity in Chwaka Bay

Chwaka Bay is found in region No. 51 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 Chwaka Bay there are at least 38 fish families (Appendix IXa) and not less than 157 fish species (Appendix IXb). None of the families or species is 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).

4.2.11.3 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 Chwaka fishermen report large numbers of fish migrating from marine areas into the estuarine 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 Chwaka Bay. 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 specialised 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. Poamacentridae, Chaetodontidae, Pomacanthidae, Monocanthridae, Ostraciontidae, Tetraodontidae). A few groups, mainly small schooling fishes in the families Pomacentrridae, Clupeidae and Antherinidae, are zooplankton feeders.

4.2.11.4 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 Chwaka Bay 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 complete all their lifecycle there (Thallot, 1992). This situation is also expected to occur in shallow water Chwaka Bay. The lack of many potential predators in the bay provides a conducive 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 Gereidae, Antherinidae, Clupeidae, Teraponidae, Acropomidae, 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. Chwaka Bay has creeks and fishermen report of the presence of reefs at the edge of the bay where it joins the marine environment. The presence of these areas diversify the habitats available for fish in the area and provide opportunity for fish to undertake short term feeding migration between these habitats.

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. Seagrass 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 Chwaka Bay 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. Places reported to be important for fish breeding in the estuarine included Mchenga/Kidimani, Vijawi, Kumvi and Haibari "river". These breeding sites have special significance in Chwaka bay as they form an important breeding area for fish because the corals which are usually good breeding sites for fish are reported by fishermen to be on the edge of the bay where it joins the marine environment. It is important to note here that seagrass farming is also actively practised by the local people especially women in Chwaka Bay (FAO/Department of Environment Zanzibar, 1999). This has a positive effect on fishery as the seagrasses provide shade, feeding and nursery grounds for fish.

4.2.11.5 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 20). Many of these fish occur in deep water sea or are benthic species so are not easily seen by the local people. 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 20: Threatened fish species (IUCN) reported as occurring on 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	*Epinepheleus tukula*	Potato grouper	LR
LABRIDAE	*Cheilinus undulatus*	Hampered wrasse	LR
CARCHARHINIDAE	*Carharhinus plumbeus*	Sandbar shark	LR
CARCHARHINIDAE	*Carharhinus taurus*	Grey nurse shark	EN
CARCHARHINIDAE	*Carharhinus falciformis*	Silky shark	LR
CARCHARHINIDAE	*Galeocerdo cuvier*	Tiger shark	LR
SERRANIDAE	*Cromileptes altivelis*	Barramund grouper	LR

FAMILY	SPECIES	ENGLISH NAME	IUCN STATUS
SERRANIDAE	*Epinepheleus fuscoguttatus*	Flowery grouper	LR
SERRANIDAE	*Epinepheleus malabaricus*	Malabar grouper	LR
SERRANIDAE	*Epinepheleus 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 djeddensis*	White spotted wedge fish	LR
DASYATIDAE	*Taeniura lymna*	Ribbontail 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

4.2.11.6 Fishing and fish production

(a) Number of Fishers

A survey conducted by Commission for Natural Resources found that there were 23,734 fisher on Zanzibar, of which 11,965 were based on Unguja Island and 303 were in Chwaka Bay. The Chwaka Bay fishers make about 1.2 % of Zanzibar and 2.5% of Unguja fishers respectively (FAO/Department of Environment Zanzibar, 1999).

(b) Fishing vessels

Fishing vessels employed include dugout canoes, outrigger canoes, planked motorised boats and planked sailing boat. A survey conducted by the Commission for Natural Resources showed that there were 5,149 fishing vessels on Zanzibar and 2,933 on Unguja. Chwaka Bay had 167 vessels or 3.2% and 5.6% of Zanzibar and Unguja vessels respectively (FAO/Department of Environment Zanzibar, 1999).

(c) Fish production

Data on fish production from Chwaka Bay and Unguja 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.

In Chwaka Bay fish production by artisanal fishermen has dropped by 89% between 1994 and 2000 (Table 21). On the other hand fish production for the whole of Zanzibar has remained more or less unchanged between 1993 to 1997 with only a slight increase of 1.2% in total fish production for 1997 compared to that of 1993 (Table 22). This suggests that probably fishing intensity has not changed over the specified period or there has been a minimal fish habitat destruction which has enabled the fish stocks to remain healthy.

Table 21: Fish catch (kgs) at Chwaka Bay by artisanal fishermen from 1994 to 2000

YEARS	1994	1995	1996	1997	1998	1999	2000
GROUP/SPECIES							
SIGANIDAE	48576	42266	41844	34730	36292	19987	9320
SCARIDAE/LABRIDAE	40998	57658	72566	38611	15721	9678	8511
LETHRINIDAE	60782	83946	89800	72483	60572	41550	17628
HAEMULIDAE	6134	9337	18837	8846	1777	341	116
MULLIDAE	21880	14022	18186	12888	3977	3500	2340
ACANTHURIDAE	15045	4050	7213	2762	244	16	-
MUGILIDAE	14132	384	897	610	3540	2010	262
DEMERSALS	16640	9763	14850	8417	-	-	-
ENGRAULIDAE	17003	4834	6886	3936	4	110	-
CLUPEIDAE	8514	-	794	1418	-	-	-
SCOMBRIDAE	20763	3360	3724	2817	2378	-	-
CARANGIDAE	19509	13322	18801	10251	3994	7873	1692
SCOMBRIDAE	2309	-	2510	71	206	18	2212
ISTIOPHORIDAE	10607	-	-	490	-	100	-
SCOMBRIDAE	13769	1852	6271	3642	218	50	-
SYPHRINIDAE	18045	3067	8657	9528	1136	1367	440
PELAGICS	27256	18076	20446	13376	-	-	-
ELASMOBRANCHIA	33432	25805	34709	20396	24400	12464	1796
LOLIGIDAE/OCTOPODIDAE	29537	28021	31340	24865	38118	12955	6561
PENAIDAE	8203	2281	6375	2066	1591	-	-
Others	35337	6455	14469	15145	4950	18762	5952
TOTAL	**468473**	**328499**	**419175**	**286348**	**216118**	**130779**	**56830**

Source: Zanzibar Fisheries Department

Table 22: Fish production on Unguja Island between 1993 to 1997

Year	Catch (kg)
1993	7,354,249
1994	8,059,401

Year	Catch (kg)
1995	7,321,500
1996	7,817,800
1997	7,443,227
Total	**37,996,227**

Source: Zanzibar Fisheries Department

Fishing gears

Fishing gears in Chwaka Bay 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).

4.2.10.7 Threats to fisheries resources

Marine biodiversity threats are divided into two aspects: proximate threats and root causes. Data from Zanzibar Fisheries Department show a decrease in weight of fish caught in recent years. The decline is attributed to:

1. Some of the fishers decided to shift from the fishing activities to seaweed farming (possibly due to decline in fish production)
2. Destruction of breeding and nursery grounds especially coral reefs, through dynamiting
3. The use of the illegal fishing gears especially the small mesh size nets resulting in over fishing of both mature and juvenile fish (FAO/Department of Environment Zanzibar, 1999).

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.

In Chwaka Bay some fishers use fishing techniques and gears which are illegal including dynamiting and poison fishing. These techniques are unselective and kill large numbers of invertebrates that are then not harvested (IUCN, 1990; Salvat, 1987). Some fishing gears that are illegal in the area include small mesh size fishing nets and harpoon guns. Many marine organisms, including corals, sponges, molluscs, echinoderms, puffer and tiger fishes are collected widely for the curio trade and jewellery (IUCN, 1990; Martens, 1992; Wells, 1988).

Physical alteration and habitat loss

Organisms are adapted to specific abiotic environments, the conditions in each place are crucial in determining the community of species that live there. Dugan and IUCN (1990) reported that vast areas of mangrove, estuaries and beaches are cleared for activities like aquaculture a common practice in many developing countries. Since more valuable and commercially important fish species depend on these coastal habitats as nursery grounds their survival is thus threatened. Also some fishing methods like beach seining disturb the seabed and cause physical damage and reduced photosynthesis caused by suspension of sediment (Salvat, 1987).

In Chwaka Bay there are various activities which cause physical alteration and habitat loss. The human population increase and increase of the tourism industry are potential threats to the area. Other activities causing the physical alterations in this area are construction, clearing for aquaculture, and dynamiting of the coral reefs, which cause serious beach erosion. Negative impacts of tourism includes trampling, and boat anchoring on the coral reefs (Martens, 1992).

Pollution: human sewage (together with pathogenic organisms) and aquaculture runoff (with increasing amounts of inorganic fertilisers) which are rich in nitrogen and phosphorous, form a major source of pollution of coastal waters.

Chemicals such as trace metals and petrol residues become toxic environmental contaminants when discharged in excess concentrations. Increased use and disposal of plastics, solid wastes and debris cause widespread mortality in marine species through entanglement and ingestion (Carr, 1987).

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/ICUN/UNEP, 1992).

4.2.11.8 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.

Local initiatives

In the past traditional management practices such as closing of the octopus fishery for certain periods were implemented. Now days due to population increase and culture changes such practices are no longer in existence in most fishing villages. However, in Chwaka fishermen claim that they still do practice a fishing moratorium for octopus and prawns. Currently there is a need for establishing a marine protected area in Chwaka Bay. This could be implemented by emulating examples found elsewhere in Zanzibar like Menai Bay, Mnemba and Misali where conservation areas have been established and at Chumbe Island where there is a coral park. Mnemba and Chumbe are privately managed under special agreements with the Government. In all those protected areas community participation is given a high priority. Major problems of these protected areas are shortage of funds, which lead to poor law enforcement. Although Chwaka Bay will be annexed into the proposed National Park, the management programme of the bay could be designed such that local community participation is included (FAO/Department of Environment Zanzibar, 1999).

4.2.12 Invertebrates (Lepidopterans and Odonata)

A total of 204 individual specimens of Lepidoptera and Odonata were sampled during this study. These comprised of 163 Lepidoptera (46 species of Butterflies and 13 families of Moths), and 41 Odonata (12 species of Dragonflies and Damselflies). The complete checklist

is given on Appendix Xa, and the number of individuals from the six sites is given in Appendix Xb. At least 68 species seen by Archer *et al* (1991) were not sampled during this survey.

Relative abundance was similar at five out of the six sites. There were 34, 43, 43, 36, and 30 individual specimens per total sampling effort at the first five sampling sites (see Table in Appendix IXd). The sixth site (thicket) had low relative abundance of both Lepidoptera and Odonata (18 individual specimens per total sampling effort). Sampling effort was low due to the short time spent in the field. This is indicated by the large number of species represented by single specimens (singletons). For example, for Butterflies, the percentage of singletons was 58.7%. Most of the butterflies and Odonata are common in lowland parts of East Africa. The following species deserve special attention:

a) Rare species

Acraea cerasa cerasa, commonly known as the "tree-top acraea", is rare in Tanzania. This species is found in tree tops of coastal forests. Its larval food plant are the forest tree species, *Rowsonia lucida* and *R. usambarensis* (Family Flacourtiaceae) and *Rinorea convallarifolia* (Family Violaceae).

b) Endemic species

Two species *Abisara zanzibarica* and *Bicyclus kiellandi* are endemic to Tanzania. The first was described from specimens collected at Jozani Zanzibar in 1988. The second is found in woodland, grassland and forest edges in localised areas from sea level to mid-altitude. It has been collected in Mikumi and the Udzungwa Mountains.

c) Forest species

Forest species are indicated with an asterisk (*) in Appendix Xa. These need special conservation priority because their habitat (forest) is subjected to pressure from economic activities (agriculture etc.). Examples include: *Amauris niavius dominicus* (the frier or monnik) is an unpalatable species to predators and serves as a model to several other butterflies (mimics). Its larval host plant is *Gymnema sylvestre.* The adults are found all year around. *Charaxes brutus natalensis* (the white-barred charaxes) is found in most coastal and island forests. Its larval host plants include *Triclia emetica*, *T. dregeana*, *Turraea* spp. and others. *Papilio nireus lyaeus* (green-banded swallowtail) occurs in forest and woodland from

sea level to about 1500m above sea level. Larval food plants include members of Family Rutaceae such as *Toddalia* spp., *Clausena* spp. and *Citrus* spp.

4.2.12.1 New records from Jozani-Chwaka Bay

Butterflies not recorded by Archer *et al*. (1991) at Jozani-Chwaka are indicated (by a star (✪) in Appendix Xa.

4.2.12.2 Observations of other invertebrates

Opportunistic sampling of other Invertebrates revealed a rich and diverse fauna. Some interesting examples include the following: Freshwater pools in the Ground-water Natural Forest and Ground-water Forest Plantation areas harboured several snail species, including *Bulinus nasutus* and *Bulinus globosus*. The same pools had fresh-water crabs of genus *Potamonautes* and larvae of mosquitoes, including *Aedes aegypti* and *Culex quinquefasciatus*. *Anopheles funestus* adults were observed in the Wooded Grassland area. Other invertebrates observed in various places included Adults and larvae of dung beetles (Scarabaeidae), Field Crickets (Orthoptera: Griliidae), centipedes and millipedes (Diplopoda and Chilopoda) and earthworms (Annelida: Oligochaeta), among others.

Molluscs

(Class: Gastropoda, Sub Class: Pulmonata, Order: Stylommatophora, Family: Achatinidae). Many live specimens and shells of the giant African snail (*Achatina fulica*) were seen in Jozani forest and other areas surrounding the forest. Many shells were observed scattered especially in Tovu area. The Zanzibar variety used to be called ssp. *hamillei* (versus ssp. *rodatzi*), the Dar es Salaam subspecies. The naming was based on shell striations and patterning, which in semi-fossilised shells are already weathered. However both the Zanzibar and Dar es Salaam varieties have been found to interbreed in areas where the two varieties converge such as Mbudya, Bongoyo islands off the coast of Dar es Salaam and eastern coast along Bagamoyo and Saadani.

5.0 EVALUATION OF BIOLOGICAL RESOURCES AND THEIR CONSERVATION VALUE

Although in terms of biodiversity Jozani and Zanzibar as a whole may not be as rich as the coastal forests (Frontier, 1995) and Eastern arc mountains on the mainland most of the species on Zanzibar 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.

Some species found in Jozani are of potential value as a genetic resource. Species like *Coffea psudozanguebariae* (Rubiaceae) is of potential importance in crossbreeding to produce coffee hybrids.

A tree species *Pandanus rabiensis* has been singled out as the most inactive indigenous species in the groundwater forest. Accounts of its regeneration capacity are not available. This could form part of a research project to study its biology including breeding systems, dispersal mechanisms and seed viability. The species may not be economically importyant but its conservation is essential in terms of biodiversity conservation.

It is known that over 75% of the closed forests originally present on Zanzibar were destroyed by 1966 (Hedberg and Hedberg, 1966), more of the forest has been cleared since then. Human population increase was a major factor in the decline of forests. Understanding human demography of populations living on the edge of proposed park is essential in the biodiversity conservation of the area since this will allow designing appropriate conservation programmes taking which take into account the growing human populations.

There is also the issue of alien species like *Areca catechu* (*mipopoo*) (Palmae). No studies have bee conducted on this species which is known to suppress indigenous vegetation and little effort appeart to have been unable to control their spread.

For plant resources outside protected areas which can be exploited they may provide medicinal plants, grazing areas, timber, building materials and good habitat for beekeeping

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. Understanding the status of the Zanzibar leopard is of exceptional importance due to the controversial conservation status of the animal. 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.

6.0 POTENTIAL THREATS TO BIODIVERSITY

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 Jozani is similar to that found in the Eastern Arc Mountains on the mainland. The following were identified as threats to Jozani-Chwaka Bay proposed National Park biological diversity:

1. Human population pressure

Humans are a major cause of biodiversity loss in coastal ecosystems (Martens, 1995). Zanzibar is experiencing a fast growing population (annual population growth rate r = 0.03) Jozani forest and the surrounding areas are important source of fuelwood, charcoal, building poles (Plates 25, 26, 28), medicines, food and fodder (Appendix V). 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 (Plates 2, 8, 9).

The introduced trees in Jozani area include coconut palm (*Cocos nucifera*), mangoes (*Mangifera indica*), tamarind (*Tamarindus indica*), guavas (*Psidium guajava*), banana (*Musa* spp.) (Plate 22) all of which are widespread in what was once natural vegetation area. Humans are also responsible for over utilisation of animal resources from both terrestrial and marine ecosystems through hunting, fishing and invertebrates collection (sea cucumbers, bivalves).

2. Grazing impact

A number of people in Jozani and surrounding areas keep livestock including cattle, goats and a few donkeys. Fodder plants include trees shrubs, forbs and grasses. Some species have exceptionally high nutritive values and are preferred by domestic stock. Baobab (*Adansonia digitata*) for instance contains about 16.9% crude protein and is so palatable that its seedlings

are scarce and big trees are rare. Increased livestock number cause negative impact on fodder species (Plate 29). With heavy grazing the habitat may change for such an extent that some species may not be able to survive and these will be lost from the ecosystem, causing a change in biodiversity. This threat is made worse by the free grazing system practiced in most of the villages surrounding the Jozani forest and sometimes livestock encroach into forest (See Appendix V).

3. 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, 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 (Plate 31a and b). 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.

A number of alien species have been introduced to Zanzibar including the Javan civet (*Viverricula indica*), House rat (*Rattus rattus*) and Common rat (*Rattus norvegicus*) (Moreau and Pakenham, 1941). These species are common in the proposed national park. 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).

4. Extraction of forest resources

Timber harvesting is one of the most pressing threats to biodiversity in the study area. For valuable timber species only a few individuals of *Burttdavya nyasica* were encountered during the survey while *Milicia exelsa* was completely missing. Stumps of *Burttdavya nyasica* were encountered in few stands especially in *Pandanus-Raphia-Vitex* groundwater forest. The basal areas of many of the timber trees were also very low indicating timber tree sizes had already been over-harvested. The timber trees in Jozani include *Sorindeia madagascariensis, Terminalia boivinii, Casearia gladiiformis, Macaranga capensis, Bridelia micrantha, Trichilia emetica, Xylocarpus granatum, Rapanea melanophloeos, Milicia excelsa, Syzigium cordatum, Syzigium cumini, Albizia adiathifolia, Afzelia qaunzensis, Burttdavya nyasica, Vitex doniana, Erythrophleum suaveolens* and *Callophylum inophyllum*. The basal areas for these species are presented in Appendix III. Collection of fuelwood, building poles and medicinal plants are other activities that may cause loss of species and therefore pose a threat to biodiversity.

5. Agriculture

Most of the area is unsuitable for farming but Mapopwe and Cheju areas are more fertile and large areas of Mapopwe have been cleared for farms (Plate 8). Mapopwe area is dominated by *Albizia* forest and wildlife there is at risk due to poison which is put into ripe pawpaws and bananas to kill "pest" animals that destroy crops. The bait was meant to kill monkeys including vervet, blue and red colobus monkeys. Large areas of forest were cleared and long coral rock walls are erected to protect farm plots from wild pigs and other animals. Such walls were also encountered as ruins in secondary forest in Mapopwe.

6. Fire

Man made fires have a great effect on plants and biodiversity in general. Depending on the intensity and frequency the effects of fire may range from mild where a few fire resistant species are favoured to severe whereby an area is made completely devoid of vegetation. Although no event of recent fire was recorded in the study area, the signs of past fires were noted, especially in the wooded grassland and in the bracken bush. Interviews with the local people revealed that poachers and honey collectors caused most fires. Fire is also a great

threat to reptiles, amphibians and invertebrates. Serious fires damage habitats, so reducing their quality. Fire may also cause changes in species composition of an area through encouraging some species and supressing others.

7. Habitat loss and fragmentation

This 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. The decline in the Zanzibar red colobus numbers is mainly attributed to habitat loss and fragmentation. This factor is also known to affect to some extent the duiker species in the area. There are obviously many other species affected in this way. 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.

8. Hunting/over exploitation

This includes both illegal and uncontrolled legal hunting. Hunting is the main cause of the decline in numbers of duikers and blue monkeys in the survey area. It is reported that there is increased demand for wild meat and trophies by tourists coming to the south eastern Zanzibar and this is a potential threat to some animals especially the antelopes. Fish, molluscs and other marine resources are adversely affected by over exploitation.

9. 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). The possibility of such an event is high

given the large number of visitors from all over the world going to Jozani each year. The primates in Jozani would be the most susceptible to this problem.

10. Pollution

In Jozani area 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. This is mainly due to the increase in tourism activities. For the marine environment sewage from coastal settlements and run-off from inland are potential threats. Inland run off water may carry soil, pesticides, chemicals and other suspended materials into the sea. The potential threat from pesticide misuse needs to be taken into consideration.

11. Motorway mortality

Despite its effect on wildlife, road kills of animals is often not documented (Lode, 2000). Animal mortality is also reported to increase exponetially with increase in traffic volume. At Jozani forest a number of animals including the Red colobus, are reported to be killed by speeding vehicles (Struhsaker and Siex, 1998). Other affected species include blue monkeys, antelopes, and occasionally birds, reptiles and amphibians. A suspended bridge constructed for red colobus to cross the highway at Jozani is not used by the colobus. Improved designs and new approaches may be necessary to reduce the road accidents. Road humps and sign boards in areas frequently used by animals to cross have not proved to be very effective either. Construction of underground passages and fauna ducts reduced mortality of crossing animals in western France by 21% to 31% in places where road mortality reached 100% (Lode, 2000).

12. Small population paradigm (Caughley, 1994)

Most of the plant and animal species and communities in Zanzibar are 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 or pythons, hippos and crocodiles which are known to be able to swim across the continental shelf between the mainland and Zanzibar (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.

13. Declining population paradigm (Caughley, 1994)

Generally island populations have higher extinction rates than continetal 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 the Zanzibar leopard, Aders' duiker, blue duiker and sykes monkey and some plants 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.

14. Tourism

About 216, 000 tourists visit Zanzibar each year and most of them visit Jozani forest. This area is therefore an important tourist destination. There are a number of impacts arising from tourism including cultural, economic and environmental (e.g. pollution, disease transmission). Habituation of red colobus and littering are examples of problems currently existing in Jozani. No studies have been done to determine the acceptable number of visitors which can visit the area without having serious negative impact on the environment. Since Zanzibar is increasingly becoming a major tourist destination in East Africa, levels of acceptable use for the proposed national park should determined to avoid future problems.

