

**COASTAL FOREST RESEARCH  
PROGRAMME**

**KAZIMZUMBWI FOREST RESERVE  
A Biodiversity Survey**

**Hall, S.M., Staddon, S., Howell, K.M. and Fanning, E. (Eds.)**

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**FOR MORE INFORMATION:**

Dept. of Zoology & Marine Biology  
University of Dar es Salaam  
P.O. Box 35064, Dar es Salaam, Tanzania  
Tel: 255-22-2410462  
E-mail: [zoology@udsm.ac.tz](mailto:zoology@udsm.ac.tz)

Society for Environmental Exploration  
50-52 Rivington Street, London, U.K.  
Tel: +44 20 76 13 24 22  
Fax: +44 20 76 13 29 92  
E-mail: [info@frontier.ac.uk](mailto:info@frontier.ac.uk)

Frontier-Tanzania  
Project Co-ordinator  
Forest Research Programme  
P.O. Box 9473  
Dar es Salaam  
E-mail: [frontier@twiga.com](mailto:frontier@twiga.com)

## EXECUTIVE SUMMARY

Kazimzumbwi Forest Reserve encompasses a 35.5 km<sup>2</sup> area of East African Coastal Forest. It lies at an altitude of 120 to 280 m a.s.l., on the Pugu Hills in the District of Kisarawe, Pwani Region, some 20 km south-west of Dar es Salaam.

As part of the Coastal Forest Research Programme, Frontier Tanzania conducted a baseline biodiversity survey of the northern half of Kazimzumbwi FR between June and August 2001. The floral diversity of Kazimzumbwi FR was surveyed using a combination of systematic vegetation plots, regeneration sub-plots and opportunistic botanical collections. Mature trees and shrubs were sampled within the vegetation plots at an intensity equal to 0.06% of the total reserve area. Faunal diversity was assessed through surveying the following target taxa; mammals (including bats), reptiles, amphibians, butterflies, molluscs and millipedes. Surveying was achieved through a combination of standardised, repeatable methods at 'zoological trapsites', surveys of dung and other animal signs along specific transects and opportunistic collection and observation. An investigation of forest use and human impact within the reserve was made through systematic transect surveys and observations on an opportunistic basis. This report provides inventories of tree and shrub species recorded within plots and through opportunistic collection, and of all the targeted faunal taxa. Each species listed is described in terms of its ecological requirements, endemic status and conservation status. These criteria are used to assess the uniqueness of biodiversity within the reserve and its vulnerability to human disturbances. A summary of these findings is presented in Table 1.

**Table 1.** Summary of biodiversity surveyed within Kazimzumbwi Forest Reserve.

Taxon	Total number of species	Number of forest dependent species	Number of endemic species <sup>^</sup>	Number of species not previously recorded in Kazimzumbwi FR
Plants	111 *	11 (10%)	21 (19%)	13 (12%)
	11 **	1 (10%)	3 (27%)	0
	50 ***	5 (10%)	8 (16%)	7 (14%)
Mammals	32	7 (22%)	4 (13%)	9 (28%)
Reptiles	28	5 (18%)	4 (14%)	14 (50%)
Amphibians	23	6 (26%)	7 (30%)	8 (24%)
Butterflies	140	42 (30%)	12 (9%)	81 (58%)
<b>Total</b>	<b>395</b>	<b>77 (20%)</b>	<b>59 (15%)</b>	<b>132 (33%)</b>

<sup>^</sup> Endemic species: Trees and shrubs endemic to the Swahilian Regional Centre of Endemism

Fauna endemic to