Table 23: Summary of potential threats to biodiversity in Jozani-Chwaka Bay Zanzibar

Group	Species	Threats
Protected area		Encroachment, vegetation clearing, resources exploitation
Mammals	Zanzibar leopard	Hunting, disturbances, small & declining populations paradigm
	Zanzibar red colobus	Habitat loss and fragmentation, road kills, hunting
	Aders duiker	Hunting, habitat loss and fragmentation, small & declining populations paradigm
	Blue duiker	Hunting, habitat loss and fragmentation, small & declining populations paradigm
	Suni	Hunting
	Galagos	Habitat loss
Reptiles	Sea turtles	Exploitation, loss of nesting sites, marine pollution
	Tortoises	Wildfires, habitat loss
Amphibians		Pollution, habitat loss
Fish		Exploitation, marine pollution, habitat damage

Group	Species	Threats
Invertebrates	Molluscs (terrestrial, fresh water)	Pollution, wildfires
	Molluscs (marine)	Marine pollution, exploitation
	Lepidoptera	Pollution, wildfires
	Orthoptera	Pollution, wildfires
	Odonata	Pollution, wildfires

7.0 RECOMMENDATIONS

The proposed National Park has 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 Jozani-Chwaka Bay proposed National Park, 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 proposed park 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 such as the Zanzibar Red Colobus (*Piliocolobus kirkii*), Zanzibar leopard (*Panthera pardus adersi*) and the over exploited plants; *Croton sylvaticus* and *Burttdavya nyasica*. There is also a need to address the issue of duiker hunting in areas surrounding the park, as hunting appears to be one of the major threats to the duikers. The conservation of the new species of frog (*Kassina* sp.) is another important issue to address as indications are that the frog is endemic to Zanzibar. 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:

1. There are five key areas, which need to be considered when formulating the strategic conservation and management plan for the proposed park. These include:

- the proposed Jozani - Chwaka National Park
- the forest plantations
- the Mapopwe enclave
- the surrounding habitats and communities involving neighbours to the proposed park
- the mangroves and Chwaka Bay which are ecologically different from the other terrestrial habitats.

2. A habitat and population viability analysis including sensitivity test for the Zanzibar red colobus is recommended to ensure an effective planning of its sustainable conservation

3. Immediate scientific measures should be taken to establish the actual conservation status of the Zanzibar leopard (*Panthera pardus adersi*) in order to have a conclusive statement on its presence on Zanzibar.

4. The ecology of the new species of frog (*Kassina* sp.) needs to be investigated to allow for its description. A close collaboration is needed between The Department of Commercial crops, Fruits and Forestry, CARE and University of Dar es Salaam to facilitate this process.

5. The proposed park should remain a core habitat for the duiker populations. Since duiker hunting on the edge of the proposed park also threatens duiker populations inside the park, it is advised to impose a temporary ban or moratorium on duiker hunting to ensure their recovery and give authorities time to plan properly the conservation strategy for the duikers. Where appropriate, initiate or continue with breeding in captivity programmes for certain species such as the red duiker breeding programme (Williams *et al.* 1996)

6. A number of plant and animal populations in the proposed park are either rare, endemic, small or declining. Some populations may even be not viable. Immediate measures need to be taken to serve these species from disappearing. These species should also be subjected to monitoring programmes. Affected plants include those over-used for medicine, especially C*roton sylvaticus* and *Burttdavya nyasica* used for timber. 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.

7. Heavy logging has been reported to be the cause of disappearance of timber valuable species like *Milicia excelsa*. It is recommended to increase the population of the scarce ones through enrichment planting of such species.

8. Forest plantations have been neglected for a long time. Tending operations should be re-introduced to save them from further deterioration. In the *Casuarina* plantation there is no regeneration following harvesting because *Casuarina* does not coppice from stumps. Efforts should be directed to rehabilitate harvested blocks previously under *Casuarina*

plantation. In the *Acacia* plantations profuse coppicing occurs especially in *Acacia mangim*. This species should be thinned out to obtain a few good pole-stems. Uncontrolled harvesting in Kibele plantations and other plantation blocks should follow proper management plans. The plant nursery at Jozani forest headquarters should be expanded so that more seedling stocks can be raised for distribution to villages and expansion of forest plantations.

9. 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.

10. 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 Zanzibar is expected to have insular species because it is an island.

11. 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 of Jozani-Chwaka Bay area 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.). Jozani is a unique ground water forest habitat and fresh water habitats outside the proposed park are under threat. It is, therefore, important to protect the environment and the suitable habitats inside the park.

12. Undertake the study of the ecology and forest dynamics of Jozani forest to identify the key pollinators and dispersal agents in the ecosystem.
13. Monitor the introduced species of plants and animals on the ecology of the park and determine their potential threats to the indigenous populations of plants and animals and take appropriate measures to control the situation

14. Mangrove formations for instance must be treated differently from the terrestrial ecosystem. A separate natural resource management and conservation programme should be put in place to ensure effective conservation of its biological diversity. This may start by a simple measure of making the protected areas exclusive while long term conservation measures are planned.

15. To ensure that the depleted marine resources in Chwaka Bay are restored, involve local communities in marine resources management and conservation and prepare a comprehensive management and conservation plan for the fisheries resources in the area.
16. To control or discourage man-made fires. Human activities that cause fires such as poaching (hunting), charcoal burning and honey collection can be controlled by reinforcing the existing by-laws and even by formulating new ones. Create fire breaks in vulnerable areas through using techniques like plantation block roads.

17. To restrict free trails into the proposed National Park area. There were very few fresh trails leading into the forest, but cut stems were prevalent in the dry scrub forest and in the bushland and thickets.

18. The forest area has been used by people living on the forest edge through generations. The forest plantations were specifically established for harvesting, whereas access by the local people to the natural forest is now restricted although there are indications that they are still somehow still dependent on it. 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 proposed park.

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 the city (*ex situ* conservation).

20. 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.

21. Evaluate the agricultural practices in areas surrounding the proposed park to determine potential threats to biodiversity arising from these practices including use and disposal of pesticides and other pollutants

22. Since there are a number of human activities and livestock grazing occurring inside the proposed park, their impacts need to be investigated. Nevertheless, livestock should be excluded from the proposed national park. For integrated management in areas outside the proposed park, the actual number of livestock should be known and fodder plant species should be properly monitored. Encouraging zero grazing is one measure to minimize threats caused by the free grazing of domestic animals. This is because most tree planting and woodlot establishment is done in the grazing, small-farming areas such as in Mapopwe where livestock herding is free-range. Free grazing animals destroys tree seedlings before they reach maturity. In such areas the farmers raise livestock more than the land can support. The excessive livestock not only damage trees but also cause soil compaction and overall soil degrdation. The villagers can be encouraged to reduce the number of animals.

23. During our discussion with local people the impression we had was that many people seem to be unaware of the proposed changes of the conservation status of the area and conservation issues in general. 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. During interviews and questionnaires some people were reluctant to cooperate for fear of being evacuated.

24. A reference collection/display should be established to maintain limited mounted specimens of plant species, small mammals, and insects found in the proposed park. Technical staff should be recruited and trained to man the reference collection. Research facilities should be incorporated into the management plan.

25. 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.

26. 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

27. A close evaluation of the impact of the Mapopwe enclave activities on the park need to be studied and evaluated. This will provide clues on whether its future existence inside the park is sustainable or not.

28. 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.

29. 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 caused by fire, land clearance for agriculture, forest plantation, 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

30. Improve the publicity of Jozani forest at the same time taking precaution on the effect of having too much ecotourism

31. This report provides conditions outside the proposed park in 2002. 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 park.

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TERMS OF REFERENCE

Outputs of the contract

- A vegetation map of the National Park showing vegetation types and their distribution. The vegetation classification used will be agreed between the consultant and Jozani - Chwaka Bay Conservation Project (JCBCP) at the beginning of the project. 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. The location of rare and/or important species.

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

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

Other agreement

- At the end of the consultancy period all specimens collected, data, maps, reports and any other intellectual information will remain the sole property of the JCBCP

Appendix I: Plant checklist of Jozani-Chwaka Bay Proposed National Park, Zanzibar

FAMILY	BOTANICAL NAME	LOCAL NAME	Group
Adiantaceae	*Achrosticum aureum* L.		(P)
Aspleniaceae	*Asplenium nidus* L.		(P)
Blechnaceae	*Stenochlaena tenufolia*	Chani cha chatu	(P)
Dennstaedticeae	*Pteridium aquilinum* (L.) Kuhn		(P)
Polypodiaceae	*Phymatodes scolopendria* (Burm. F.) Ching		(P)
Oleandraceae	*Nephrolepis biserrata* (Swartz) Schott		(P)
Schizaeaceae	*Lygodium microphylum* (Cav.) R. Br.		(P)
Thelypteridaceae	*Thelypteris madagascariensis* (Fee) Schult		(P)
Agavaceae	*Sansevieria kirkii*	Mkongepori	(M)
Amarylidaceae	*Scadoxus multiflorus* (Martyn.) Rf. subsp. *multiflorus*	Yangimamga	(M)
Araceae	*Anchomanes abbreviatus* Engl.		(M)
	Culcasia orientalis Mayo		(M)
	Gonatopus boivinii Hook.f.	Wangadume	(M)
Commelinaceae	*Commelina diffusa* Burm.f.	Kongwa	(M)
	Commelina erecta L.		(M)
Cyperaceae	*Carex echinochloe* Kuntze		(M)
	Cyperus compresus L.		(M)
	Cyperus distans L.f.		(M)
	Cyperus immensus C.B. Cl.		(M)
	Cyperus obtusiflorus Vahl		(M)
	Cyperus rotundus L.		(M)
	Fimbristylis hispidula (Vahl.) Kunth		(M)
	Kyllinga alba Nees		(M)
	Kyllinga aurata Nees		(M)
	Mariscus dubius	Ndago	(M)
Dracaenaceae	*Dracaena steudineri* Engl.		(M)
Gramineae	*Euclasta condylotricha* (Stud.)Stapf		(M)
	Dactyloctenium aegyticum Willd		(M)
	Hyparrhenia rufa (Nees) Stapf.		(M)
	Loudetia simplex (Nees) C.E. Hubb		(M)
	Oplismenus compositus (L.) Beav.		(M)
	Panicum repentellum Napper		(M)
	Panicum trichocladum K.Schum		(M)
	Paspallum scrobiculatum L.		(M)
	Paspallum vaginatum Sw		(M)
	Pennisetum polystachyon (L.) Schult.		(M)
	Sorghastrum stipoides (Kuunze) Nash.		(M)
Orchidaceae	*Aerangis hologlottis* (Schltr.) Schltr.		(M)
	Microcoelia exilis Lindl		(M)
	Nervilia umbrosa (Reichb.f) Schttr.		(M)
	Vanilla roscheri		(M)
	Vanilla zanzibarica		(M)
Zingiberaceae	*Aframomum agustifolium* (Sonnerat.) K. Schum.	Matunguu	(M)
Acanthaceae	*Asystacia gangentica* (L.) T. Anders		(D)
Amaranthaceae	*Achyranthes aspera* L.		(D)
	Aerva lanata (L.) Schult		(D)
	Amaranthus viridis L.		(D)
Anacardiaceae	*Anacardium occidentale* L.	Mkorosho	(D)
	Mangifera indica Jacq.		(D)
	Lannnea schweinfurhii (Engl.) Engl.	Muumbu/Mfupapu	(D)
	Ozoroa obovata (Oliv.) R.A. Fema	Mn'gombe	(D)
	Rhus longipes Engl. var. l*ongipes*	Mchengele	(D)
	Rhus natalensis Krauss	Mkumba/mlapaa	(D)

FAMILY	BOTANICAL NAME	LOCAL NAME	Group
	Sclerocarya birrea (L. Rich.) Hochst	Mng'ongo	(D)
	Sorideia madagascariensis DC.	Mtikiza	(D)
Annonaceae	*Annona senegalensis* Pers.	Mtopetope	(D)
	Mkilua fragrans Verdc.	Mkilua	(D)
	Monathotaxis ferruginea (Oliv.) Verdc.		(D)
	Monodora grandidieri Baill.	Mchofu	(D)
	Uvaria acuminata Oliv.		(D)
	Monoathotaxis faulknerae (Oliv.) Verdc.	Mwenyechaa	(D)
Apocynaceae	*Ancylobothrys petersiana* (Kl.) Piere	Mtowe	(D)
	Rauvolfia mombasiana Stapf	Muwango	(D)
	Saba comorensis (Bojer) Pichon	Mabungo	(D)
	Strophanthus zimmernanianus Monach.		(D)
	Tabernaemontana ventricosa A.DC.		(D)
Araliaceae	*Cussonia zimmermannii* Harms	Mpapai dume	(D)
Balsaminaceae	*Impatiens walleriana* Hook.f.		(D)
Bignoniaceae	*Markhamia acuminata* (Klotzsch.) K.Schum.		(D)
	Markhamia lutea (Benth.) K.Schum.	Mtarawanda	(D)
	Markhamia zanzibarica K.Schum.	Mtalawanda	(D)
Bombacaceae	*Adansonia digitata* L.	Mbuyu	(D)
	Ceiba pentandra (L.) Gaertn.	Msufi	(D)
Boraginaceae	*Argusia argentea (*L.f.) Heine		(D)
	Bourreria petiolaris (Lam.) Thulin	Mpanda jongoo	(D)
	Cordia myxa L.	Mkamasi	(D)
Caesalpiniaceae	*Afzelia quanzensis* Welw.	Mtamati, Mbambakofi	(D)
	Cassia abbreviata Oliv.		(D)
	Cassia mimosoides L.		(D)
	Erythrophleum suavoelens (Guill & Perr.) Brenan	Mwavi/Mbaraka	(D)
	Senna petersiana Bolle	Mkunde nyika/ Muumbuzi/ mpingua ume	(D)
	Tamarindus indica L.	Mkwaju	(D)
Casuarinaceae	*Casuarina equesitifolia* L.	Mvinje	(D)
Celastraceae	*Elaeodendron schweinfurthianum* (Loes.) Loes	Mlanunga/mnyum vuu	(D)
	Maytenus mossambicensis Kl.	Mnusi	(D)
	Maytenus undata (Thunb.) Blakelock		(D)
	Mystroxylon aethiopicum (Thunb.) Loes.	Mlimbolimbo/Kifu gu	(D)
	Salacia madagascariensis (Lam.) DC.		(D)
Combretaceae	*Combretum paniculatum* Engl.		(D)
	Terminalia boivinii Tul.	Mkunguni	(D)
	Terminalia catappa L.	Mkungu	(D)
Compositae	*Emilia abyssinica* (A.Rich.) C. Jeffrey		(D)
	Emilia coccinea (Sims.) Sweet		(D)
	Emilia javanica (Burm.f.) Merr		(D)
	Laggera brevipes Oliv & Hiern		(D)
	Laggera crispata (Vahl) Hepper & T.R.I. Wood		(D)
	*Launaea cornuta (*Oliv. & Hiern). C.Jeffrey	Mchunga	(D)
	Mikania cordata Robins		(D)
	Pluchea sordida Oliv. & Hiern		(D)
	Psiadia punctulata (DC.) vatke	Mkeneta	(D)
	Ethulia conyzoides L.		(D)
	Synedrella nodiflora Daecn.		(D)
	Vernonia amygdalina Del.	Kikunde cha kuku	(D)
	Vernonia glabra (Steetz.) Vatke	Dimi la ng'ombe	(D)
	Vernonia zanzibarensis Less.	Mtukutu	(D)

FAMILY	BOTANICAL NAME	LOCAL NAME	Group
Connaraceae	*Agelaea setulosa* Schellem b.		(D)
	Rourea orientalis Baill.		(D)
Convolvulaceae	*Hewitia sublobata (*L.f.)O. Ktze.		(D)
	Ipomoea aquatica Forsk.		(D)
	Ipomoea batatas (L.) Lam.	Kiazi	(D)
	Ipomea obscura (L.) Ker-Gawl.var.obscura		(D)
	Ipomea shupangensis Bak.		(D)
	*Merremia tridentata [*L.] Hall.f.		(D)
Cucurbitaceae	*Cocinia adoensis* (A. Rich.) Cogn.		(D)
Zamiaceae	*Encephalartos hildebrandtii* A. Br. & Bouche	Mgwede	(D)
Dilleniaceae	*Tetracera littoralis* Gilg	Mkala, Malafisi	(D)
Ebeneceae	*Euclea racemosa* Hiern ssp. schimperii (A.D.C.) F. White	Mdaa	(D)
	Euclea natalensis A.D.C. ssp. *obovata* F. White	Msiliza	(D)
	Diospyros consolatae Chiov.	Mkururu/Mjengo	(D)
	Diospyros natalensis (Harv.) Brenan	Mtimweusi	(D)
Escalloniaceae	*Brexia madagascariensis* Thou.	Mfurugudu	(D)
Euphorbiaceae	*Antidesma venosum* Tul.	Mtimagoa/Msisimizi	(D)
	Bridelia micrantha (Hochst.) Baill.	Mututututu	(D)
	Croton pseudopulchellus Pax	Mgeuka, Mpashu	(D)
	Croton sylvaticus Krauss	Msinduzi/Mdawadawa	(D)
	Drypetes natalensis (Harv.) Hutch.	Mjafari	(D)
	Drypetes reticulata Pax		(D)
	Erythrococca kirkii (Muell.Arg.) Prain	Mjafari	(D)
	Euphorbia nyikae Pax.	Mkweche	(D)
	Euphorbia hirta L.	Mziwaziwa	(D)
	Macaranga capensis (Baill.) Sim.	Mkaranga/Mlangamakelele	(D)
	*Mallotus opposifoloius (*Geisel.)Muell.Arg.	Mtundutundu/Mtumbika	(D)
	Margaritaria discoidea (Baill.)Webster	Mkwamba	(D)
	Mildbraedia carpinifolia (Pax) Hutch	Mtapatapa	(D)
	Phyllanthus amarus Schum & Thonn		(D)
	Spirostachys africana Sond.		(D)
	Suregada zanzibarensis Baill.	Mdimu msitu	(D)
Flacourtiaceae	*Caesaria gladiiformis* Mast	Mdegepa	(D)
	Dovyalis macrocalyx (Oliv.) War	Mtumbua	(D)
	Oncoba spinosa Forsk		
	Xylotheca tettensis (Kl.) Gilg	Mchekachaka	(D)
Guttiferae	*Calophylum inophyLlum* L.	Mtondoo	(D)
Icacinaceae	*Apodytes dimidiata* Arn. *var. acutilolia* (A.Rich.) Boutque	Mlambuzi	(D)
Asparagaceae	*Asparagus africanus* Lam.		(M)
Agavaceae	*Dracaena steudneri* Engl.		(M)
Lauraceae	*Cassytha filiformis*	Mlangamaia	(D)
Liliaceae	*Gloriosa superba* L.	Mkalamu	(M)
Loganiaceae	*Anthocleista grandiflora* Gilg	Mkungu maji	(D)
	Strychnos angolensis Gilg.	Mvuje msitu	(D)
	Strychnos cocculoides Bak.	Mtonga	(D)
	Strychnos spinosa Lam.	Mtongo	(D)
Loranthaceae	*Agelanthus kayneri* (Engl.) Baill		(D)
	Agellanthus scassellatii(chiov.)Polh.&Wiens		(D)
	Erianthemum dregei (Eckl. & Zeyh.) Thieg.		(D)
	Erianthemum sodenii (Engl.) Balle.		(D)
Lythraceae	*Ammannia auriculata* Willd.		(D)

FAMILY	BOTANICAL NAME	LOCAL NAME	Group
Malvaceae	*Hibiscus seineri* Engl.		(D)
	Hibiscus surattensis L		(D)
	Hibiscus tiliaceus L.		(D)
	Sida acuta Burm.f	Mfagio	(D)
Melastomataceae	*Dissotis rotundifolia* (Sm.) Triana		(D)
	Memecylon deminutum Brenan		(D)
Meliaceae	*Azadirachta indica* A. Juss.		(D)
	Trichilia emetica Vahl.	Mkungwina	(D)
	Turraea floribunda Hochst.	Mtamagoa	(D)
	Turraea holstii Guerke		(D)
	Turraea nilotica Kotschy		(D)
	Xylocarpus granatum Koen.	Mkomafi,/Mtonga-pwani	(D)
Melianthaceae	*Bersama abyssinica* Fresen	Mwangwakwao	(D)
Menispermaceae	*Tiliacora funifera* (Miers) Oliv.	Msisi	(D)
Mimosaceae	*Acacia auriculiformis* A. Cunn.	Mkwaju wa kihindi	(D)
	Acacia hockii De Wild.	Mguga	(D)
	Acacia mearasii De wild.	Muwati	(D)
	Acacia mangium		(D)
	*Albizia adianthifolia (*Schumach.) W.F. Wight	Mchapia tumbili/Mkenge	(D)
	Albizia glaberrima (Schumach. Thonn.) Benth.	Mkenge	(D)
	Albizia zygia (DC.) Macbr.		(D)
	Dichrostachys cinerea L.	Mgunga	(D)
Moraceae	*Artocarpus heterophyllus* Lam.	Mfenesi mfuu	(D)
	Ficus cyathistipula Warb.		(D)
	Ficus exasperata Vahl.	Msasa dume	(D)
	Ficus lutea Vahl.	Mlangawa/Mtago	(D)
	Ficus natalensis Hochst.	Mtonga mwitu/Mlandege	(D)
	Ficus sur Forssk.	Mkuyu	(D)
	Ficus sycomorus L.	Msasa dume	(D)
Myrsinaceae	*Rapanea melanophloeos* (L.) Mez.	Mkangalashamba	(D)
Myrtaceae	*Eucalyptus* sp.	Mkaratusi	(D)
	Eugenia capensis (Eckl & Zeych.) Sond ssp. *multiflora* F. White	Mkaaga/Mdalasini mwitu	(D)
	Psidium guajava L.	Mpera	(D)
	Syzygium cordatum Krauss	Mzambarau ziwa/Mlati	(D)
	Syzygium cumini (L.) Skeels	Mzambarau	(D)
Ochnaceae	*Ochna atropurpurea DC.*	Mzambarau	(D)
	Ochna thomasiana Engl.		(D)
Oleaceae	*Jasminum fluminense* Vell.	Mramba mwitu	(D)
	Olea europaea L. *subsp. africana* (Mill.) P.S. Green	Mwafu	(D)
	Olea woodiana Knobl.	Mchungwa mwitu/Mlimbo	(D)
Oxalidaceae	*Averrhoa mbilimbi* L.	Mbilimbi	(D)
Papilionaceae	*Alysicarpus glumaceus* (Vahl.) DC.		(D)
	Antylosia scarabaecides (L.) Benth.		(D)
	Canavalia rosea (Sw.) DC.	Magobi	(D)
	Crotalaria gooddiformis Vatke		(D)
	Dalbergia melanoxylon Guill. & Perr.	Mviongozi	(D)
	*Desmodium adscendens (*Sw.) DC. var. *adscendens*		(D)
	Desmodium gangeticum (L.) DC.		(D)
	Desmodium salicifollium (Poir) DC. *var. densiflorum* Schubert		(D)

FAMILY	BOTANICAL NAME	LOCAL NAME	Group
	Indigofera dendroides Jacq		(D)
	Macrotyloma africanum (Wilczek) Verdc.		(D)
	Rhynchosia sublobata (Schum. Thonn.) Meikle.		(D)
	Sophora tomentosa L.	Utupa wa mwitu	(D)
	Tephrosia pumila (Lam.) Pers.		(D)
	Tephrosia villosa (L.) Pers.		(D)
	Tephrosia vogelii Hook. P.	Utupawa mrima	(D)
Passifloraceae	*Adenia kirkii* (Must.) Engl.		(D)
Piperaceae	*Piper umbellatum* L.	Mnamiapang	(D)
Pittosporaceae	*Pittosporum viridiflorum* Sims	Mpande	(D)
Ranunculaceae	*Clematis hirsuta* Guill & Perr		(D)
	Clematis viridiflora Bertol		(D)
Rubiaceae	*Agathisanthemum bojeri* Klotzch.		(D)
	Buttdavya nyasica Hoyle	Mvule maji	(D)
	Canthium mombazense Baill.		(D)
	Chassalia discolor K.Schum.		(D)
	Chassalia parvifolia K.Schum.		(D)
	Coffea pseudozanguebariae Brids.		(D)
	Cremaspora trifolia Thonn.	Mkanja	(D)
	Guettard aspeciosa L.		(D)
	Kohautia lasiocarpa Klotsch		(D)
	Leptactina platyphylla Hiern	Mbuni mwitu	(D)
	Oldenlandia corymbosa L.		(D)
	Pavetta crebrifolia Hiern		(D)
	Pentas parvifolia Hiern		(D)
	Polysphaeria multiflora Hiern	Mchesi/mkanja/mlapaa	(D)
	Polysphaeria parvifolia Hiern	Mlapaa	(D)
	Pyrostria bibracteata (Bak.) Cavaco	Mkonge/Mfupapo	(D)
	Psychotria goetzei (K.Schum.) Petit	Mtimafuta/Mwango	(D)
	Psychotria holtzii (K.Schum.) Petit		(D)
	Psychotria punctata Vatke var. *punctata*	-	(D)
	Spermacoce laevis (Lam.) Griseb.		(D)
	Tarenna pavettoides (Harv.) Sim	Mlashore	(D)
	Triainolepis africana Hook.f. ssp. hildebrandtii(Vatka)Verdc.		(D)
Rutaceae	*Clausena anisata* (Willd.) Hook.f.	Mvuje	(D)
	*Citrus aurantiacus (*Christm.) Swi	Mdimu	(D)
	Vepris eugeniifolia (Engl.) Verdc.		(D)
Sapindaceae	*Allophylus africanus* P.Beauv.		(D)
	Allophylus pervillei Blume *ssp. trifoliotus* Radlk.		(D)
	Apporrhiza paniculata Radlk.	Mchembelele	(D)
	Blighia unijugata Baker	Mkukilemba/Mtikivuli	(D)
	Deinbollia borbonica Scheff.	Mkunguma	(D)
	Dodonaea angustifolia L.f.	Mkeneta	(D)
	Dodonaea viscosa Jacq. *ssp. viscosa*	Mkeng'eta	(D)
	Lecaniodiscus fraxinifolius Bak. ssp.*vanghanii* (Dunkley)Friis		(D)
	Macphersonia gracilis O.Hoffm.	Mjoma	(D)
	Majidea zanguebarica Oliv.	Mtimweusi	(D)
	Paulinia pinnata L.	Mduyuyu	(D)
Sapotaceae	*Englerophytum natalense* (Sond) Pennington	Mduyuyu	(D)
	Manilkara sansibarensis (Engl.) Dub.		(D)
	Pouteria alnifolia (Bak.) Roberty	Mguoguo	(D)
FAMILY	**BOTANICAL NAME**	**LOCAL NAME**	**Group**

	Mimusops fruticosa A. DC	Mnyuvuu, mgambo, kapu, mkoke	(D)
Scrophulariaceae	*Buchnera hispida* D. Don.		(D)
Simaroubaceae	*Harrisonia abyssinica* Oliv.		(D)
Solanaceae	*Physalis peruviana* L.		(D)
Senneratiaceae	*Sonneratia alba* Sm.	Mlilana/Mpira	(D)
Sterculiaceae	*Cola microcarpa* Decne	Mshunduzi	(D)
	Melhania ovata (Cuv.) Spreng		(D)
	Pterygota schummaniana Engl.	Mshunduzi	(D)
	Sterculia africana (Lour.) Fiori	Ungamweupe	(D)
Thelypteridaceae	*Thelypteris madagascariensis* (Fee) Schott		(P)
Tiliaceae	*Corchorus trilocularis* L.		(D)
	Grewia capitellata Bojer	Mkole	(D)
	Grewia glandulosa Vahl		(D)
Thymlaeaceae	*Synaptolepis kirkii* Oliv.	Mbibikiu	(D)
Ulmaceae	*Celtis africana* Burm.f.	Kimungwe	(D)
	*Trema orientalis (*L.) Bl.	Mpesi	(D)
Urticaceae	*Boehmeria macrophylla* Hornen.		(D)
Verbenaceae	*Clerodendrum rotundifolium* Oliv.		(D)
	Clerodendrum sansibarense Gurke		(D)
	Gmelina arborea Roxb.		(D)
	Lantana trifolia L.		(D)
	Stachytarpheta jamaicensis (L.) Vahl.		(D)
	Vitex doniana Sweet	Mfuu	(D)
Violaceae	*Rinorea ilicifolia* (Oliv.) Kuntze		(D)
Vitaceae	*Cayratia gracillis* (Guill & Perr) Suesseng		(D)
	Cissus aralioides (Bak.) Planch. ssp. Orientalis Verdc.		(D)
	Cissus integrifolia Planch		(D)
	Cissus phymatocarpa Masinde & L.E. Newton		(D)
	*Cyphostemma kirkianum (*Planch.) Wild & Drum. ssp. *kirkianum*		(D)
	*Cyphostemma paucidentatum (*Kl.) Wild & Drum. ssp. zanzibaricum Verdc		(D)
	Cissus zanzibarizum Verdc.		(D)
	Cissus producta Afz.		(D)
	Cyphostema adenocaule (A.Rich.) Willd&Drum	Mdudu upande	(D)
	Rhoicissus revoilii Planch.	Mtongo	(D)
	Rhoicissus tridentata (L.f.) Willd & Drummond.	Mtongo	(D)
	KEY		
	P = PTERIDOPHYTES		
	M = MONOCOTYLEDONS		
	D = DICOTYLEDONS		

Appendix II: Species abundance in herb and shrub layers in Jozani-Chwaka Bay proposed National Park, Zanzibar

TRANSECT I: HERBS (0.5m x 2m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Aframomum angustifolium*	1				1	1.08	9.09
2	*Asystacia gangetica*	2				2	2.15	9.09
3	*Blighia unijugata*	1				1	1.08	9.09
4	*Gonatopus boivinii*	1				1	1.08	9.09
5	*Euclasta* sp.	2				2	2.15	9.09
6	*Impatiens walleriana*	3				3	3.23	9.09
7	*Trenochlaena tenuifolia*	6				6	6.45	9.09
8	*Paspalum vaginatum*		25	25	25	75	80.65	27.27
9	*Pluchia sordida*	2				2	2.15	9.09
						93		
TRANSECT I: SHRUBS (2m x 5m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Acrostichum aureum*	3				3	27.27	33.33
2	*Aframomum angustifolia*	7				7	63.63	33.33
3	*Trema orientalis*	1				1	9.09	33.33
						11		
TRANSECT II: HERBS (0.5m x 2m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F.
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Cissus quadrangularis*			1		1	0.69	4.55
2	*Cissus rotundifolia*		2	2		4	2.78	9.09
3	*Crotalaria goodiiformis*	1				1	0.69	4.55
4	*Cyphostema adenocaule*			1		1	0.69	4.55
5	*Dalbergia melanoxylon*			2	1	3	2.08	9.09
6	*Diospyros consolatae*			3	4	7	4.86	9.09
7	*Encephalartos hildebrandtii*		1			1	0.69	4.55
8	*Macphersonia gracilis*		4	1	4	9	6.25	13.64
9	*Olea woodiana*			100		100	69.44	4.55
10	*Phymatodes scolopendria*	4	3			7	4.86	9.09
11	*Psychotria goetzei*				1	1	0.69	4.55
12	*Pyrostria bribracteata*				1	1	0.69	4.55
13	*Rourea* sp.	4				4	2.78	4.55
14	*Sansevieria kirkii*	2				2	1.38	4.55
15	*Synaptolepis*			1		1	0.69	4.55
16	*Terminalia boivinii*		1			1	0.69	4.55
						144		

TRANSECT II: SHRUBS (2m x 5m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Alophylus pervillei*	1				1	1.22	3.57
2	*Annona senegalensis*			1		1	1.22	3.57
3	*Apodytes dimidiata*				1	1	1.22	3.57
4	*Cussonia zimmermannii*				1	1	1.22	3.57
5	*Diospyros consolatae*				2	2	2.44	3.57
6	*Encephalartos hildebrandtii*			1	1	2	2.44	7.14
7	*Euclea racemosa*	1				1	1.22	3.57
8	*Euclea schimperi*	1				1	1.22	3.57
9	*Macphersonia gracilis*		12	1	8	21	25.61	10.71
10	*Maytenus mossambicensis*			2		2	2.44	3.57
11	*Mystroxylon aethiopicum*		1	2		3	3.66	7.14
12	*Olea woodiana*			2		2	2.44	3.57
13	*Ozoroa obovata*		3			3	3.66	3.57
14	*Polysphaeria parvifolia*	7	1	1		9	9.76	7.14
15	*Polysphaeria parrifolia*					1	1.22	3.57
16	*Bersama abyssinica*			3		3	3.66	3.57
17	*Pyrostria bribracleata*		9	5	5	19	23.17	10.71
18	*Rinorea ilicifolia*			1	1	1	1.22	3.57
19	*Synaptolepis kirkii*	1				1	1.22	3.57
20	*Terminalia boivinii*		6			8	9.76	7.14
						82		
TRANSECT III: HERBS (0.5m x 2m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F.
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Cassia mimosoides*				3	3	1.55	4.00
2	*Commelina erecta*		1	2		3	1.55	8.00
3	*Cyperus distans*				4	4	2.07	4.00
4	*Emilia javanica*		1	1		2	1.04	8.00
5	*Heteropogon contortus*	42	59	10	12	123	63.73	16.00
6	*Hyparrhenia rufa*	9			3	12	6.22	8.00
7	*Launaea cornuta*		1			1	0.52	4.00
8	*Panicum repentellum*				3	3	1.55	4.00
9	*Pennisetum polystachyon*		1	3		4	2.07	8.00
10	*Polygala* sp.	4	1			5	2.59	8.00
11	*Pleridium aquilinum.*			3		3	1.55	4.00
12	*Tephrosia pilosa*	9	10	1		20	10.36	12.00
13	*Tephrosia pumila*				4	4	2.07	4.00
14	*Triainolepis africana*			1		1	0.52	4.00
15	*Vernonia glabra*				5	5	2.59	4.00
						193		
TRANSECT III: SHRUBS (2m x 5m)								

S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Annona senegalensis*	1	58	1		60	95.24	50.00
2	*Vernonia glabra*	1		1		2	3.17	37.50
3	*Vitex doniana*	1		1		1	1.59	12.50
						63		

TRANSECT IV: HERBS (0.5m x 2m)

S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Desmodium salicifolium*	7				7	6.03	5.56
2	*Diospyros consolatae*		32	1	8	41	35.34	16.67
3	*Diospyros mafiensis*			2		2	1.72	5.56
4	*Eugenia*			1	3	4	3.45	11.11
5	*Macphersonia gracilis*	3	4	1	5	13	11.21	22.22
6	*Mariscus dubius*	15				15	12.93	5.56
7	*Memecylon deminutum*		2			2	1.72	5.56
8	*Panicum trichocladum*	25				25	21.55	5.56
9	*Phymatodes scolopendria*		4			4	3.45	5.56
10	*Pyrostria bribracteata*					1	0.86	5.56
11	*Synaptolepis kirkii*		1			1	0.86	5.56
12	*Tacca leontopetaloides*	1				1	0.86	5.56
						116		

TRANSECT IV: SHRUBS (2m x 5m)

S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Allophylus africanus*	1				1	3.70	3.70
2	*Bridelia micrantha*	1				1	3.70	3.70
3	*Diospyros consolatae*		1		1	2	7.41	7.41
4	*Elaeodendron schweinfurthianum*		1			1	3.70	3.70
5	*Euclea schimperi*		1			1	3.70	3.70
6	*Eugenia capensis*			1		1	3.70	3.70
7	*Macphersonia gracilis*		1	1	1	3	11.11	11.11
8	*Maytenus mossambicensis*		1			1	3.70	3.70
9	*Mimusops fruticosa*	1				1	3.70	3.70
10	*Ozoroa obovata*	1				1	3.70	3.70
11	*Pittosporum viridiflorum*	1	1		1	3	11.11	11.11
12	*Polysphaeria parvifolia*	1	1	1	1	4	14.81	14.81
13	*Psychotria goetzei*	1				1	3.70	3.70
14	*Pyrostria bribracleata*			1	1	2	7.41	7.41
15	*Terminalia boivinii*	1	1	1		3	11.11	11.11
16	*Triainolepisi africana*	1				1	3.70	3.70
						27		

TRANSECT V: HERBS (0.5m x 2 m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Cassia mimosoides*		4	7		11	9.16	10.00
2	*Diospyros consolatae*	5			2	7	5.83	10.00
3	*Euclea racemosa*	6				6	5.00	5.00
4	*Eragrostis ciliaris*		4			4	3.33	5.00
5	*Frimbristylis hispidula*			7	5	12	10.00	10.00
6	*Kohautia lasiocarpa*		5			5	4.17	5.00
7	*Macphersonia gracilis*	3				3	2.50	5.00
8	*Mariscus dubius*		14	5	8	27	22.50	15.00
9	*Mystroxylon aethiopicum*	1				1	0.83	5.00
10	*Polysphaeria parvifolia*				5	5	4.17	5.00
11	*Rhoicissus revoilii*	1				1	0.83	5.00
12	*Synaptolepis kirkii*	2				2	1.67	5.00
13	*Tephrosia purpurea*		1	34		35	29.17	10.00
14	*Terminalia boivinii*				1	1	0.83	5.00
						120		

TRANSECT V: SHRUBS (2m x 5m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Diospyros consolatae*	11		1		12	16.90	6.90
2	*Dodonea viscosa*			1		1	1.41	3.45
3	*Euclea racemosa*		2	1		3	4.23	6.90
4	*Euclea schimperi*		2	1		3	4.23	6.90
5	*Eugenia capensis*				3	3	4.23	3.45
6	*Macphersonia gracilis*	1				1	1.41	3.45
7	*Maytenus mossambicensis*	1	1			2	2.82	6.90
8	*Mimusops fruticosa*	2				2	2.82	3.45
9	*Mystroxyloa aethiopicum*			4	3	7	9.86	6.90
10	*Olea woodiana*				2	2	2.82	3.45
11	*Pluchea sordida*		2			2	2.82	3.45
12	*Polysphaeria parvifolia*		4	11		15	21.13	6.90
13	*Pyrostria bribracteata*		1	1		2	2.82	6.90
14	*Pyrostria pallida*			1		1	1.41	3.45
15	*Rapanea melanophloeos*		1	1	2	4	5.63	10.34
16	*Rhus natalensis*		3		1	4	5.63	6.90
17	*Terminalia boivinii*		1		6	7	9.86	6.90
18	*Triainolepis africana*		3			3	4.23	3.45
						71		

TRANSECT VI: HERBS (0.5m x 2m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F

		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Achyranthes aspera*		4			4	7.41	6.25
2	*Albizia adianthifolia*		1			1	1.69	6.25
3	*Asparagus africanus*			1		1	1.69	6.25
4	*Asystacia gangetica*	10				10	16.95	6.25
5	*Deinbellia borbonica*			1		1	1.69	6.25
6	*Desmodium gangeticum*	6				6	10.17	6.25
7	*Macphersonia gracilis*	6	3		2	11	18.64	18.75
8	*Monodora grandidieri*			4		4	7.41	6.25
9	*Ochna holtzii*				5	5	8.47	6.25
10	*Polysphaeria parvifolia*		9			9	15.25	6.25
11	*Psychotria goetzei*	3				3	5.08	6.25
12	*Rinorea ilicifolia*		1	1		2	3.39	12.50
13	*Synaptolepis kirkii*				2	2	3.39	6.25
						59		

TRANSECT VI: SHRUBS (2m x 5m)

S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Agelaea* sp.			1		1	1.85	3.57
2	*Albizia adianthifolia*	2	3	1		6	11.11	10.71
3	*Blighia unijugata*			3		3	5.56	3.57
4	*Coffea pseudozangueriae*		1		1	2	3.70	7.14
5	*Deinbollia borbonica*			3		3	5.56	3.57
6	*Ficus lutea*	1				1	1.85	3.57
7	*Grewia conacarpa*			1		1	1.85	3.57
8	*Macphersonia gracilis*				2	2	3.70	3.57
9	*Majidea zanguebarica*		1	1		2	3.70	7.14
10	*Mallotus opposifolius*		1	3		4	7.41	7.14
11	*Mildbraedia carpinifolia*				1	1	1.85	3.57
12	*Monodora grandidiera*			2	1	3	5.56	7.14
13	*Monothotaxis ferruginea*		2			2	3.70	3.57
14	*Polysphaeria parvifolia*	1	6	7		14	1.85	3.57
15	*Rauvolfia kirkii*			1		1	1.85	3.57
16	*Senna petersiana*		1			1	1.85	3.57
17	*Sorindeia madascariensis*		1			1	1.85	3.57
18	*Strophanthus zimmermmianus*	1				1	1.85	3.57
19	*Suregada zanzibarensis*				1	1	1.85	3.57
20	*Uvaria acuminata*		2			2	3.70	3.57
21	*Uvaria tanzaniae*	1		1		2	3.70	7.14
						54		

TRANSECT VII: HERBS (0.5m x 2m)

S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Anthocleista grandiflora*			2		2	3.57	7.14

2	*Areca catechu*	4	12		1	17	28.60	21.43
3	*Culcasia orientalis*	6				6	10.71	7.14
4	*Flagellaria indica*		1			1	1.79	7.14
5	*Stenochlaena tenuifolia*		3	6	3	12	21.43	21.43
6	*Pandanus rabaiensis*			10	3	13	23.21	14.29
7	*Polysphaeria parvifolia*	4	2			6	8.93	14.29
8	*Stenochlaena tenuifolia*	1				1	1.79	7.14
						56		

TRANSECT VII: SHRUBS (2m x 5m)

S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Anthocleista grandiflora*			2		2	6.25	6.67
2	*Areca catechu*		1		1	2	6.25	13.33
3	*Calophyilum inophyllum*		3			3	9.38	6.67
4	*Nephrolepis biserrata*			1		1	3.13	6.67
5	*Ozoroa obovata*				1	1	3.13	6.67
6	*Pandanus rabaiensis*		1	1	1	3	9.38	20.00
7	*Polysphaeria parvifolia*	7	7	3	1	18	56.25	26.67
8	*Stenochlaena tenuifolia*			1	1	2	6.25	13.33
						32		

TRANSECT VIII:HERBS (0.5m x 2m)

S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Aframomum angustifolium*			1		1	1.70	7.14
2	*Elaeis guineensis*			4		4	6.70	7.14
3	*Stenochlaena termifolia*	10	18	3	2	33	55.00	28.57
4	*Pandanus rabaiensis*			1		1	1.70	7.14
5	*Polyphaeria parvifolia*	2	2			4	6.70	14.29
6	*Raphia farinifera*	1				1	1.70	7.14
7	*Thelypteris madagascariensis*				4	4	6.70	7.14
8	*Triainolepis africana*	2	4		6	12	20.00	21.43
						60		

TRANSECT VIII: SHRUBS (2m x 5m)

S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Antidesma venosum*				1	1	5.26	14.29
2	*Elaeis guineensis*	1				1	5.26	14.29
3	*Pandamus rabaiensis*			4		4	21.05	14.29
4	*Polysphaeria parvifolia*	1	5		5	11	57.90	42.86
5	*Triainolepis africana*				2	2	10.52	14.29
						19		

TRANSECT IX: HERBS (0.5m x 2m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Aframomum angustifolium*	2				2	6.45	14.29
2	*Asystacia gangetica*			1		1	3.23	14.29
3	*Phymatodes scolopendria*	6	10	6	5	27	87.10	57.14
4	*Psychotria goetzei*			1		1	3.23	14.29
						31		
TRANSECT IX: SHRUBS (2m x 5m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	
1	*Blighia unijugaa*			1		1	16.70	16.67
2	*Mangifera indica*			1		1	16.70	16.67
3	*Phoenix reclinata*	1				1	16.70	16.67
4	*Psychotria goetzei*	1		1		2	33.33	33.33
5	*Rauvolfia mombasiana*			1		1	16.70	16.67
						6		
TRANSECT X: SHRUBS (0.5m x 2m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Casuarina equisetifolia*	27	21	1		49	33.50	25.00
2	*Cocos nucifera*				5	5	3.57	8.33
3	*Ficus natalensis*				2	2	1.43	8.33
4	*Macaranga capensis*				2	2	1.43	8.33
5	*Pandanus kirkii*	9				9	6.43	8.33
6	*Phoenix reclinata*	1				1	0.71	8.33
7	*Triainolepis africana*	1	11	34	26	72	51.43	33.33
						140		
TRANSECT X: SHRUBS (2m x 5m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Bersama abyssinica*		1			1	11.11	14.29
2	*Diospyros consolatae*		3			3	33.33	14.29
3	*Euclea racemosa*	1	1			2	22.22	28.57
4	*Rapanea melanophloeos*		1			1	11.11	14.29
5	*Xylocarpus granatum*	2				2	22.22	28.57
						9		
TRANSECT XI: HERBS (0.5m x 2m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F

		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Euclea racemosa*		1		5	6	9.84	13.33
2	*Euclea schimperi*		1			1	1.64	6.67
3	*Fimbristylis hispidula*	2				2	3.28	6.67
4	*Heteropogon* contortus	3				3	4.92	6.67
5	*Kohautia lasiocarpa*	5				5	8.20	6.67
6	*Kyllinga elata*	1	26			27	44.26	13.33
7	*Macphersonia gracilis*				2	2	3.28	6.67
8	*Mariscus dubius*	7				7	11.48	6.67
9	*Mimusops fruticosa*			1		1	1.64	6.67
10	*Polysphaeria parvifolia*		2			2	3.28	6.67
11	*Pyrostria bibracteata*			1		1	1.64	6.67
12	*Synaptolepis kirkii*	1		3	1	5	6.56	13.33
						61		

TRANSECT XI: SHRUBS (2m x 5m)

S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Apodytes dimidiata*	1				1	1.43	4.17
2	*Chassalia discolor*		3	1		4	5.71	8.33
3	*Diospyros consolatae*	3	1		2	6	8.57	12.50
4	*Euclea racemosa*		1	2		3	4.29	8.33
5	*Euclea schimperi*	1	2	2		5	7.14	12.50
6	*Macphersonia gracilis*				2	2	2.86	4.17
7	*Maytenus mossambicensis*	1				1	1.43	4.17
8	*Mystroxylon aethiopicum*	1				1	1.43	4.17
9	*Polysphaeria parvifolia*		2	2		4	5.71	8.33
10	*Pyrostria bribracleata*	8	8	12	10	38	54.29	16.67
11	*Rhus natalensis*	1				1	1.43	4.17
12	*Synaptolepis kirkii*	1		2	1	4	5.71	12.50
						70		

TRANSECT XII: HERBS (0.5m x 2m)

S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Bolbilis* sp.	1				1	1.79	5.88
2	*Chassalia discolor*	1				1	1.79	5.88
3	*Culcasia orientalis*	4				4	7.14	5.88
4	*Deinbolia borbonica*	4				4	7.14	5.88
5	*Euclea racemosa*			1		1	1.79	5.88
6	*Eugenia capensis*	1				1	1.79	5.88
7	*Mariscus* sp.			1	11	12	21.43	11.76
8	*Macaranga capensis*		11		7	18	31.03	11.76
9	*Pandanus kirkii*	1				1	1.79	5.88
10	*Psiadia punctulata*				1	1	1.79	5.88
11	*Pyrostria bribracteata*			1		1	1.79	5.88
12	*Rauvolfia kirkii*	1				1	1.79	5.88

13	*Rhus natalensis*			3		3	5.36	5.88
14	*Synaptolepis kirkii*		1			1	1.79	5.88
15	*Turraea floribunda*		5			5	8.93	5.88
						56		

TRANSECT XII: SHRUBS (2m x 5m)

S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Allophylus pervillei*		1			1	1.52	4.55
2	*Areca catechu*	2				2	3.03	4.55
3	*Chassalia parvifolia*		5			5	7.58	4.55
4	*Euclea racemosa*				1	1	1.52	4.55
5	*Eugenia capensis*	2	1			3	4.55	9.09
6	*Maytenus mossambicensis*		2			2	3.03	4.55
7	*Mimusops fruticosa*			1		1	1.52	9.09
8	*Macaranga capensis*		3			3	4.55	9.09
9	*Polysphaeria parvifolia*				3	3	4.55	4.55
10	*Pyrostria bribracteata*			21	7	28	42.42	9.09
11	*Rapanea melanophloeas*			1		1	1.52	4.55
12	*Rhus natalensis*				2	2	3.03	4.55
13	*Rinorea ilicifolia*		1			1	1.52	4.55
14	*Suregada sansibarensis.*		1			1	1.52	4.55
15	*Synaptolepis kirkii*		1			1	1.52	4.55
16	*Taberuaemontana ventricosa.*	9				9	13.64	4.55
17	*Turraea floribunda*		1			1	1.52	4.55
18	*Uvaria acuminata*		1			1	1.52	4.55
						66		

TRANSECT XIII: HERBS (0.5m x 2m)

S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Phymatodes scolopendria*	3	5	7	1	16	19.48	14.29
2	*Blighia unijugata*			1		1	1.30	4.76
3	*Chassalia discolor*		3		2	5	6.50	9.52
4	*Encephalartos hildebrandtii*				1	1	1.30	4.76
5	*Elaedendron schweinfurthianum*			1		1	1.30	4.76
6	*Eugenia `capensis*				3	3	3.90	4.76
7	*Macphersonia gracilis*				3	3	3.90	4.76
8	*Maytenus mossambicensis*				1	1	1.30	4.76
9	*Ochna thomsiana*			1		1	1.30	4.76
10	*Polysphaeria parvifolia*		12			12	15.60	4.76
11	*Pyrostria bribracteata*				1	1	1.30	4.76
12	*Synaptolepis kirkii*			1	5	6	7.80	9.52
13	*Tacca leontopetaloides*		2			2	2.60	4.76
14	*Thelypteris madagascariensis*	10				10	13.00	4.76
15	*Triainolepis africana*	1	13			14	18.20	9.52
						77		

TRANSECT XIII: SHRUBS (2m x 5m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Blighia unijugata*			1		1	2.63	7.14
2	*Chassalia discolor*			1		5	13.16	14.29
3	*Clerodendron rotundifolium*			1		1	2.63	7.14
4	*Diospyros consolatae*					3	7.90	7.14
5	*Eleaedendron schweinfurthianum*			1		1	2.63	7.14
6	*Euclea racemosa*					5	13.16	7.14
7	*Eugenia spinostachyum*			1		1	2.63	7.14
8	*Flagelaria indica*	1				1	2.63	7.14
9	*Macphersonia gracilis*					2	5.30	7.14
10	*Mallotus oppositifolius*					3	7.90	7.14
11	*Polysphaeria parvifolia*	5	9			14	36.84	14.29
12	*Rapanea melanophloes*			1		1	2.63	7.14
						38		

TRANSECT XIV: HERBS (0.5m x 2m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Cissus producta*			1		1	1.20	6.25
2	*Desmodium*	4				4	4.82	6.25
3	*Dichrostachys cinerea*		1			1	1.20	6.25
4	*Euclea racemosa*			4		4	4.82	6.25
5	*Euclea schimperi*	1		2		3	3.61	12.50
6	*Eugenia capensis*			15		15	18.07	6.25
7	*Hyparrhenia rufa*		3			3	3.61	6.25
8	*Kyllinga erecta*	10		10	22	42	50.60	18.75
9	*Macphersonia gracilis*	1				1	1.20	6.25
10	*Olea woodiana*	1				1	1.20	6.25
11	*Stenotaphrum dimidiatum*		2			2	2.40	6.25
12	*Phymatodes scolopendria*	3				3	3.61	6.25
13	*Pteridium aquilinum*				3	3	3.61	6.25
						83		

TRANSECT XIV: SHRUBS (2m x 5m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Anthocleista grandiflora*			2		2	3.77	4.76
2	*Bersama abyssinica*			1		1	1.89	4.76
3	*Carpodiptera africana*			1		1	1.89	4.76
4	*Diospyros consolatae*	3	4	1		8	15.09	14.29
5	*Euclea racemosa*			1		1	1.89	4.76
6	*Euclea schimperi*			2		2	3.77	4.76
7	*Jasminum fluminense*			2		2	3.77	4.76
8	*Macphersonia gracilis*	4				4	7.55	4.76

9	*Maytenus mossambicensis*				1	1	1.89	4.76
10	*Mimusops fruticosa*	1				1	1.89	4.76
11	*Mystroxylon aethiopicum*		1			1	1.89	4.76
12	*Olea woodiana*				2	2	3.77	4.76
13	*Polysphaeria parvifolia*		3			3	5.66	4.76
14	*Pyrostria bribracteata*		6			6	11.32	4.76
15	*Pyrostria pallida*			5		5	9.43	4.76
16	*Rapanea melanophloeos*				7	7	31.21	4.76
17	*Rhus natalensis*		1			1	1.89	4.76
18	*Terminalia boivinii*	2				2	3.77	4.76
19	*Triainolepsis africana*		1			1	1.89	4.76
						53		

TRANSECT XV: HERBS (0.5m x 2m)

S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Acacia mangium*		1			1	2.60	6.25
2	*Agathisanthemum bojeri*				2	2	5.12	6.25
3	*Bridelia micrantha*				2	2	5.12	6.25
4	*Commelina erecta*		1			4	10.30	6.25
5	*Desmodium obovata*		12			12	30.80	12.50
6	*Heteropogon contortus*		3			3	7.70	6.25
7	*Pyrostria bribracteata*				1	1	2.60	6.25
8	*Sida acuminata*	2				2	5.12	18.75
9	*Suregada zanzibarica*				1	1	2.60	6.25
10	*Synaptolepis kirkii*				1	1	2.60	6.25
11	*Tacca leontopetaloide*		1			1	2.60	6.25
12	*Panicum trichocladum*	2			4	7	18.00	6.25
13	*Vernonia glabra*	2				2	5.12	6.25
						39		

TRANSECT XV: SHRUBS (2m x 5m)

S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Acacia mangium*	1	2		7	10	22.73	10.71
2	*Annona senegalensis*	2	2	1		5	11.36	10.71
3	*Bridelia micrantha*	2				2	4.55	3.57
4	*Euclea schimperi*		1	1		2	4.55	7.14
5	*Ficus natalensis*			1		1	2.30	3.57
6	*Flueggea virosa*	1				1	2.30	3.57
7	*Hoslundia opposita*		1			2	4.55	7.14
8	*Jasminum flumenses*		1			1	2.30	3.57
9	*Pyrostria bribracteata*	2	2	1	1	6	13.64	14.29
10	*Rapanea melanophloeos*		1	1		6	4.55	7.14
11	*Rauvolfia mombasiana*			1		2	2.30	3.57
12	*Rhus natalensis*			1		1	2.30	3.57
13	*Suregada zanzibarica*		1			1	2.30	3.57
14	*Synaptolepis kirkii*			1		1	2.30	3.57

15	*Triainolepis africana*	2		1		1	6.82	7.14
16	*Turraea floribunda*					3	4.55	3.57
17	*Vernonia glabra*	3				2	6.82	3.57
						44		
TRANSECT XVI: HERBS (0.5m x 2m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Agathisanthemum bojeri*	4				4	2.10	3.85
2	*Asystacia gangetica*				1	1	0.52	3.85
3	*Bourreria petiolaris*			12	3	15	7.77	7.69
4	*Desmodium salicifolium*				3	3	1.55	3.85
5	*Flueggea virosa*	1	1			2	1.04	7.69
6	*Gonatopus boivinii*		1			1	0.52	3.85
7	*Heteropon contortus*			5		5	2.60	3.85
8	*Kyllinga erecta*			6		6	3.11	3.85
9	*Leucaena glauco*			8	10	18	9.33	7.69
10	*Panicum repentellum*				16	16	8.30	3.85
11	*Sida acuminata*	2		31	12	45	23.32	11.54
12	*Staphenophyta* sp.	25	1	22		48	24.90	11.54
13	*Suregada zanzibarensis*	1				1	0.52	3.85
14	*Tephrosia pumila*	12	3	10		25	13.00	11.54
15	*Vernonia cinerea*	1			1	2	1.04	7.69
16	*Waltheria indica*	1				1	0.52	3.85
						193		
TRANSECT XVI: SHRUBS (2m x 5m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Acacia mangium*		25			25	31.25	5.56
2	*Annona senegalensis*			4		4	5.00	5.56
3	*Casuarina equisetifolia*	3	1			4	5.00	11.11
4	*Clerodendron myrioides*		1			1	1.25	5.56
5	*Euclea zacemosa*			1		1	1.25	11.11
6	*Flueggea virosa*			2	3	5	6.25	11.11
7	*Hoslundia opposita*	4				4	5.00	5.56
8	*Leucaena glauco*			2	5	7	8.75	11.11
9	*Psidium guajava*	2				2	2.50	5.56
10	*Rhus natalensis*			1		1	1.25	5.56
11	*Sida acuminata*			2	20	22	27.50	11.11
12	*Triainolepis africana*				1	1	1.25	5.56
13	*Vernonia glabra*			3		3	3.75	5.56
						80		
TRANSECT XVII: HERBS (0.5m x 2m)								
S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVID	(%)	(%)

						UALS		
1	*Acacia mangium*	1				1	1.90	6.67
2	*Asystacia gangetica*		5			5	9.43	6.67
3	*Gmelina arborea*	2				2	3.77	6.67
4	*Jasminum flumenense*		2			2	3.77	6.67
5	*Nephrolepis biserrata*			10		10	18.90	13.33
6	*Pyrostria bribracteata*			1		1	1.90	6.67
7	*Rhus vulgaris*	1				1	1.90	6.67
8	*Sida alba*		3			3	5.70	6.67
9	*Sorindeia madagascariensis*	1				1	1.90	6.67
10	*Stenochlaena termifolia*			20		20	37.74	6.67
11	*Synaptolepis kirkii*			1		1	1.90	6.67
12	*Turraea floribunda*	1				1	1.90	6.67
13	*Panicum trichocladum*		5			5	9.43	13.33
						53		

TRANSECT XVII: SHRUBS (2m x 5m)

S/N	SPECIES NAME	SAMPLE POINTS				TOTAL NO. OF	R.D	R.F
		1	2	3	4	INDIVIDUALS	(%)	(%)
1	*Acacia mangium*		3			3	6.70	5.26
2	*Apodytes dimidiata*			1		1	2.33	5.26
3	*Bridelia micrantha*	3				3	6.70	5.26
4	*Flueggea virosa*		3			3	6.70	5.26
5	*Gmelina arborea*	10	7			17	39.53	10.53
6	*Jasminum flumenense*		2			2	4.70	5.26
7	*Mangifera indica*	2				2	4.70	5.26
8	*Psychotria goetzei*	1		2		3	6.70	10.53
9	*Rapanea melanophloeos*		1			1	2.33	5.26
10	*Rhoicissus tridentata*		1			1	2.33	5.26
11	*Rhus vulgaris*	1				1	2.33	15.79
12	*Triainolepis africana*	1	1			4	9.30	10.53
13	*Turraea floribunda*	1				1	2.33	5.26
14	*Vitex doniana*	1				1	2.33	5.26
						43		

Appendix III: Dominance of tree species in various transects representing different habitat types in Jozani-Chwaka Bay proposed National Park, Zanzibar

Transect	Species	No. of individuals	Basal Area ($m^2.ha^{-1}$)	Relative dominance	
				(%)	rank
1	*Ficus exasperata*	1	0.02	0.08	1
2	*Diospyros consolatae*	37	8.3804	24.40	1
	Olea woodiana	21	6.5761	19.14	2
	Ozoroa obovata	10	4.4344	12.91	3
	Mystroxylon aethiopicum	12	3.5248	10.26	4
	Apodytes dimidiana	6	2.8695	8.35	5
	Maytenus mossambicensis	10	2.0368	5.93	6
	Pittosporum viridiflorum	2	1.505	4.38	7
	Terminalia boivinii	5	1.3997	4.07	8
	Mimusops fruticosa	5	1.0511	3.06	9
	Eugenia capensis	4	0.766	2.23	10
	Eugenia capensis	3	0.6385	1.86	11
	Rapanea melanophloeos	3	0.4339	1.26	12
	Macphersonia gracilis	2	0.284	0.83	13
	Pandanus kirkii	1	0.1994	0.58	14
	Encephalartos hildebrandtii	1	0.0868	0.25	15
	Euclea natalensis	1	0.0816	0.24	16
	Euclea racemosa ssp schimperii	1	0.0816	0.24	17
	Total Transect 2	**121**	**34.3496**	100.00	
			0		
3	*Annona senegalensis*	6	1.6698	31.75	1
	Bridelia micrantha	3	1.6698	31.75	2
	Syzigium cumini	1	0.3902	7.42	3
	Vitex doniana	5	1.5293	29.08	4
	Total transect3	**15**	**5.2591**	100.00	
4	*Diospyros consolatae*	52	17.3273	27.95	1
	Pittosporum viridiflorum	24	9.5953	15.48	2
	Olea woodiana	10	5.2594	8.48	3
	Ozoroa obovata	5	4.9991	8.06	4
	Bersama abyssinica	18	4.9047	7.91	5
	Ficus sur	16	3.3754	5.44	6
	Mimusops fruticosa	7	2.8139	4.54	7
	Maytenus mossambicensis	8	2.4243	3.91	8
	Mystroxylon aethiopicum	9	1.965	3.17	9
	Macphersonia gracilis	9	1.5502	2.50	10
	Syzigium cumini	3	1.3974	2.25	11
	Rapanea melanophloeos	3	1.1575	1.87	12
	Apodytes dimidiana	1	1.1473	1.85	13
	Euclea natalensis	8	1.0906	1.76	14
	Cussonia zimmermanii	4	0.8797	1.42	15
	Terminalia boivinii	1	0.5892	0.95	16
	Senna petersiana	4	0.5563	0.90	17
	Eugenia capensis	1	0.2154	0.35	18
	Rinorea sp	1	0.1836	0.30	19
	Macaranga capensis	1	0.1406	0.23	20

Transect	Species	No. of individuals	Basal area (m^2. ha^{-1})	Relative dominance	
				%	rank
	Euclea racemosa ssp *schimperii*	1	0.115	0.19	21
	Pyrostria bibracteata	1	0.115	0.19	22
	Albizia adianthifolia	1	0.109	0.18	23
	Onchoba spinosa	1	0.0868	0.14	24
	Total transect 4	**189**	**61.998**	100.00	
5	*Rapanea melanophloeos*	8	1.2015	21.97	1
	Diospyros consolatae	10	0.9679	17.70	2
	Apodytes dimidiana	4	0.7912	14.47	3
	Pittosporum viridiflorum	4	0.5482	10.03	4
	Mystroxylon aethiopicum	4	0.5224	9.55	5
	Sideroxylon inerme	4	0.3942	7.21	6
	Olea woodiana	3	0.2904	5.31	7
	Sideroxylon inerme	2	0.1785	3.26	8
	Mimusops fruticosa	2	0.1732	3.17	9
	Maytenus mossambicensis	1	0.1683	3.08	10
	Ficus lutea	1	0.1404	2.57	11
	Terminalia boivinii	1	0.092	1.68	12
	Total transect 5	**44**	**5.4682**	100.00	
6	*Albizia adianthifolia*	27	34.6703	53.19	1
	Syzigium cuminii	12	8.1789	12.55	2
	Mallotus oppositifolius	29	5.7031	8.75	3
	Ficus cycomorus	12	3.118	4.78	4
	Grewia conocarpa	7	2.8509	4.37	5
	Bridelia micrantha	3	2.4223	3.72	6
	Tamarindus indica	2	1.8754	2.88	7
	Senna petersiana	9	1.7846	2.74	8
	Rapanea melanophloeos	4	1.0136	1.56	9
	Suregada zanzibariensis	6	0.945	1.45	10
	Bourreria petiolaris	2	0.6563	1.01	11
	Diospyros consolatae	2	0.577	0.89	12
	Ficus lutea	3	0.4705	0.72	13
	Psychotria goetzei	1	0.2477	0.38	14
	Macphersonia gracilis	1	0.2321	0.36	15
	Sorindeia madagascariensis	1	0.1911	0.29	16
	Bersama abyssinica	1	0.1472	0.23	17
	Polyphaeria parvifolia	1	0.0975	0.15	18
	Total transect 6	**123**	**65.1815**	100.00	
7	*Vitex doniana*	33	66.0982	30.89	1
	Elaeis guineensis	46	54.0484	25.26	2
	Areca catechu	225	31.9247	14.92	3
	Pandanus rabaiensis	69	26.1012	12.20	4
	Calophyllum inophyllum	31	15.0134	7.02	5
	Anthocleista glandiflora	12	7.4476	3.48	6
	Syzigium cumini	5	6.0531	2.83	7
	Burttdavya nyasica	2	2.0773	0.97	8
	Eugenia capensis	13	1.8694	0.87	9
	Ficus lutea	1	1.7914	0.84	10
	Albizia glaberrima	2	1.1531	0.54	11
	Ficus sur	1	0.2771	0.13	12
	Mimusops fruticosa	1	0.1032	0.05	13
	Total transect 7	**441**	**213.9581**	100.00	

Transect	Species	No. of individuals	Basal Area ($m^2.ha^{-1}$)	Relative dominance	
				%	rank
			0		
8	*Calophyllum inophyllum*	13	41.6361	20.88	1
	Vitex doniana	20	36.6929	18.40	2
	Elaeis guineansis	27	35.6176	17.86	3
	Pandanus rabaiensis	25	24.414	12.24	4
	Raphia farinifera	10	23.9379	12.00	5
	Ficus sur	8	12.1032	6.07	6
	Anthocleista glandiflora	12	10.5131	5.27	7
	Ficus lutea	3	7.9774	4.00	8
	Albizia zygia	2	4.2405	2.13	9
	Ficus natalensis	3	1.9625	0.98	10
	Ficus sycomorus	1	0.2321	0.12	11
	Eugenia capensis	1	0.0795	0.04	12
	Total transect 8	**125**	**199.4068**	100.00	
			0		
9	*Calophyllum inophyllum*	74	142.745	72.83	1
	Casuarina equisetifolia	45	41.1637	21.00	2
	Cocos nucifera	5	4.8637	2.48	3
	Pandanus kirkii	5	2.459	1.25	4
	Pandanus rabaiensis	4	2.2702	1.16	5
	Ficus sur	2	1.0763	0.55	6
	Macaranga capensis	2	1.0345	0.53	7
	Phoenix reclinata	1	0.3899	0.20	8
	Total transect 9	**138**	**196.0023**	100.00	
			0		
10	*Syzigium cumini*	13	35.4226	52.16	1
	Xylocarpus granatum	25	17.2925	25.46	2
	Cocos nucifera	6	10.1579	14.96	3
	Pittosporum viridiflorum	3	2.7711	4.08	4
	Diospyros consolatae	9	1.3626	2.01	5
	Ficus natalensis	3	0.4096	0.60	6
	Onchoba spinosa	2	0.2139	0.31	7
	Heritiera littoralis	1	0.1991	0.29	8
	Euclea schimperii	1	0.0866	0.13	9
	Total transect 10	**63**	**67.9159**	100.00	
			0		
11	*Olea woodiana*	26	5.3859	31.64	1
	Diospyros consolatae	19	4.3361	25.48	2
	Apodytes dimidiana	5	2.5556	15.01	3
	Olea europaea	1	1.2842	7.54	4
	Maytenus mossambicensis	9	1.0487	6.16	5
	Euclea racemosa	7	0.8211	4.82	6
	Mystroxylon aethiopicum	3	0.615	3.61	7
	Sideroxylon inerme	3	0.479	2.81	8
	Rapanea melanophloeos	10	0.2944	1.73	9
	Eugenia capensis	1	0.109	0.64	10
	Terminalia boivinii	1	0.092	0.54	11
	Total transect 11	**85**	**17.021**	100.00	
			0		
12	*Bourreria petiolaris*	13	4.2291	25.86	1
	Markhamia acuminata	3	2.2867	13.98	2
	Macaranga capensis	3	1.2651	7.74	3
	Ozoroa obovata	4	1.1854	7.25	4
	Tabernamontana ventricosa	5	1.0277	6.28	5

Transect	Species	No. of individuals	Basal area (m^2ha^{-1})	Relative dominance	
				%	rank
	Albizia glaberrima	1	0.9634	5.89	6
	Rapanea melanophloeos	6	0.9272	5.67	7
	Bersama abyssinica	4	0.7405	4.53	8
	Senna petersiana	2	0.6237	3.81	9
	Macphersonia gracilis	4	0.5995	3.67	10
	Olea woodiana	4	0.5547	3.39	11
	Mallotus oppositifolius	3	0.4991	3.05	12
	Apodytes dimidiata	3	0.3909	2.39	13
	Mimusops fruticosa	2	0.3898	2.38	14
	Ficus sur	3	0.3787	2.32	15
	Suregada zanzibariensis	1	0.115	0.70	16
	Areca catechu	1	0.092	0.56	17
12	*Pyrostria bibracteata*	1	0.0867	0.53	18
	Total transect 12	**63**	**16.3552**	100.00	
			0		
13	*Syzigium cumini*	4	15.5707	22.87	1
	Vitex doniana	11	15.0357	22.09	2
	Eugenia capensis	40	7.437	10.93	3
	Elaeis guineansis	5	4.7827	7.03	4
	Apodytes dimidiata	4	4.4843	6.59	5
	Ficus natalensis	1	4.0286	5.92	6
	Ficus exasperata	2	3.8276	5.62	7
	Ficus lutea	3	2.1243	3.12	8
	Blighia unijugata	4	1.985	2.92	9
	Maytenus mossambicensis	11	1.4771	2.17	10
	Rapanea melanophloeos	5	1.4142	2.08	11
	Diospyros consolatae	5	1.046	1.54	12
	Phoenix reclinata	9	1.0382	1.53	13
	Macphersonia gracilis	5	0.9348	1.37	14
	Senna petersiana	4	0.6716	0.99	15
	Psychotria goetzei	4	0.5783	0.85	16
	Ficus sur	1	0.5091	0.75	17
	Bersama abyssinica	1	0.4475	0.66	18
	Euclea racemosa	2	0.2192	0.32	19
	Polysphaeria parvifolia	2	0.1786	0.26	20
	Bourreria petiolaris	1	0.1542	0.23	21
	Mallotus opposifolia	1	0.1273	0.19	22
	Total transect 13	**125**	**68.072**	100.00	
			0		
14	*Diospyros consolatae*	187	4.2611	20.39	1
	Afzelia quanzensis	10	3.8518	18.43	2
	Ozoroa obovata	8	1.7987	8.61	3
	Olea woodiana	5	1.5411	7.37	4
	Maytenus mossambicensis	9	1.288	6.16	5
	Terminalia boivinii	8	1.2307	5.89	6
	Rhizophora mucronata	4	1.1609	5.55	7
	Mimusops fruticosa	5	1.0197	4.88	8
	Pittosporum viridiflora	5	0.9749	4.66	9
	Eugenia spinostachyum	5	0.6831	3.27	10
	Mystroxylon aethiopicum	2	0.5667	2.71	11
	Apodytes dimidiata	4	0.5312	2.54	12
	Ficus sur	3	0.4536	2.17	13
	Casuarina equisetifolia	1	0.4012	1.92	14
	Grewia capitellata	1	0.2584	1.24	15

Transect	Species	No. of individuals	Basal area ($m^2.ha^{-1}$)	Relative dominance	
				%	rank
	Euclea natalensis	1	0.2235	1.07	16
	Macphersonia gracilis	2	0.2193	1.05	17
	Euclea racemosa ssp. *schimperii*	1	0.1273	0.61	18
	Bersama abyssinica	1	0.109	0.52	19
	Senna petersiana	1	0.1032	0.49	20
	Pyrostria bibracteata	1	0.0975	0.47	21
	Total transect 14	**264**	**20.9009**	100.00	
			0		
15	*Acacia auriculiformis*	102	13.452	53.59	1
	Acacia mangium	44	6.393	25.47	2
	Bridelia micrantha	7	1.9498	7.77	3
	Annona senegalensis	8	1.1262	4.49	4
	Terminalia catapa	4	1.0663	4.25	5
	Ficus sur	4	0.5449	2.17	6
	Casuarina equisetifolia	3	0.3099	1.23	7
	Apodytes dimidiata	1	0.0866	0.34	8
	Ficus exasperata	1	0.0866	0.34	9
15	*Rapanea melanophloeos*	1	0.0866	0.34	10
	Total transect 15	**175**	**25.1019**	100.00	
16	*Casuarina equisetifolia*	79	12.9869	98.64	1
	Acacia auriculiformis	2	0.1785	1.36	2
	Total transect 16	**81**	**13.1654**	100.00	
			0		
17	*Calophyllum inophyllum*	68	116.3404	95.08	1
	Rapanea melenophloeos	17	2.9325	2.40	2
	Eucalyptus sp	1	1.5595	1.27	3
	Apodytes dimidiata	8	1.3276	1.08	4
	Euclea racemosa	2	0.2016	0.16	5
	Total transect 17	**96**	**122.3616**	100.00	

Appendix IV: Questionnaire

Yafuatayo ni maswali ambayo tunakuomba utupatie majibu yake kwa kujaza form hii:

1. **Jinsia: Mke/ Mume:----------**
2. **Umri: Miaka: ----------**
3. **Kazi: ----------**

4. **Mimea**

i) Orodhesha majina ya mimea inayotumika kwa wingi kwa matumizi mbalimbali.

	Jina	Matumizi
1.	----------	----------
2.	----------	----------
3.	----------	----------
4.	----------	----------
5.	----------	----------
6.	----------	----------
7.	----------	----------
8.	----------	----------
9.	----------	----------
10.	----------	----------
11.	----------	----------
12.	----------	----------
13.	----------	----------
14.	----------	----------
15.	----------	----------
16.	----------	----------
17.	----------	----------
18.	----------	----------
19.	----------	----------
20.	----------	----------

ii) Tafadhali taja ni sehemu gani ya mmea uliotajwa hapo juu hutumika

	Mmea	Sehemu itumikayo (tunda, shina, mizizi, majani, mbegu, nyingineyo taja)
1.	----------	----------
2.	----------	----------
3.	----------	----------
4.	----------	----------
5.	----------	----------
6.	----------	----------
7.	----------	----------
8.	----------	----------
9.	----------	----------
10.	----------	----------
11.	----------	----------
12.	----------	----------
13.	----------	----------

14. ---------- ----------
15. ---------- ----------
16. ---------- ----------
17. ---------- ----------
18. ---------- ----------
19. ---------- ----------
20. ---------- ----------

iii) Huu msitu wa kupandwa una faida gani kwa wanakikjiji? ----------
---

iv) Je utaratibu wa kutoa leseni za kukata miti kwenye msitu wa kupandwa ukoje? ----------
---

5. Wanyama na mifugo

i) Taja aina ya wanyamapori na ndege wanaopatikana katika msitu wa hifadhi wa Jozani

Mnyama

1. ---------- 11. ----------
2. ---------- 12. ----------
3. ---------- 13. ----------
4. ---------- 14. ----------
5. ---------- 15. ----------
6. ---------- 16. ----------
7. ---------- 17. ----------
8. ---------- 18. ----------
9. ---------- 19. ----------
10. ---------- 20. ----------

ii) Taja matumizi ya wanyama uliowataja

Mnyama	Matumizi
1. ----------	----------
2. ----------	----------
3. ----------	----------
4. ----------	----------
5. ----------	----------
6. ----------	----------
7. ----------	----------
8. ----------	----------
9. ----------	----------
10. ----------	----------

ii) Kwa kukisia kuna idadi gani ya mifugo katika eneo hili?

Mbuzi:----------, Kondoo:----------, Ng'ombe:----------, Wengine:----------

iii) Sababu kuu za kufuga: ----------
---

iv) Ni aina gani ya ufugaji inayotumika hapa kijijini? Weka alama X mbele ya jibu sahihi:

a) Ufugaji wa ndani ya banda na kuleta malisho
b) Ufugaji wa nje wa kuwafungia mahali pamoja
c) Ufugaji wa nje wa kuachia mifugo iijitafutie malisho

(v) Taja mimea inayopendwa au inayoliwa sana na mifugo

(vi) Je mifugo katika eneo hili huathirika zaidi na magonjwa gani?

(vi) Je kuna magonjwa ambayo huambikiza kati ya mifugo na wanyama pori au binadamu?
NDIYO/HAPANA.
Yataje: ----------

---

6. Mengineyo

(i) Unavyojua wewe hiki kijiji kinaweza kuwa na wakazi wangapi:----------

ii) Eneo unalomiliki au unalotumia kwa shughuli za kilimo na mifugo liko umbali gani toka msitu wa hifadhi wa Jozani? Weka alama X mbele ya jibu sahihi

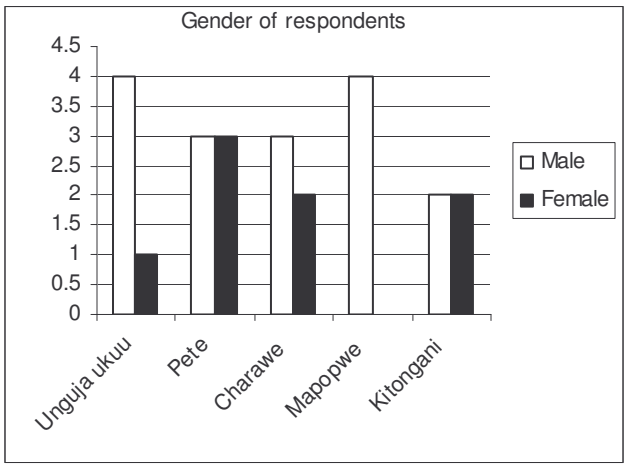
a) liko ndani ya msitu wa hifadhi
b) limepakana na msitu wa hifadhi
c) liko mbali na msitu wa hifadhi

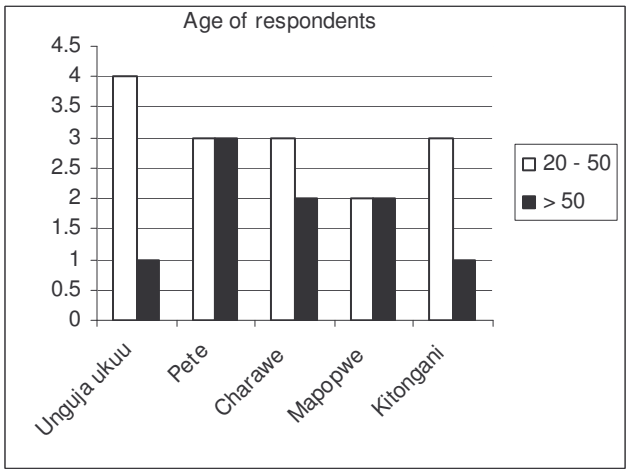
iii) Kama eneo unalomiliki au unalotumia kwa shughuli za kilimo na mifugo liko ndani ya hifadhi au limepakana na msitu wa hifadhi utapenda kuhamia sehemu nyingine kama serikali ikiamua hivyo?

Appendix V: Information collected from a survey using structured questionnaires in five villages surrounding Jozani Forest Reserve, Zanzibar

(i) Demographic structure of respondents

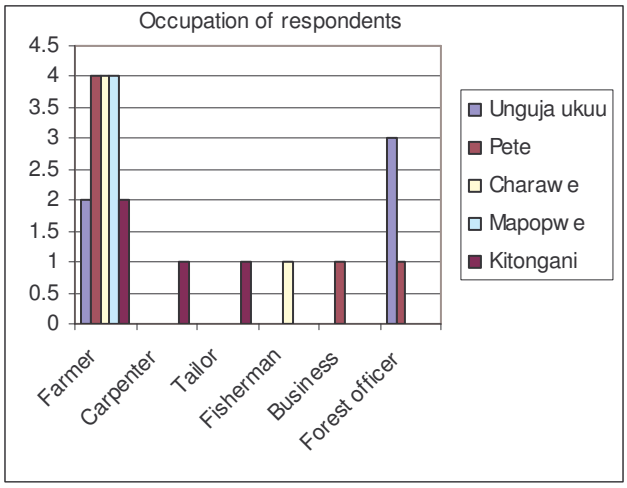
In the two villages of Unguja kuu and Mapopwe there were more male respondents. The average age of respondents was around 50 years suggesting that they had a good knowledge and history of the area. As in most parts of the country the main occupation is farming although it was expected that fishing would also be mentioned as an economic activity for the area.





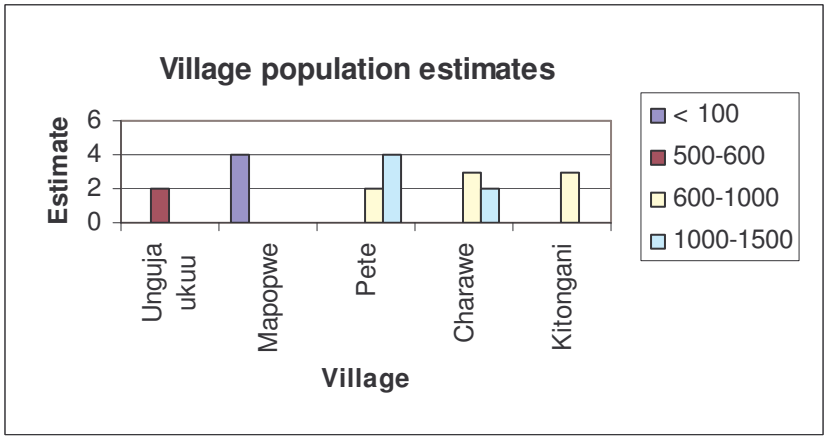
(ii) Occupation of respondents

Farming is the major activity in all the five villages surveyed while in Unguja Ukuu many respondents were employed in the forestry sector mostly to take care of forest plantations. Therefore, forest plantations provide employment to local residents in addition to wood supply.



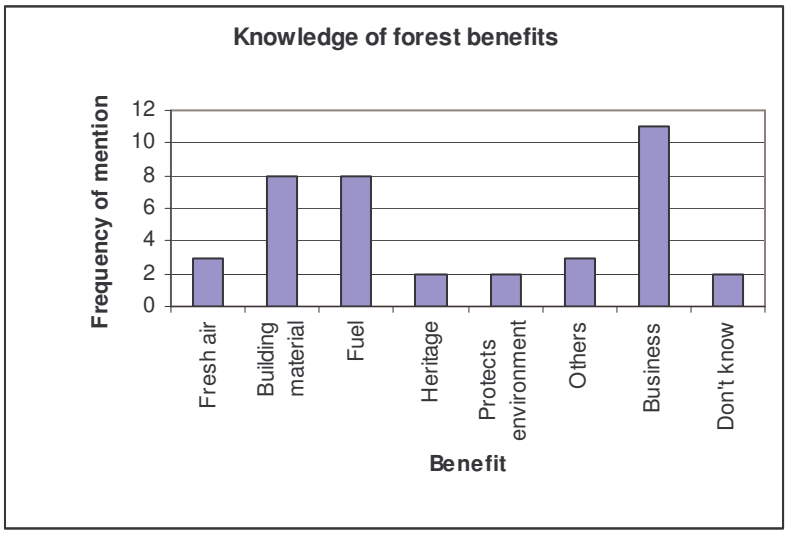
(iii) Population estimates

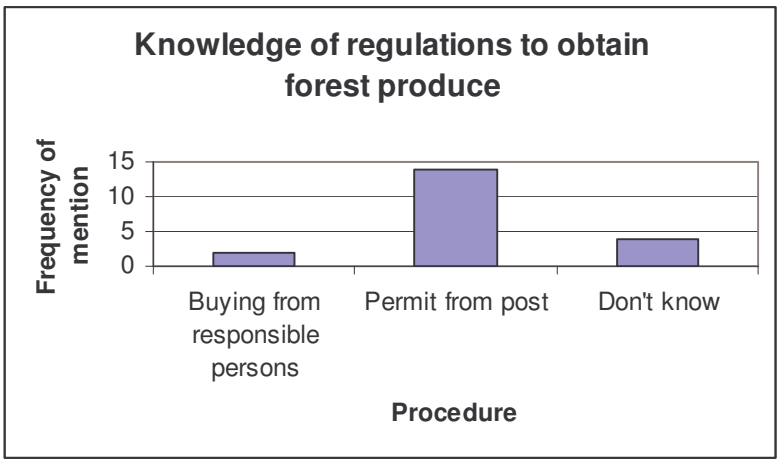
Population estimates for respective villages were obtained from interviewed villagers. Figures may not reliable especially for villages like Charawe and Pete. More accurate data may be obtained from the Shehias because no records of human populations are available in most villages.



(iv)Forest Reserve benefits and Regulations:
The responses on forest benefit were not as detailed as expected, this may be due to little knowledge of what would occur in the absence of the forest, rather than due to lack of appreciation for the present forest.

The forestry officers were very clear on the regulations regarding purchase or extraction of forestry products. Villagers were also aware of the regulations safeguarding forest products exploitation. However, a few villagers appeared to be unclear of the forest rules and regulations There is probably a communication problem between the two parties, users and caretakers.





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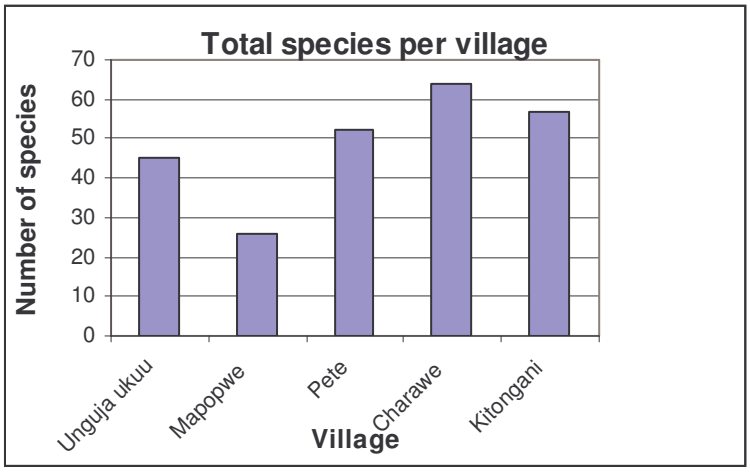
(vi) Vegetation
The figure below indicates the total number of plant species used in each village



Below is information on the indigenous knowledge on uses of cultivated and wild plants of Jozani-Chwaka Bay proposed National Park, as collected through questionnaires

Local name	Scientific name	Use	Tissue used
Dimi la ng'ombe		Food	Fruit
Kifauongo		Medicinal	Stem
Kifugu	*Mystroxylon aethiopicum*	Building	Stem
Kifunga ng'ombe		Building, Fuel	Stem
Kiraramba	*Olea* sp.	Food	Root
Majimbi	*Xanthosoma sagitifolium*	Fodder	Fruit
Mbalungi	*Ctrus maxima*	Fuel	Stem
Mbamba kofi	*Afzelia quanzensis*	Food	Fruit
Mbebeta wa juu	*Psiadia punctulata*	Food, medicinal	Fruit, root
Mbilinganyi	*Solanum melongena*	Building	Stem
Mbirimbi	*Averrhoa bilimbi*	Food	Fruit
Mboga	*Curcubita maxima*	Food	Seed
Mbulugam		Food	Leaves
Mbungo	*Saba comorensis*	Fuel	Stem
Mbuyu	*Adansonia digitata*	Food, Fuel	Stem
Mchaichai	*Cymbopogon citratus*	Food	Fruit
Mchengele	*Rhus longipes*	Medicinal, Fuel	Roots, leaves, stem
Mchenza	*Citrus nobilis*	Medicinal	Leaves
Mchikichi	*Elaeis guineansis*	Food, Fuel	Fruit, Stem
Mchovu	*Mondora grandidieri*	Fuel	Stem
Mchu	*Avicennia marina*	Building, Food	Stem
Mchungwa	*Citrus sinesis*	Medicinal, Food	Fruit
Mchupaka		Medicinal, Building	Roots
Mdaa/ Msiliza	*Euclea racemosa*	Medicinal	Fruit
Mdimu	*Citrus aurantiifolia*	Food, medicinal	Fruit
Mdimu msitu	*Surregada zanzibarensis*	Food, timber	Fruit, Stem
Mdodoki	*Luffa acutangula*	Medicinal	Leaves

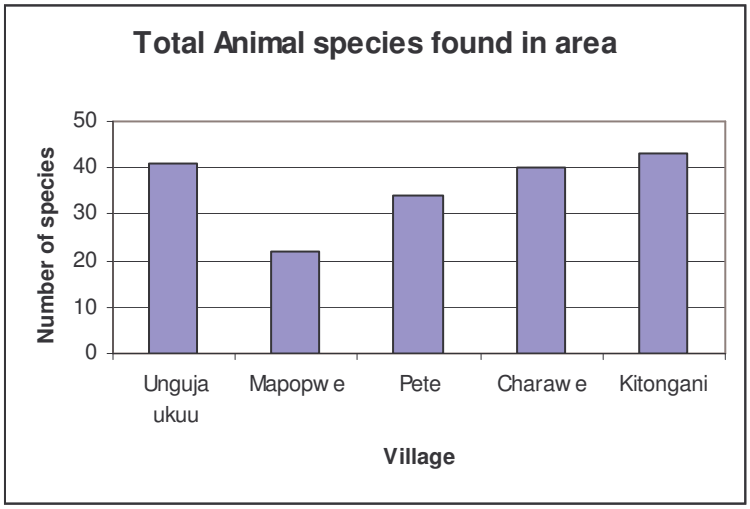
Local name	Scientific name	Use	Tissue used
Mdoriani	*Durio zibethinus*	Medicinal, Fuel	Stem
Mfenesi	*Artocarpus heterophyllus*	Medicinal	Leaves
Mfurugundu	*Brexia madagascariensis*	Timber, Fuel	Stem
Mfusho		Fuel, Timber	Stem,canoe
Mfuu	*Vitex doniana*	Food, Fuel	Fruit, Stem
Mgenenge		Building, Fuel	Stem
Mgerenge	*Albzia adianthifolia*	Food	Fruit
Mgo			Roots
Mgoma		Medicinal	Leaves
Mgomba	*Musa* spp.	Soap	Fruit
Mgwede	*Encephalartos hildebrandtii*	Food	Seed
Mhali udi	*Vetiveria zizanoides*	Food, medicinal	Fruit, root
Mharage	*Phaseolus vulgaris*	Toxin for fish	Root
Mharita	*Sapindus saponaria*	Medicinal	Root, Bark
Migerenge	*Alibizia adiantifolia*	Medicinal	Root, Bark
Mjafari	*Drypetes natalensis*	Fuel, Building	Stem
Mjoma	*Machphersonia gracilis* O.Hoffm	Medicinal, Fuel	Stem, Bark
Mkaaga	*Eugenia capensis*	Medicinal	Root, leaves
Mkadi	*Pandanus kirkii*	Fuel	Stem
Mkandika	*Sideroxylon inerme*	Building, Fuel	Fruit, Stem
Mkangala shamba	*Rapanea melanophloeos*	Spice,Timber	Seeds, Stem
Mkarafuu	*Syzigium aromaticus*	Building	Stem
Mkarati	*Bridelia micrantha*	Medicinal	Root
Mkaratusi	*Eucalyptus* spp.	Fuel	Stem
Mkeneta	*Dodonea viscosa*	Building	Stem
Mkesia	*Acacia* spp.	Timber	Stem,medicine
Mkoko	*Rhizophora mucronata*	Fuel	Stem
Mkole	*Grewia conocarpa*	Herbal cure	Flowers
Mkomafi	*Xylocarpus granatum*	Building, Fuel	Stem
Mkomwe	*Caesalpinia bonduc; Cordia subcordata*	Fuel	Stem
Mkonge	*Pyrostria bibracteata*	Timber	Fruit
Mkumba	*Rhus natalensis*	Building, Fuel	Stem
Mkungu	*Anthocleista glandiflora*	Bird feed	Fruit
Mkururu	*Diospyros consolatae Chiov.*	Food,Fuel	Fruit,Stem
Mkuyu	*Ficus sur*	Fuel	Stem
Mkwaju	*Tamarindus indica*	Essence	Fruit
Mkwamba	*Margaritaria discoidea*	Fuel, Food, Building	Stem, Fruit
Mlangi langi	*Cananga odorata*	Medicinal	Root
Mlapaa	*Polyphaeria parvifolia*	Spice, Fuel	Fruit, Stem
Mlashore	*Trianolepis africana*	Food	Fruit
Mlimau	*Citrus limon*	Food, timber	Fruit, Stem
Mnanasi	*Ananas comosum*	Fuel, Medicinal	Stem
Mnazi	*Cocos nucifera*	Fuel	Stem
Mng'ombe	*Ozoroa obovata*	Medicinal	Barks
Mninga	*Pterocarpus angolensis*	Food	Fruit

Local name	Scientific name	Use	Tissue used
Mnusi	*Maytenus mossambicensis*	Medicinal	Root, Bark
Mpachori	*Artemisia dracunculus*	Food	Fruit
Mpande	*Pittosporum viridiflorum*		
Mpapai	*Carica papaya*	Food, medicinal	Fruit
Mpashu	*Croton pseudopulchellus*	Building	Stem
Mpeasi	*Trema orientalis*	Food	Fruit
Mpera	*Psidium guajava*	Food, Fuel	Fruit, Stem
Mpesheni	*Passiflora foetida*	Spice, Fuel	Fruit, Stem
Mpesu	*Tema orientalis*	Medicinal	Root
Mpilipili	*Capsicum annuum*	Food	Fruit
Mpilipili doria	*Sorindea madagascariensis*	Fuel	Stem
Mpilipili hoho	*Capsicum frutescens*	Timber	Stem
Mpinguaume	*Senna petersiana*	Timber	Tissue used
Mrimbo mti		Medicinal	Leaves
Mrunga		Food, timber	Fruit, Stem
Msaji	*Tectona grandis*	Medicinal, Fuel	Stem
Mshelisheli	*Artocarpus altilis*	Fruit	Leaves
Mshinduzi	*Croton slyvaticus*	Building	Stem
Mshoki shoki	*Nephelium lappaceum*	Canoe, Mattress	Stem, Fruit
Mstafeli	*Annona muricata*	Food, Fuel	Fruit, Stem
Msufi	*Ceiba pentandra*	Fuel	Stem
Mtamagoa	*Turraea floribunda*	Mashuwa, Timber	Stem
Mtondoo	*Calophyllum inophyllum*	Medicinal	Stem
Mtonga	*Strychnos innocua, Strychnos spinosa*	Medicinal, Fuel	Leaves, Stem
Mtopetope	*Annona senegalensis*	Medicinal	Roots, leaves
Mtufaa	*Syzigium malaccensis*	Food, medicinal	Stem
Mtunda	*Sideroxylon inerme*	Food	Fruit
Mtundutundu	*Mallotus oppositifolia*	Fuel	Stem
Mtunguja	*Solanum officianarum*	Medicinal	Fruit
Mua	*Saccharum offinarum*	Food	Root
Muarikali		Medicinal, Fuel	Leaves, Stem
Muarubaini	*Adzirachta indica*	Building, Medicinal	Stem
Muhogo	*Manihot esculenta*	Poison to animals	Stem
Muumbuzi	*Senna petersiana*	Building, Fuel	Stem
Muwango	*Rauvolfia mombasiana*	Timber	Stem
Muwangwa kwao	*Bersama abyssinica*		Stem
Mvinje	*Casuarina equisetifolia*	Medicinal	Leaves
Mvule	*Milicia excelsa*	Food	Fruit
Mvumbasi/Kivumbasi		Food, herbs	Fruit, Stem
Mvumo	*Borassus aethiopum*	Fuel	Stem
Mwache	*Borassus aethiopum*	Food, Fuel, medicinal	Fruit, Stem, root
Mwembe	*Mangifera indica*	Food	Root
Mwembe mwitu	*Rauvolfia caffra*	Building	Stem
Mwembe wa kizungu	*Spondias cytherea*	Fuel	Fruit
Mzambarau	*Syzigium cuminii (L) Skeels*	Medicinal	Leaves, Root

Local name	Scientific name	Use	Tissue used
Mzingifuri	*Bixia orellana*	Medicinal	Leaves
Patakuva		Medicinal	Leaves
Upundi		Food	Fruit
Utupa	*Euphorbia nyikae*	Food?	Leaves
Uyoga	Mushroom	Medicinal	Roots
Viazi	*Ipomea batatas*	Medicinal	Leaves

(v) Animals known in the area

The number of animal species found in each village as reported by local people is presented in the figure below



The following is a list of animals and their uses as provided by the local people:

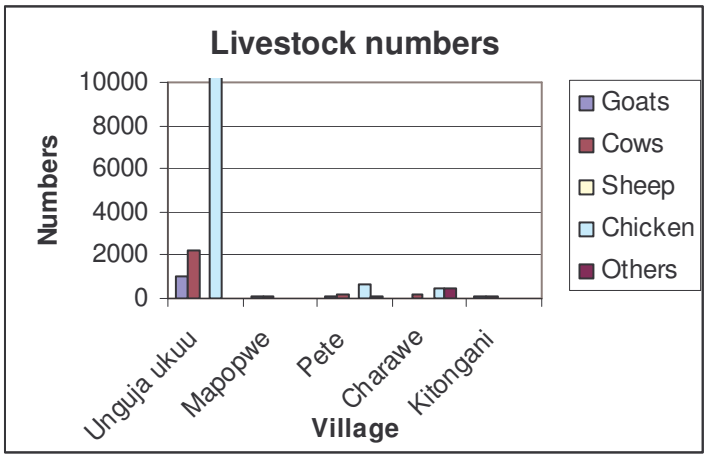
Local name	English name	Use
Buku	Cane rat?	None
Bugi		None
Bundi	Owl	None
Chatu	Python	Skin for leather
Cheche	Mongoose	None
Chindi	Squirrel	None
Chozi	Sunbird	Food
Chui	Leopard	Skin for leather

Local name	English name	Use
Chura	Frog	None
Dete		None
Dumichuma		None
Fungo	Civet	None
Fyembe		None
Golegole		None
Gonota		None
Huwa	Pigeon	None
Jemse		None
Jogoo mwitu	Wild cockerel	None
Jore		None
Kaa wa maji baridi	Fresh water crab	None
Kanga	Guinea fowl	Food
Karora		None
Kenge	Monitor lizard	Food, skin
Kichinita		None
Kidete makungu		None
Kijumba mshare		None
Kihodi		None
Kima	Vervet monkey	None
Kima mweusi	Sykes monkey	Pet
Kima punju	Red colobus	Tourist attraction
Kindi		None
Kinyonga	Chameleon	None
Kitu		None
Komba	Galago	None
Kopanga		None
Korongo	Stork	None
Kororo		Food
Kumbizi		None
Kunguru	Pied crow	None
Kuruwiji	Thrush	None
Mbuzi	Goat	Food
Mbwa	Domestic dog	Security, hunting
Mnana		None
Msese		None
Ndere		None
Ngawa	Civet	None
Ng'ombe	Cattle	Food
Ngombo		Food
Nguruwe	Bushpig	Food
Ninga	Green pigeon	Food
Nyoka	Snake	None
Paa	Suni	Food, skin
Paa chesi	Blue duiker	Food, skin
Paa nunga	Aders' duiker	Food, skin
Panya	Rat	None

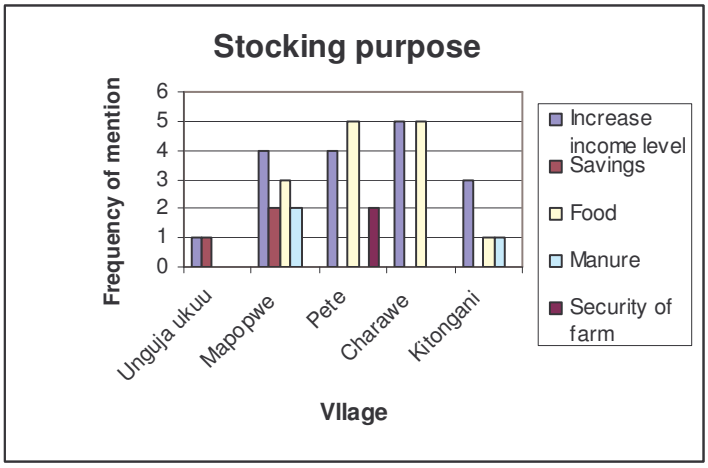
Local name	English name	Use
Pelele	Hyrax	None
Pugi	Wood dove	None
Shore	Bulbul	None
Siafu	Red ants	None
Tetere	Dove	None
Tipitipi	Coucal	None
Tiva	Boubou	None
Tomboro		None
Tore		None
Uhange		None
Ushundwi		None
Yangeyange	Egret	None
Ziwade		None

(vi) Livestock

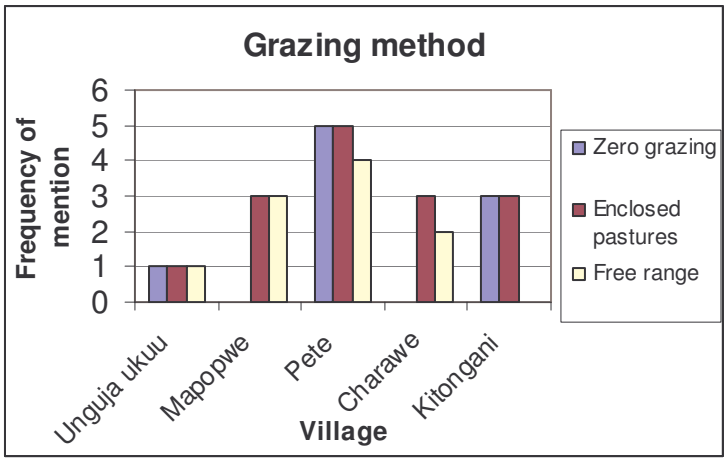
Livestock in the area consists mainly of cattle and goats, though chicken numbers register quite high. Livestock are mainly free ranging.



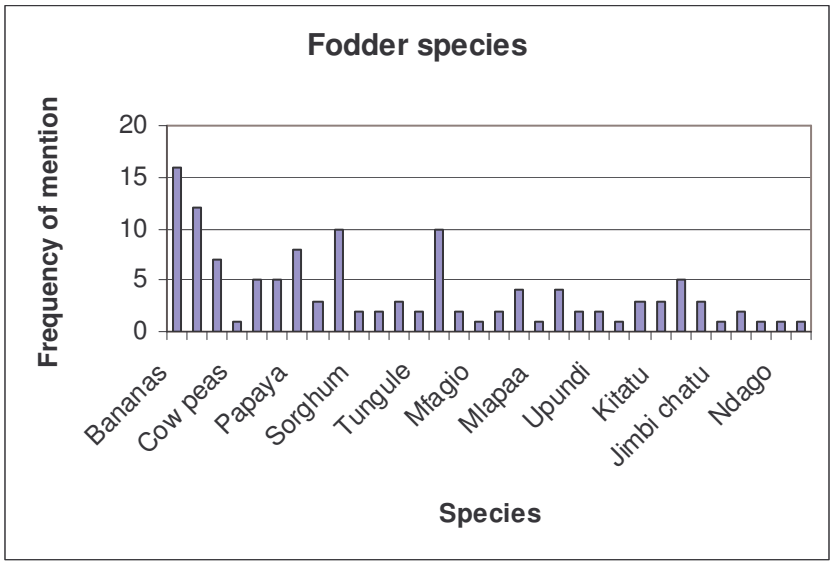
As in many other areas the reasons for keeping livestock i.e to raise the household income and for food are distinguishably the most prominent.



Grazing methods rank evenly, suggesting that the availability of fodder determine the grazing method at a particular period

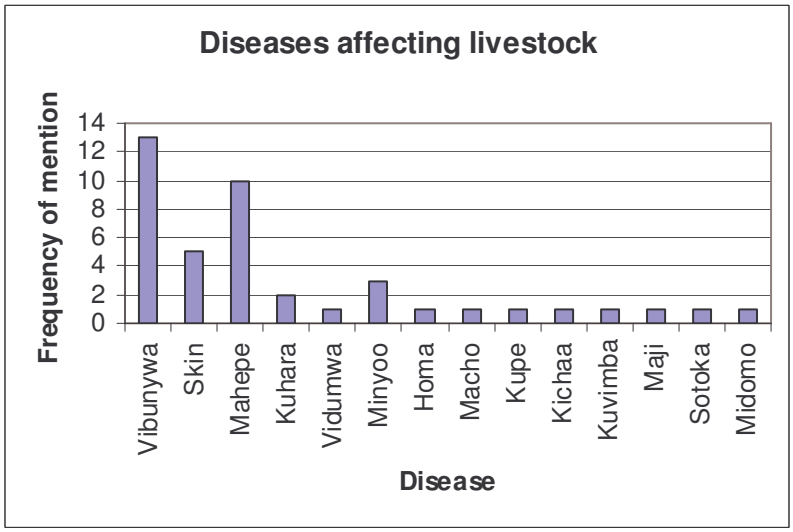


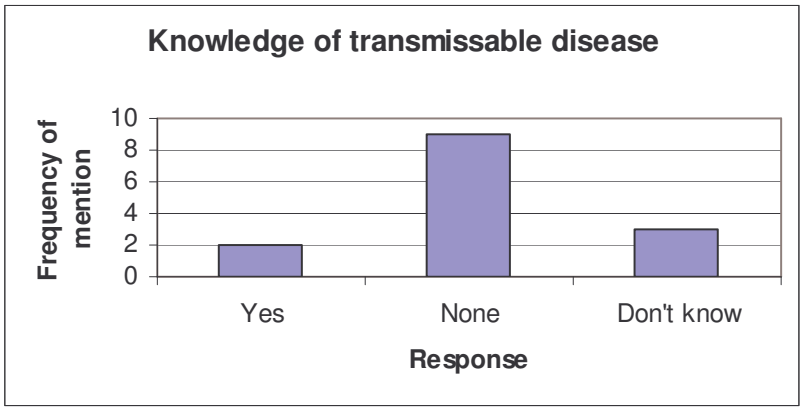
Fodder species mentioned are mainly related to zero grazing as these are by products of farm produce. In some cases livestock are brought to the farm to graze. Sorghum fodder is mostly found within the farm/house compounds



(vii) Disease affecting livestock and transmissible diseases

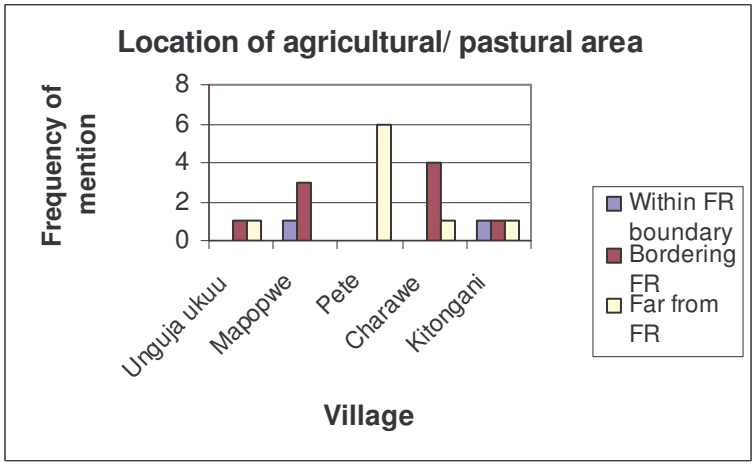
Though the perception of diseases affecting livestock is high, the knowledge on transmissible diseases between humans, wildlife and livestock is lacking. This may be due to respondents ignorance of human-animal interactions

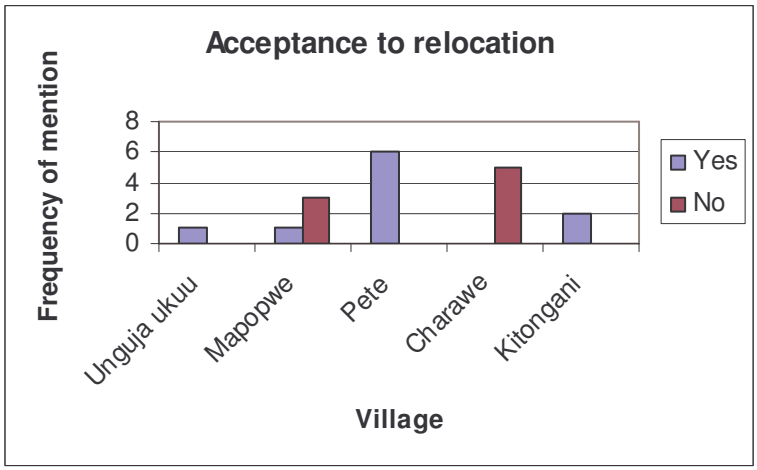




(viii) Relocation issues

Kitongani, Mapopwe and Charawe villages have farmland within the forest boundary and thus relocation is not a light issue with these three villages particularly Mapopwe and Charawe. Land use is an important agenda in these vilages especially due to the high human population found there.




Acceptance to relocation
Frequency of mention
8
6
4
2
0
Yes
No
Ungujà ukuu
Mapopwe
Pete
Charawe
Kitongani
Village

Appendix VI: List of algae and seagrass species found in Chwaka Bay (Source: Mohammed S. 1999)

Algae
Caulerpa lentilifa
Caulerpa scaperis
Caulerpa serulars
Chaetomorpha sp
Cladophora fasciculs
Cystoceira sp
Dictyota sp
Enteromorpha sp
Gracillaria sp
Halimeda macrola
Halimeda opuntia?
Hormophysa triequea
Hydroclathrs clathrats
Hypnea sp
Laurentia sp
Lyngbya? Sp
Padina sp
Sargassum binderi
Sargassum iliciforlim
Turbinaria sp
Udotea indica
Ulva fasciata
Ulva retivulaa

Seagrasses
Cymodocea rotundata
Cymodocea serulata
Enhallus acroides
Hallodule uninervis
Hallodule wrighty
Hallophila ovalis
Hallophila stiplacea
Syringoides sp.
Thallasia hamprichii
Thallosodendron ciliatum

Appendix VII: Checklist of animals recorded during a survey conducted in Jozani - Chwaka Bay proposed National Park, between 29th June - 8th July 2002 and those known to occur on Zanzibar

Species	Recorded in Jozani	Known for Zanzibar
Amphibians		
PIPIDAE		
Xenopus muelleri (Peters, 1844) Muller's Clawed Frog	x	x
BUFONIDAE		
Bufo gutturalis Power, 1927 Guttural Toad		x
Mertensophryne micranotis (Loveridge, 1925)	x	x
Stephopaedes howelli	x	
HEMISIDAE		
Hemisus marmoratus (Peter's 1854). Mottled Shovel-snouted Frog	x	x
RANIDAE		
Phrynobatrachus acridoides (Cope, l867). East African Puddle Frog	x	x
P. minutus (Boulenger,1895)	x	x
P. natalensis (Smith, l849). Snoring Puddle Frog		x
P. pakenhami Loveridge, 1941	x	x
Hylarana galamensis (Perret, l977) Golden-backed Frog		x
Ptychadena anchietae (Bocage, 1867) Savanna Ridged Frog	x	x
P. mascareniensis (Dumeril & Bibron, 1841) Mascarene Frog		x
P. mossambica (Peters, 1854) Mozambique Ridged Frog ?	x	
RHACOPHORIDAE		
Chiromantis xerampelina Peters, 1854. Grey Foam-nest Treefrog	x	x
ARTHROLEPTIDAE		
Arthroleptis stenodactylus Pfeffer, 1893 Common Squeaker	x	
Schoutedenella xenodactyloides (Hewitt, 1933) Dwarf Squeaker	x	x
HYPEROLIIDAE		
Afrixalus brachycnemis (Boulenger, 1896) Short-legged Banana Frog	x	x
A. fornasinii (Bianconi, 1849) Fornasini's Leaf-folding Frog	x	x
A. pygmaeus *(Ahl, 1931)*	x	x
Hyperolius argus Peters, 1854 Argus Reed Frog		x
H. mitchelli Loveridge, 1953 Mitchell's Reed Frog		x
H. nasutus Gunther, 1864 Sharp-nosed Reed Frog ?	x	x
H. parkeri Loveridge, 1933 Parker's Reed Frog	x	x
H. viridiflavus mariae (Barbour & Loveridge, 1928)		x
Kassina maculata (Dumeril, 1893) Red-legged Kassina		x
Kassina sp	x	
Leptopelis flavomaculatus (Gunther, 1844) Yellow-spotted Tree Frog	x	x
Species	**Recorded in Jozani**	**Known for Zanzibar**

Reptiles		
DERMOCHELYIDAE		
Dermochelys coriacea *Leatherback Turtle*		x
CHELONIIDAE		
Chelonia mydas Green Turtle		x
Eretmochelys imbricata *Hawksbill Turtle*		x
TESTUDINIDAE		
Geochelone gigantea Aldabra Giant Tortoise		x
Kinixys belliana Bell's Hinged Tortoise	x	x
PELOMEDUSIDAE		
Pelusios castanoides Yellow-bellied Hinged Terrapin	x	x
GEKKONIDAE		
Hemidactylus brookii Brook's Gecko		x
H. mabouia Tropical House Gecko	x	x
H. platycephalus Tree Gecko	x	x
Lygodactylus luteopicturatus Yellow-headed Dwarf Gecko	x	x
Phelsuma dubia Dull-Green Day Gecko		x
CHAMAELEONIDAE		
Chamaeleo dilepis Flap-necked Chamaeleon	x	x
Rhamphoeleon brevicaudatus Short-tailed Pygmy Chameleon	x	
SCINCIDAE		
Cryptoblepharus boutoni Coral Rag Skink	x	x
Mabuya maculilabris Speckle-lipped Skink	x	x
M. striata Striped Skink	x	x
Lygosoma sundevalli Sundevall's Writhing Skink		x
CORDYLIDAE		
Cordylus trypidosternum Tropical Girdled Lizard	x	
GERRHOSAURIDAE		
Gerrhosaurus major Great Plated Lizard	x	x
VARANIDAE		
Varanus niloticus Nile Monitor	x	x
TYPHLOPIDAE		
Ramphotyphlops braminus Flower-pot Blind Snake	x	x
Rhinotyphlops lumbriciformis Worm-like Blind Snake		x
R. pallidus Zanzibar Blind Snake		x
Species	**Recorded in Jozani**	**Known for Zanzibar**
R. schlegelii		x
BOIDAE		
Python sebae Rock Python	x	x
COLUBRIDAE		

Atractaspis bibronii Bibrons' Burrowing Asp		x
Dipsadoboa aulica Marbled Tree Snake		x
Crotaphopelis hotamboeia White-lipped Snake	x	x
Dasypeltis medici East African Egg-eater	x	x
Dispholidus typus Boomslang	x	x
Lamprophis fuliginosus Brown House Snake	x	x
Lycophidion capense Cape Wolf Snake		x
Mehelia capensis Cape File Snake		x
M. nyassae Black File Snake		x
Natriciteres olivacea Olive Marsh Snake		x
Philothamnus macrops Usambara Green Snake		x
P. semivariegatus Spotted Bush Snake	x	x
Psammophis sibilans Short-snouted Grass Snake		x
P. subtaeniatus Stripe-bellied Sand snake	x	x
Thelotornis capensis Savanna Twig Snake	x	x
ELAPIDAE		
Dendroaspis angusticeps Green mamba	x	x
Naja melanoleuca Forest Cobra	x	x
Naja mossambica Mozambique Spitting Cobra	x	x
VIPERIDAE		
Causus defilippii Snouted Night Adder		x
Mammals		
SORICIDAE		
Crocidura olivieri African Giant Shrew	x	x
C. fuscomurina Zanzibar Pygmy Shrew	x	x
C. viaria Larger Savanna Shrew		x
Suncus murinus Indian Musk Shrew		x
MACROSCELIDIDAE		
Petrodromus tetradactylus Four-toed Elephant Shrew	x	x
Rhynchocyon petersi Black and rufous Elephant Shrew	x	x
PTEROPODIDAE		
Eidolon helvum Straw- coloured Fruit-bat	x	x
Epomophorus minor Little epaulated Fruit-bat	x	x
E. wahlbergi Wahlberg's Epaulated Fruit-bat		x
EMBALLONURIDAE		
Species	**Recorded in Jozani**	**Known for Zanzibar**
Taphozous mauritianus Mauritian Tomb-bat		x
NYCTERIDAE		
Nycteris grandis Large Slit-faced Bat		x
N. hispida Hairy Slit-faced Bat		x
N. macrotis Dobson's Slit-faced Bat		x
N. thebaica Egyptian Slit-faced Bat	x	x

MEGADERMATIDAE		
Cardioderma cor Heart-nose Big-eared Bat		x
Lavia frons Yellow-winged Bat	x	x
RHINOLOPHIDAE		
Rhinolophus deckeni *Decken's Horse-shoe Bat*		x
R. swinyi *Swinny's Horse-shoe Bat*		x
HIPPOSIDERIDAE		
Hipposideros caffer Sundevall's Africa Leaf-nosed Bat	x	x
H. commersoni Commerson's Leaf-nosed Bat	x	x
VESPERTILIONIDAE		
Eptesicus capensis Cape Serotine		x
Pipistrellus nanus Banana Pipistrelle		x
Scotophilus nigrita Brown Bat	x	x
S. nigrita Yellow House Bat	x	x
MOLOSSIDAE		
Tadarida brachyptera Mozambique Free-tailed Bat	x	x
T. pumila Little Free-tailed Bat		x
GALAGONIDAE		
Galago senegalensis Lesser Bushbaby		x
Galagoides zanzibaricus Zanzibar Galago	x	x
Otolemur garnettii Greater Galago	x	x
CERCOPITHECIDAE		
Cercopithecus mitis Sykes Monkey	x	x
Piliocolobus kirkii Zanzibar Red Colobus	x	x
VIVERRIDAE		
Bdeogale crassicauda Bushy-tailed Mongoose		
Herpestes sanguineus Zanzibar Slender Mongoose	x	x
Mungos mungo Banded Mongoose	x	x
Viverra civetta African Civet	x	x
Viverricula indica Javan Civet	x	x

Species	**Recorded in Jozani**	**Known for Zanzibar**
FELIDAE		
Panthera pardus Leopard		x
PROCAVIIDAE		
Dendrohyrax validus Tree Hyrax	x	x
SUIDAE		
Potamochoerus porcus Bush Pig	x	x
Sus scrofa Wild Boar		x

BOVIDAE		
Cephalophus adersi Zanzibar duiker	x	x
C. monticola Blue Duiker	x	x
Neotragus moschatus Suni	x	x
SCIURIDAE		
Heliosciurus rufobranchium Red-legged Sun Squirrel		x
Paraxerus palliatus Red Bush Squirrel	x	x
MURIDAE		
Cricetomys gambianus Giant Rat	x	x
Grammomys sp	x	
Mus musculus White-bellied house Mouse		x
Rattus norvegicus Common Rat		x
R. rattus House Rat	x	x

The taxonomic list of mammals follows Wilson & Reeder (1993); Kingdon (1997), Reptiles follows Spawls et al. (2002) and Amphibians follows Frost, 1984.

Appendix VIII: Results from trapping effort using bucket pitfalls, snap and Sherman's traps in Jozani - Chwaka proposed National Park, Zanzibar, 29th June - 8th July 2002

Bucket Pitfall Trapline I:	-	-	-	-	-	-	-	-	-	-	-
Location:	S. 06o 13.552'										
	E. 39o 24.642'										
Habitat:	Evergreen scrub forest/Coastal coral rag forest close to salt marsh grassland (Wangwani area)									**Total**	**Catch rate**
											(x 100)
Date:		01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul	08-Jul		
Trapping effort (No. of Buckets)		**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**88**	
Stephopaedes howelli		2	2	1	0	0	0	0	2	**7**	7.95
Arthroleptis stenodactylus	-	8	2	2	1	2	2	0	1	**18**	20.45
Schoutedenela xenodactyloides		7	0	1	0	2	0	0	0	**10**	11.36
Kassina sp		4	1	2	0	0	0	1	0	**8**	9.09
Crocidura fuscomurina ?		0	1	0	0	1	0	0	0	**2**	2.27
Crocidura olivieri		0	0	0	0	1	0	0	0	**1**	1.14
Trapping effort (No. of snaps)		**0**	**0**	**0**	**15**	**15**	**15**	**15**	**15**	**75**	
Species:											
Paraxerus palliatus					0	0	0	0	1	**1**	1.33
Herpestes sanguinea					0	0	0	0	1	**1**	1.33
Trapping effort (No. of Shermans)		**0**	**0**	**0**	**5**	**5**	**5**	**5**	**5**	**25**	
Species:											
Grammomys sp					0	0	1	0	0	**1**	4.00
Bucket Pitfall Trapline 2:	-	-	-	-	-	-	-	-	-	-	
Location:	S. 06o 13.563'										
	E. 39o 24.765'										
Habitat:	Wooded grassland patch (Wangwani area)										
										Total	Catch rate

Date:		01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul	08-Jul		(x/100)
Trapping effort (No. of Buckets)		**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**88**	
Species:											
Phrynobatrachus minutus ?		2	0	0	0	0	0	0	0	**2**	2.27
Hemisus marmoratus		0	0	1	0	0	0	0	1	**2**	2.27
Arthroleptis stenodactylus	-	6	7	5	0	2	7	0	1	**28**	31.82
Schoutedenela xenodactyloides		1	5	0	20	0	0	4	4	**34**	38.64
Kassina sp		1	1	6	0	0	0	1	0	**9**	10.23
Hyperolius tuberilinguis		0	0	0	5	0	0	0	0	**5**	5.68
Trapping effort (No. of snaps)		**0**	**0**	**0**	**15**	**15**	**15**	**15**	**15**	**75**	
(No capture)											
Trapping effort (No. of Shermans)		**0**	**0**	**0**	**5**	**5**	**5**	**5**	**5**	**25**	
(No capture)											
Bucket Pitfall Trapline 3:	-	-	-	-	-	-	-	-	-	-	
Location:	S. 06o 15.017'										
	E. 39o 25.625'										
Habitat:	Evergreen scrub forest (Bondeni area)										
										Total	Catch rate
Date:		01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul	08-Jul		(x/100)
Trapping effort (No. of Buckets)		**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**88**	
Species:											
Stephopaedes howelli		0	0	2	0	1	0	0	0	**3**	3.41
Arthroleptis stenodactylus	-	1	0	0	1	1	0	0	0	**3**	3.41
Kassina sp		7	4	7	2	1	0	2	1	**24**	27.27
Trapping effort (No. of snaps)		**0**	**0**	**0**	**15**	**15**	**15**	**15**	**15**	**75**	
Species:											
Paraxerus palliatus					0	0	1	0	0	**1**	1.33
Trapping effort (No. of Shermans)		**0**	**0**	**0**	**5**	**5**	**5**	**5**	**5**	**25**	

(No capture)											
Bucket Pitfall Trapline 4:	-	-	-	-	-	-	-	-	-	-	
Location:	S. 06o 16.273'										
	E. 39o 25.102'										
Habitat:	Ground water forest plantation (near Jozani forest HQ)										
										Total	Catch rate
Date:		01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul	08-Jul		(x/100)
Trapping effort (No. of Buckets)		**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**88**	
Species:											
Stephopaedes howelli		0	0	0	1	0	0	0	1	**2**	2.27
Hemisus marmoratum		3	1	4	0	0	0	0	1	**9**	10.23
Arthroleptis stenodactylus	-	1	2	0	1	0	2	0	1	**7**	7.95
schoutedenella xenodactyloides	-	0	0	1	0	0	1	1	0	**3**	3.41
Phrynobatrachus acridoides ?	-	0	7	5	0	0	0	0	0	**12**	13.64
Phrynobatrachus minutus	-	0	0	0	0	8	0	0	0	**8**	9.09
Crocidura fuscomurina ?		0	0	1	0	2	0	0	0	**3**	3.41
Trapping effort (No. of snaps)		**0**	**0**	**0**	**15**	**15**	**15**	**15**	**15**	**75**	
Species:											
Petrodromus tetradactylus					1	0	0	0	0	**1**	1.33
Trapping effort (No. of Shermans)		**0**	**0**	**0**	**5**	**5**	**5**	**5**	**5**	**25**	
Species:											
Crocidura sp					0	1	0	0	0	**1**	4.00
Bucket Pitfall Trapline 5:	-	-	-	-	-	-	-	-	-		
Location:	S. 06o 16.381'										
	E. 39o 25.355'										
Habitat:	Ground water forest (Tovu/Mnazi Mmoja area)										
										Total	Catch rate

Date:		01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul	08-Jul		(x/100)
Trapping effort (No. of Buckets)		**0**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**77**	
Species:											
Xenopus muelleri			0	0	1	1	2	0	0	**4**	5.19
Hemisus marmoratum			3	4	1	1	0	1	0	10	12.99
Arthroleptis stenodactylus	-		3	1	1	1	3	0	0	9	11.69
Schoutedenella xenodactyloides	-		32	4	0	0	2	0	6	**44**	57.14
Phrynobatrachus acridoides ?	-		0	0	21	0	0	0	0	**21**	27.27
Phrynobatrachus minutus	-		1	22	0	14	2	1	0	**40**	51.95
Mabuya maculilabris	-		0	0	0	1	0	0	0	**1**	1.30
Kassina sp			0	1	0	0	0	4	0	**5**	6.49
Crocidura olivieri			0	0	0	1	0	1	0	**2**	2.60
Trapping effort (No. of snaps)		**0**	**0**	**0**	**15**	**15**	**15**	**15**	**15**	**75**	
(No capture)											
Trapping effort (No. of Shermans)		**0**	**0**	**0**	**5**	**5**	**5**	**5**	**5**	**25**	
Species:											
Grammomys sp					1	0	0	0	0	**1**	4.00
Bucket Pitfall Trapline 6:	-	-	-	-	-	-	-	-	-		
Location:	S. 06o 15.422'										
	E. 39o 23.075'										
Habitat:	Forest plantation (Unguja Ukuu)										
										Total	Catch rate
Date:		01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul	08-Jul		(x/100)
Trapping effort (No. of Buckets)		**0**	**11**	**11**	**11**	**11**	**11**	**11**	**0**	**66**	
Species:											
Mertensophryne micranotis			0	0	1	0	0	0		**1**	1.52
Arthroleptis stenodactylus	-		0	1	1	1	0	0		**3**	4.55
Kassina sp			10	7	2	0	0	1		**20**	30.30
Crocidura fuscomurina ?			1	1	0	0	0	0		**2**	3.03

Trapping effort (No. of snaps)		**0**	**0**	**15**	**15**	**15**	**15**	**15**	**0**	**75**	
(No capture)											
Trapping effort (No. of Shermans)		**0**	**0**	**5**	**5**	**5**	**5**	**5**	**0**	**25**	
Bucket Pitfall Trapline 7:	-	-	-	-	-	-	-	-	-		
Location:	S. 06o 12.509'										
	E. 39o 23.403'										
Habitat:	Legume dominant natural forest (Mapopwe)										
										Total	catch rate
Date:		01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul	08-Jul		(x/100)
Trapping effort (No. of Buckets)		**0**	**11**	**11**	**11**	**11**	**11**	**11**	**0**	**66**	
Species:											
Stephopaedes howelli			0	0	0	1	0	0		**1**	1.52
Arthroleptis stenodactylus	-		1	2	2	0	2	1		**8**	12.12
Schoutedenella xenodactyloides	-		0	0	0	9	1	0		**10**	15.15
Phrynobatrachus acridoides ?	-		1	0	1	0	0	1		**3**	4.55
Crocidura fuscomurina ?			0	1	0	0	0	1		**2**	3.03
Trapping effort (No. of snaps)		**0**	**0**	**15**	**15**	**15**	**15**	**15**	**0**	**75**	
Species:											
Paraxerus palliatus				0	0	0	1	1		**2**	2.67
Trapping effort (No. of Shermans)		**0**	**0**	**5**	**5**	**5**	**5**	**5**		**25**	
Species:											
Paraxerus palliatus				0	0	0	2	0		**2**	8
Bucket Pitfall Trapline 8:	-	-	-	-	-	-	-	-	-		
Location:	S 06o 16' 38.5"										
	E 039o 25' 36.3"										
Habitat:	Bushland and thicket close to mangrove forest (Kichanga area)										

										Total	Catch rate
Date:		01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul	08-Jul		(x/100)
Trapping effort (No. of Buckets)		**0**	**0**	**11**	**11**	**11**	**11**	**11**	**11**	**66**	
Species:											
Kassina sp				1	4	4	0	0	0	**9**	13.64
Arthroleptis stenodactylus	-			2	1	1	1	0	1	**6**	9.09
Trapping effort (No. of snaps)		**0**	**0**	**15**	**15**	**15**	**15**	**15**	**15**	**90**	
Species:											
Paraxerus palliatus				0	0	0	1	0	**0**	**1**	1.11
Trapping effort (No. of Shermans)		**0**	**0**	**5**	**5**	**5**	**5**	**5**	**5**	**30**	
(No capture)											

Appendix IXa: Brief description of some fish Families/Genera occurring in Chwaka Bay, Zanzibar

ARIIDAE: CATFISHES

- Colour usually grey/blue, dark grey/brown on back and sides
- are found in schools or singly in marine, brackish or freshwater
- Male practises oral incubation of the eggs, which are rather large in number.

Geographical distribution and behaviour

West Coast of India to Indo-Australia. Found along all shores, throughout its range. Feeds mainly on invertebrates and small fishes

ALBULIDAE

Colour side silvery, back blue/green or olive

Geographical distribution and behaviour

Known from the Red Sea to Madagascar. An inshore shalow-water species associated with sand and, mud bottom. Feeds by grubbing in the substratum with the snout.

ACANTHURIDAE

Colour: often brown or grey, but some species very colourful.

Geographical distribution and behaviour

Occurs throuthout most of the Indo-Pacific. Feeds on zooplankton.

AMBASSIDAE

Colour: translucent or semi- translucent, often silvery

Used as bait

ATHERINIDAE

Colour: blue/green or olive on back.

Geographical distribution and behaviour

Appear to have narrow range. Restricted to the cape and east coast of Africa. Are used as subsistence fishery.

ANTENNARIIDAE

Colour: usually in two phases; a more common light phse with light tan to yellow brown or rust background. Swome frog fishes may rich sive to over 50 cm total length.

Geographical distribution and behaviour

Throughout the fishing area 51.

APOGONIDAE

Colour: are reddish in colour, mixed with silver and white, though most species are yellow, silvery and black.

Geographical distribution and behaviour

Fiji, Malaysia, Indo-Pacific, East Africa. Feeding predator on small fishes and invertebrates.

BALISTIDAE

- colour: grey dashed with olive green, 3 large white blotches on back and numerous blue spots,
- maximum size 60 cm

Geographical distribution and behaviour

Throughout tropical and subtropical parts of the region, found over sands, sponge, and weed bottom. Shallow water down to 90m, feeds on bottom fauna

BELONIDAE

Colour: green or black on the back and silver white or the lower sides.

Geographical distribution and behaviour

- Is carnivorous feeding largely on small fishes.
- Found off coast and islands throughout the area.
- Are worldwide species of tropical and warm warm-temperate waters. No special fishery.

BLENNIIDAE

Scaless body, premaxillae not protractile.

Geographical distribution and behaviour

Indian, Atlantic and Pacific; chiefly tropical and subtropical marine; rare in freshwater. Feeding: mixed diet algae and benthic invertebrates.

BOTHIDAE

Colour: eyed side brown, often with spots, blind side pale. Eyes on left side of the head, moutyh are terminal, lower jaw prominent.

Geographical distribution and behaviour

Throughout most warm waters. Inhabit the shallower muddy and sandy bottom of the continental shelf.

Feeds on bottom living animals.

CARCHARHINIDAE

Colour: variable, usually no colour pattern.

Geographical distribution and behaviour

Tropical continetal coast and offshore waters. A minority of species range into temperate waters. This family contains more dangerous species than any other. Feeding: feed heavily on bony fishes, other sharks, rays, squid, octopi, crabs, lobsters.

CHAETODONTIDAE

Colours: ground colours are white, yellow, orange and brown.

Have little value as food, young are popular aquarium fish.

Geographical distribution and behaviour

Tropical Indo-Pacific , East Africa, south africa, Zanziibar

CARANGIDAE

Colour: pale to dark blue, silvery white below

Geographical distribution and behaviour

Throughout warm waters. Habits shallow coastal areas. Feeds on crustaceans and fishes.

CONGRIDAE

Colour: plain cream, grey to black, often lighter below with a dark border to dorsal and anal fins.

Geographical distribution and behaviour

Wide spread in the Indo-West Pacific, eastward to Pacific central America. Active at night feeding variouslay on smal reef animals.

CLUPEIDAE

Colour: back usually ble/green, sside ssilvery, sometimes with a distinct silver band. Dark dots or spots along the back

Geographical distribution and behaviour

Throughout warm waters, inhabits coastal waters, pelagic, feeds on detritus.

Tropical Indo-Pacific, East Africa, South Africa

DACTYLOPTERIDAE

Colour: usually dusk red or purple with brown spots above, pinkiush or whitish below.

Geographical distribution and behaviour

Throuighout most of the area, Indo-weswt Pacific from Japan to Australia. Feeds primarlly in benthic crustaceans, clams and small fishes.

EPHIPPIDAE

Coulour: silvery grey to greenish, body with 4 to 10 vertical bands fading with age.

Geographical distribution and behaviour

Within East coastal of Africa from Natal northward to Mombasa and Zanzibar. Feed by nibbing at organisms on rocks and corals.

FISTULARIIDAE

Colour: vaiable with the species either red to oragnge brown above and silvbey below or brownish-olive above, lighter below with series of blue spotson back and snout..

Geographical distribution and behaviour

In west Indian Ocean along the East coast of Africa from Red sea to Maldives. Most common in seagrass beds and coral reefs in shallow waters. Feeds on small fishes and shrimps.

GERREIDAE

Colour: head and body usually silvery, often with faint marking such as spots or lines.

Small to medium sized fishes, body more or less compressed.

Geographical distribution and behaviour

Inhabit coastal waters down to depths of about 40m, near the bottom usually found in schools. Feeds bottom living animals.

HOLOCENTRIDAE

Colour: usually red or pink, plain or striped sometimes with black marekings around the gill opening or on fins.

Geographical distribution and behaviour

Found from Red Sea south to Durban and Madagascar. Most often seen in shallow water protected bays and coral reefs. Feedin on crabs and small fishes.

HAEMULIDAE

Colour: variable from uniform colured to banded blotched and spotted.

Geographical distribution and behaviour

Shallow coastal areas and coral reefs down to 80m depth. Feeds on bottom invertebrates and fishes.

HEMIRAMPHIDAE

Colour: dark bluish above, silvery white bellow.

Geographical distribution and behaviour

An Indo-Pacific species found in the continental coasts and islands chiefly in the area of rich submerged vegetation. Used as a food.

LABRIDAE

Colour: generally bright and elaborately patterned, often differing between sexes and changing with age.

Geographical distribution and behaviour

Throughout the region. Feeds mostly on hard shllede prey, including molluscs, crustaceans and seaurchins.

LEIOGNATHIDAE

Body oval sometimes compressed. Colour; silvery with brownish/ golden wavy on upper half. Size max. 15cm.

Geographical distribution and behaviour

Inhabits coastal waters down to depths of about 40 cm near bottom and found in schools, enters brackish waters.

LETHRINIDAE

Size moderate sized perch like fishes with a large head. Colour, olive green above, pale below.

Geographical distribution and behaviour

Inhabits coastal waters to 50m. feeds mainly on crustaceans and small fishes.

LUTJANIDAE

Colour: dark green to blue/green

Geographical distribution and behaviour

Throughout the warm waters from the surface down to depths of 100m. feeds on fishes.

MONACANTHIDAE

Colour: variable often drabs, grey or greenish with darker makings or very colourful with vivid patterns.

Geographical distribution and behaviour

Indo-West pacific and Red Sea. Feeds on plankton.

MURAENIDAE

Colour: Variable sometimes plain creamish, Brownish, puplish or blackish with minor other markings.

Geographical distribution and behaviour

East Africa to Natal, also wide spread in tropical Indo-Pacific. Found in coral reefs or elsewhere. Feeds on reef animals particularly crustaceans. Consumed locally.

MUGILIDAE

Colour: in life, blue/green, green/olive on back. Silver on sides and belly, often with 3 to 9 longitudinal streaks on back, fins hyline and dusky.

Geographical distribution and behaviour

In the area, found from Natal, Madagascar to the Gulf of Aden, the west coast of India and Sri Lanka. E.g *Liza macrolepis*

Feeds on samll algae, diatoms, foraminifora and other organic matter, both living and detrital.

MULLIDAE

Colour: variable, ground colour generally pale, some species with distinctive dark, or yellow, oragne or brown bands or stripes and spots.

Geographical distribution and behaviour

Throughout the region. Feeds mainly on crabs and other crustacean.

NEMIPTERIDAE

Colour: extremeely variable, but usually pinkish or silvery, with red, yellow and blue markings.

Geographical distribution and behaviour

Indo-West Pacific region in tropical and subtropical coastal waters. Feed priomarly on samll benthic invertebrats and small fishes. Males are usually larger and some species may be protogynous hermaphrodites.

OSTRACIIDAE

Colour:Either grey, yellow, brown usually with darker or lighter spots, blotches and refraction.

Geographical distribution and behaviour

Found throughout West Indo-Pacific. Not consumed.

PLOTOSIDAE

Colour: back and sides uniformly tan, brown or black, or with 2 or 3 whitish to yellowish lateral stripes, belly usually paler or white.

Geographical distribution and behaviour

Along the entire coastline of frishery area 51. Found oin reef, along open coasts in eastuarines and in tidal pools. Feeding on small crustaceans, molluscs and fishes.

POMACENTRIDAE

Colour: dark red/brown with l;ighter face. There is large white spot behind and sadding the dorsal fin and another over its head and behind its eyes.

Geographical distribution and behaviour

Indo-Pacific.

POMADASYIDAE

Colour: background colour with 2- diagonal bands on the head.

Geographical distribution and behaviour

Western Pacifc and India. Feedinding - are amnivores.

SIGANIDAE

Colour: coral associating species usually coloured.

Geographical distribution and behaviour

Found throughout West India-Pacific, moderate sized, herbivore fishes of shallow waters, some species live in pairs around coral, others in schools around rock and coral reefs, mangrove, estuaries and brackish lagoons.

SYNODONTIDAE

Colour: green/brown on back, lighter on flanks with a dark blotches or bars down flanks or on fins in certain species.

Geographical distribution and behaviour

Throughoput the region. Feeding mainly piscivours, but feeds also on crustaceaqns and other invertebrates.

SPHYRAENIDAE

Colour: usually grey to blue above, with silvery reflections, lighter to white below.

Geographical distribution and behaviour

Throughout the area. Elsewhere found in East Indian Ocean, western Pacific and eastern and western Atlantic. Fees on moderate or quite large fishes, either aroud reef or near the surface.

SCARIDAE

Colour: most speciwes are very colourful and many exhibit striking sexual dichromatism.

Geographical distribution and behaviour

Red sea, east African coast. Elsewhere eastern Indian Ocean and western central Pacific. Feeding; grazinjg heavily on live corals but also on algae. E.g. *Scarus ghoban*

SCORPAENIDAE

Colour: inshore scapionfishes are mostly brown or various mottled and barred with dark pigment on ligher background. Deeper water are mostly red, often with spots or darker red, rown or black and with white skin filaments.

Geographical distribution and behaviour

Thoughout the region.

SOLEIDAE

Colour: eyed side greyis brown to redish brown, blid side white. Both eyes on rightside of the head. Pectoral fins absent or present. No fin spine.

Feeding: feeds on benthic invertebrates and fishes. Are pelagic spawners.

Geographical distribution and behaviour

Western Indian Ocean,Red Sea,Natal,Mozambique, India and Japan.

SYNGNATHIDAE

Colour: variable from brown or dark brown, or banded.

Geographical distribution and behaviour

Temperate and sub-tropical Indo-Pacific, Inhaca, Mozambique, Kenya, Madagascar, Pinda and Zanzibar. Sexual dimorphic, male carry eggs exposed.

TETRAODONTIDAE

Colour: varible.

Geographical distribution and behaviour

Some species contain contanin tetraodotoxin especially inm viscera, in gonads of some species during spawning season.

Feeding: some spedcies consume abouyt ecverything where others have preference for certain invertebrates.

Distribution: tropical and subtropical, India and Pacific.

TERAPONIDAE

Colour: Body yellowish, silvery-grey with white belly, 3-longtudinal brown.

Geographical distribution and behaviour

From Red Sea, East Africa to Mozambique. Feeds on bentrhic invertebrates and small fishes.

Appendix IXb: Some fish species occurring in Chwaka Bay, Zanzibar (Fish families and species shown with asterik: * and represent those families and species identified by B. Lugendo, pers. comm.)

FAMILY	Species	Common Name
OSTRACIIDAE	*Acanthurus sp.*	Cowfish
OSTRACIIDAE	**Lactoria fornasini*	Box fish
ALBULIDAE	*Albula vulpes*	Bonefish
ANTENNARIIDAE	*Antennarius sp.*	Angle fish
ANTENNARIIDAE	**Histrio histrio*	
AMBASSIDAE	*Ambassis natalensis*	Slender glassy
AMBASSIDAE	**Ambassis gymnocephalus*	
***ACANTHURIDAE**	*Acanthurus bicommatus*	
***ACANTHURIDAE**	*Acanthuru blochii*	
APOGONIDAE	*Apogon lateralis*	Mangrove Cardinalfish
APOGONIDAE	*Apogon "silver band"*	
APOGONIDAE	*Apogon orbicularis*	Pyama-Cardinaal
APOGONIDAE	*Fowleria aurita*	
APOGONIDAE	*Chelliodipterus quinquelineatus*	Five-Lined Cardinalfish
APOGONIDAE	*Apogon cooki*	Black Banded Cardinal
APOGONIDAE	*Apogon nigripinnis*	Black Foot Cardinalfish
APOGONIDAE	*Foa brachygramma*	Foa
ARRIDAE	*Arius sp.*	Barredsea Catfish
ANTHERINIDAE	*Atherion africanus*	Pricklednose Silverside
SOLENOSTOMIDAE	*Solenostomium cyanopterus*	Ghosst Pipefish
BALISTIDAE	*Abalistes stellatus*	Satrry Triggerfish
BELONIDAE	*Tylosurus crocodilus*	Hound Needlefish
BELONIDAE	*Tylosurus sp.*	Needlefish
BELONIDAE	*Blenidae sp.*	Needlefish
BELONIDAE	**Strongylura leiura*	Banded needlefish
BOTHIDAE	*Bothus sp.*	Flounder
BOTHIDAE	*Bothus pantherinus*	Leopard Flounder
BOTHIDAE	**Pseudorhombus elevatus*	Deep flouder
CARANGIDAE	*Caranx ignobilis*	Giant Trevally
CARANGIDAE	*Caranx papuensis*	Brassy Trevally
CARANGIDAE	*Caranx sp.*	Trevally
CARANGIDAE	*Trachinitus blochii*	Snub Nose Pombano
CARANGIDAE	*Scomberoides sp.*	Queenfish
CARANGIDAE	*Caranx sexfasciatus	Bigeye trevally
CARANGIDAE	* Alectis indicus	Indian threadfin trevally
TETRAODONTIDAE	*Cathigaster solandri*	Sharp nose Puffer
TETRAODONTIDAE	**canthigaster bennetti*	Bennett's puffer
TETRAODONTIDAE	**C. valentini*	Sharpnose puffer
TETRAODONTIDAE	**Arothron hispidus*	Broad-barred Toadfish
TETRAODONTIDAE	**A. immaculatus*	Narrow-lined Toadfish
TETRAODONTIDAE	**A. stellatus*	Starry Toadfish
TETRAODONTIDAE	**Amblyrhychotes honkenii*	Toadfish
CENTRISCIDAE	*Aeoliscus punctilatus*	Speckled Shrimp Fish
CHAETODONTIDAE	*Heniochus sp.*	Banner Fish

FAMILY	Species	Common name
CHAETODONTIDAE	**Chaetodon auriga*	Threadfin butterfly fish
CLUPEIDAE	*Sardinella gibbosa*	Goldstripe Sardinella
CONGRIDAE	*Conger cinereus*	Longfin African Conger
CONGRIDAE	*Conger wilson*	Cape Conger
DACTYLOPTERIDAE	*Dactyloptena ore*	Helmet Gurnards
GOBIIDAE	*Hetereleotris zanzibarensis*	Goggle Goby
ENGRAULIDAE	*Stoiphorus indicus*	Indian Anchovy
ENGRAULIDAE	*Thrissa baelama*	Baelama Anchovy
GERREIDAE	*Gerres oyena*	Common Silver Biddy
GERREIDAE	*Gerres filamentosus*	Whipfin Silverbiddy
GERREIDAE	*Gerres acinaces*	Longtail Silverbiddy
GOBIIDAE	*Gobidae sp.*	Gobies
GOBIIDAE	*Yongeichthys nebulosus*	Shadow Goby
GOBIIDAE	*Amblygobius albimaculatus*	Butterfly Goby
HAEMULIDAE	*Plecthorhynchus albovittatus*	Two striped sweetlips
HAEMULIDAE	*Dragmma pictum*	Painter Sweetlips
HAEMULIDAE	*Plecthorhynchus sp.*	Rubberlip
HEMIRAMPHIDAE	*Hemiramphus sp.*	Halfbeak
HEMIRAMPHIDAE	*Hemiramphus dussumieri*	Dussumier Halfbeak
HEMIRAMPHIDAE	*Hyporhamphus dussumieri*	Dussumier Halfbeak
HOLOCENTRIDAE	*Neoniphon sammara*	Sammara Squirrelfish
HOLOCENTRIDAE	*Neoniphon opecularis*	Black fin Squerrel fish
LABRIDAE	*Labridae sp.*	Wrasse
LABRIDAE	**Cheilio inermis*	Cigar wrasse
LABRIDAE	**C. cholorourus*	Floral wrasse
LABRIDAE	**C. trilobatus*	Tripletail wrasse
LABRIDAE	**Helichoeres scapularis*	
LABRIDAE	**Coris audimacula*	
LABRIDAE	**Novaculichthys macrolipidotus*	
LABRIDAE	** Stethojulis strigiventer*	Silver streaked rainbowfish
LABRIDAE	**S. albovittata*	
LABRIDAE	**Epibulus insidiator*	Sling-jaw wrasse
LEOGNATHIDAE	*Leoignathus sp.*	Tooth Pony
LEOGNATHIDAE	*Gaza minuta*	Toothpony
LEOGNATHIDAE	*Leiognathus equelus*	Common Pony fish
LETHRINIDAE	*Lethrinus variegatus*	Variegated Emperor
LETHRINIDAE	*Lethrinus harak*	Thump print Emperor
LETHRINIDAE	*Lethrinus lentjan*	Red spot Emperor
LETHRINIDAE	*Lethrinus mineatus*	Long face Emperor
LETHRINIDAE	*Lethrinus ramak*	Yellow Banded Emperor
LUTJANIDAE	*Lutjanus fulviflamma*	Blackspot Snapper
LUTJANIDAE	*Lutjanus argentimaculatus*	Manrove Red Snapper
LUTJANIDAE	*Lutjanus russeli*	Russel, Snapper
LUTJANIDAE	*Lutjanus fulvae*	
LUTJANIDAE	*Lutjanus monostigma*	One Spot Snapper
LUTJANIDAE	*Lutjanus kasmira*	Common Blue stripe Snappper
LUTJANIDAE	*Lutjanus sanguines*	Malabar Blood Snapper
LUTJANIDAE	**L. ehrenbergi*	Ehrenberg's snapper

FAMILY	Species	Common name
HAEMULIDAE	*Pristipoma nigrum*	
HAEMULIDAE	**Diagramma pictum*	
HAEMULIDAE	**plectorhinchus plagiodesmus*	
MEGALOPIDAE	*Megalopa cyprinoldes*	Indo-Pacific Tarpoon
MONACANTHIDAE	**aluterus scriptus*	
MONACANTHIDAE	*Thamnaconus modestoides*	Modest Filefish
MONODACTYLIDAE	*Monodactylus argentius*	Silver Moony
MUGILIDAE	*Mugilidae sp.*	Mullet
MUGILIDAE	*Liza macrolepsis*	Large Scale Mullet
MULLIDAE	*Upeneus vittatus*	Stripped Goatfish
MULLIDAE	*Upeneus tragula*	Freckled Goatfish
MULLIDAE	**Upeneus sulphureus*	Sulphur goat fish
MULLIDAE	*Parupeneus macronema*	Long Barbel Goatfish
MULLIDAE	*Parupeneus cinnabarinus*	Cinnibar Goatfish
MULLIDAE	*Mulloides flavolineatus*	Yellow Stripe Goatfish
MULLIDAE	*Parupeneus barberinus*	Dash and dot Goatfish
MURAENIDAE	*Sideria picta*	Speckled Sideria Moray
***SIGANIDAE**	*Siganus sutor*	Shoemaker spine foot
***SIGANIDAE**	*Siganus argenteus*	Streamlined spine foot
***SIGANIDAE**	*Siganus stellatus*	Brown spotted spine foot
***SIGANIDAE**	*Siganus ludirus*	Dusky spine foot
***TERAPONODAE**	*Pelates quadrilineatus*	Four lined terapon
***TERAPONODAE**	*Terapon jarbua*	Jabua terapon
***POMACENTRIDAE**	*Chrysiptera annulata*	
***POMACENTRIDAE**	*C. animaculata*	
***POMACENTRIDAE**	**Dascyllus aruanus*	Whitetailed Humbug
***FISTULARIDAE**	*Fistularia commensonii*	Blue spotted cornet fish
***SYGNATHIDAE**	*Sygnathoides biaculatus*	Double-ended pipefish
***SCORPAONIDAE**	*Dendrochirus brachypterus*	Stonefish
	Pterois miles	
***EPHIPPIDAE**	*Platax teira*	
	P. orbicularis	Batfish
POMADASYIDAE	*Pomadasys multimaculatum*	
***SCOPRPAENIDAE**	*Synanceia verrucosa*	Stonefish
***BLENNIIDAE**	*Petroscirtes breviceps*	Blennies
***PLOTOSIDAE**	*Plotosus lineatus*	Striped eel catfish
***SCARIDAE**	**Scarus ghoban*	Yellow scale parrotfish
***SCARIDAE**	**S. ruselii*	Eclipse parrotfish
***SCARIDAE**	**Leptoscarus vaigiensis*	Marbled parrot fish
***SCARIDAE**	**Calotomus spinidens*	Spiny tooth parrotfish
***SCARIDAE**	**Hipposcarus harid*	Candelema parrot fish
***NEMIPTERIDAE**	*Scolopsis ghanam*	Arabian monocle bream
***SYNODONTIDAE**	*Saurida gracilis*	Gracile lizard fish
***SYHYRAENIDAE**	*Syhyraena barracuda*	Great barracuda
***SOLEIDAE**	*Pardachirus marmoratus*	Finless sole
SERRANIDAE	*Epinepheleus tukula*	Potato grouper
FAMILY	**Species**	**Common name**
SERRANIDAE	*Epinepheleus fuscoguttatus*	Flowery grouper
SERRANIDAE	*Epinepheleus malabaricus*	Malabar grouper
SERRANIDAE	*Epinepheleus tauvina*	Graesy grouper

SERRANIDAE	*Cromileptes altivelis*	Barramund grouper
LABRIDAE	*Cheilinus undulatus*	Hampered wrasse
CARCHARHINIDAE	*Carcharhinus plumbeus*	Sandbar shark
CARCHARHINIDAE	*Carcharhinus taurus*	Grey nurse shark
CARCHARHINIDAE	*Carcharhinus falciformis*	Silky shark
CARCHARHINIDAE	*Galeocerdo cuvier*	Tiger shark
SCOMBRIDAE	*Thunnus maccoyii*	Soutthern bluefin tuna
SYPHYRNIDAE	*Sphyrna lewini*	Scalloped hammerhead
SYPHYRNIDAE	*Sphyrna mokarran*	Great hammerhead
SQUALIDAE	*Centrophorus uyato*	Southern dogfish
LAMNIDAE	*Isurus oxyrinchus*	Short fin mako
PRISTIDAE	*Pristis microdon*	Larger tooth saw fish
RHINOBATIDAE	*Rhynchobatus djeddensis*	White spotted wedge fish
DASYATIDAE	*Taeniura lymna*	Ribbontail stingray
MOBULIDAE	*Manta birostris*	Giant Atlantic manta
MYLIOBATIDAE	*Aetobatus narinari*	Spotted eagle ray

Appendix Xa: Checklist of Lepidopterans (Butterflies and Moths) from Jozani-Chwaka Bay Proposed National Park, Zanzibar (Butterflies not recorded by Archer *et al*. (1991) at Jozani-Chwaka are indicated by a star: ✪, those recorded by Archer *et al*. but not collected in the present survey are indicated by two stars: ✪✪, and forest species are indicated by an asterik: *)

ORDER LEPIDOPTERA

Family Acraeidae

Acraea acrita *Hewitson* ✪✪
Acraea aubyni *Eltringham* ✪✪
Acraea cepheus *Linnaeus* ✪
Acraea cerasa cerasa Hewitson ✪
Acraea egina pembanus Kielland
Acraea eponina Cramer
Acraea esebria Hewitson ✪✪
Acraea insignis Distant ✪✪
Acraea natalica Boisduval
Acraea oncaea Hopffer ✪
Acraea zonata Hewitson ✪✪
Acraea zetes Linnaeus ✪✪
Bematistes aganice aganice Hewitson ✪

Family Danaidae
Amauris ochlea ochlea Boisduval*
Amauris niavius dominicanus Trimen*
Amauris niavius Linnaeus*
Danaus chrysippus chrysippus Linnaeus ✪
Danaus chrysippus dorippus Klug ✪

Family Hesperidae
Acleros mackenii Trimen ✪✪
Andronymus caesar philander Hopffer ✪✪
Borbo borbonica Boisduval
Gegenes pumilio Hoffmansegg ✪✪
Gomalia elma Trimen ✪✪
Spialia spio Linnaeus ✪✪
Tagiades flesus Fabricius ✪✪

Family Lycaenidae
Agriolaus lalos ✪✪
Anthene amarah Guerin ✪✪
Anthene kersteni Gestaecker ✪✪
Anthene rubrimaculata Strand ✪✪
Axiocerses punicea Grose-Smith ✪✪
Cupidopsis cissus Goddart ✪✪
Epamera silanus ssp.nov. ✪✪

Epamera sidus Trimen ✪✪
Epamera diametra ssp.nov. ✪✪
Epamera mermis Druce ✪✪
Euchrysops osiris Hopffer ✪✪
Hypolycaena philippus philippus Fabricius
Hypolycaena sp.
Lachnocnema bibulus Fabricius ✪✪
Lacnocnema durbani Trimen ✪✪
Lepidochrysops ignota (Trimen)
Leptotes pirithous *Linnaeus* ✪✪
Lipaphnaeus aderna spindasoides Aurivillius ✪✪
Myrna silenus fidecula Trimen ✪✪
Pentila tropicalis mombasae Grose-Smith & Kirby ✪✪
Spalgis lemolea Druce
Spindasis apelles Oberthur ✪✪
Virachola antalus Hopffer ✪✪
Virachola dariaves Hewitson ✪✪
Zizeeria knysna Trimen ✪✪

Family Nymphalidae
Bebearia orientis orientis Karsch*
Byblia anvatara acheloia *Boisduval* ✪
Byblia ilithya Drury ✪✪
Charaxes brutus natalensis Staudinger*
Charaxes ethalion Boisduval ✪✪
Charaxes macclounii Butler ✪✪
Cymothoe sp. ✪
Euphaedra neophron Hopffer*
Euphaedra neophron littoralis Talbot ✪✪
Euriphene sp.
Eurytela dryope angulata Aurivillius*
Eurytela sp.
Euxanthe wakefieldi Ward ✪✪
Hypolimnas deceptor Trimen ✪✪
Hypolimnas dubius wahlbergi Wallengren ✪✪
Hypolimnas misippus Linnaeus ✪✪
Junonia oenone oenone Linnaeus ✪✪
Junonia terea elgiva Hewitson ✪✪
Junonia natalica Felder ✪✪
Neptidopsis fulgurata platyptera Rothschild & Jordan ✪✪
Neptis laeta Overlaet ✪
Neptis penningtoni van Son ✪✪
Neptis saclava marpessa Hopffer ✪✪
Phalanta phalanta aethiopica (Rothschild and Jordan)
Precis actia Distant ✪✪
Pseudacraea lucretia Cramer*
Pseudacraea lucretia expansa Butler ✪✪
Teriomima subpunctata Kirby ✪✪

Family Papilionidae

Graphium angolanus angolanus Goeze ✪✪
Graphium *colonna* Ward ✪✪
Graphium pelopidas Oberthur ✪✪
Graphium philinoe ✪✪
Graphium policenes Cramer ✪✪
Graphium porthaon Hewitson ✪✪
Papilio dardanus cenea Stoll*✪
Papilio dardanus tibbulus Kirby ✪✪
Papilio demodocus Esper ✪✪
Papilio morania Angas ✪
Papilio nireus lyaeus Doubleday*✪

Family Pieridae
Appias lasti Grose-Smith ✪✪
Belenois creona severina Stoll ✪✪
Belenois thysa thysa Hopffer
Catopsilia florella Fabricius ✪
Colotis eunoma flotowi Suffert ✪✪
Colotis evippe omphale Godart ✪✪
Eronia cleodora dilatata Butler ✪✪
Eurema brigita Cramer
Eurema desjardinsi marshalli Butler ✪
Eurema hapale Mabille ✪
Eurema hecabe Linnaeus
Eurema regularis Butler
Leptosia alcesta inalcesta Bernardi ✪
Mylothris chloris agathina Cramer
Mylothris rubicosta attenuata Mabille ✪

Family Riodinidae
Abisara zanzibarica Kielland*

Family Satyridae
Bicyclus campinus ocelligerus Strand ✪✪
Bicyclus kiellandi Condamin* ✪
Bicyclusu safitza Hewitson ✪✪
Henotesia perspicua Trimen ✪✪
Melanitis leda africana Fruhstorfer ✪
Melanitis leda helena ✪✪
Ypthima asterope Klug ✪
Ypthima granulosa Butler ✪✪
Ypthima rhodesiana Carcasson ✪

Others
Moths (identified to Family: See below)

Checklist of Dragonflies and Damselflies from Jozani-Chwaka Bay
ORDER ODONATA
Family Aeshnidae
*Aeshna rileyi (*Calvert)*

Family Coenagriidae
Ceriagrion sp.
Enallagma sp.1
Enallagma sp.2
Ischinura senegalensis (Rambur)
Olpogastra fraseri Pinhey
Pseudagrion sp.

Family Libellulidae
Hemistigma albipuncta (Rambur)
Notiothermis jonesi Ris*
Palpopleura jucunda (Rambur)
Palpopleura lucia (Drury)
Trithermis annulata (Palisot de Beauvois)

Appendix Xb: Total Lepidopterans and Odonata collected from different locations in Jozani Chwaka Bay Proposed National Park, Zanzibar

	SM	NF	WG	GFP	GFN	THI	TOTAL
ORDER LEPIDOPTERA							
Family Acraeidae							0
Acraea cepheus			1				1
Acraea egina pembanus		3	1	1	2	1	8
Acraea eponina	1			1			2
Acraea cerasa cerasa		1					1
Acraea natalica					2		2
Acraea oncaea		1					1
Bematistes aganice aganice		1					1
Family Danaidae							0
Amauris niavius dominicanus				1	1		2
Amauris niavius		2	1				3
Amauris ochlea ochlea			1	1			2
Danaus chrysippus chrysippus				1			1
Danaus chrysippus dorippus	1	1			2		4
Family Hesperidae							0
Borbo borbonica				1			1
Family Lycaenidae							0
Hypolycaena philippus philippus	1						1
Hypolycaena sp.	1						1
Lepidochrysops ignota			1				1
Spalgis lemolea	1						1
Family Nymphalidae							0
Bebearia orientis orientis						1	1
Byblia anvatara acheloia		1			1	1	3
Charaxes brutus natalensis	2					1	3
Cymothoe sp.			1				1
Euphaedra neophron	1	1					2
Euryphene sp.		1					1
Eurytela dryope angulata		1					1
Eurytela sp.		1					1
Neptis laeta			1				1
Phalanta phalanta aethiopica			2				2
Pseudacraea lucretia						1	1
Family Papilionidae							0
Papilio dardanus cenea				1			1

	SM	NF	WG	GFP	GFN	THI	TOTAL
Papilio morania			1				1
Papilio nireus lyaeus		1		2		1	4
Family Pieridae							0
Belenois thysa thysa						1	1
Catopsilia florella		1					1
Eurema brigita					1		1
Eurema desjardinsi marshalli		1	6	2	2	6	17
Eurema hapale		2					2
Eurema hecabe				1			1
Eurema regularis				1			1
Leptosia alcesta inalcesta				1			1
Mylothris chloris agathina					2	1	3
Mylothris rubicosta attenuata			3				3
Family Riodinidae							0
Abisara zanzibarica		2		1			3
Family Satyridae							0
Bicyclus kiellandi	1	1	2		1		5
Melanitis leda africana		3		1			4
Ypthima asterope	1	2		1			4
Ypthima rhodesiana			6				6
OTHERS (MOTHS)							0
Family Arctiidae	2			2	3		7
Family Callidulidae	1				1		2
Family Cossidae	2						2
Family Epiplemidae	1						1
Family Geometridae	6	4	4	2	2	1	19
Family Lasiocampidae		1		1	1		3
Family Noctuidae		4		1	3		8
Family Pterothysanidae			1				1
Family Pyraustidae				1	1		2
Family Sphingidae (*Oligographa* sp.)				1			1
Family Tortricidae			2				2
Family Uraniidae (Sub-fam. Microniinae)		1	1			3	5
Family Zygaenidae					1		1
Total Lepidoptera	22	37	35	25	26	18	163
ORDER ODONATA							
Family Aeshnidae							
Aeshna rileyi				1			1
Family Coenagriidae							
Ceriagrion sp.		2					2
Enallagma sp.1	2			9			11
Enallagma sp.2	2						2
Ischinura senegalensis					1		1
Olpogastra fraseri					3		3
Pseudagrion sp.		1					1

	SM	NF	WG	GFP	GFN	THI	TOTAL
Family Libellulidae							
Hemistigma albipuncta	1						1
Notiothermis jonesi	1						1
Palpopleura jucunda	4	1	4				9
Palpopleura lucia	1	2	3				6
Trithermis annulata	1		1	1			3
Total Odonata	12	6	8	11	4	0	41
Grand total	**34**	**43**	**43**	**36**	**30**	**18**	**204**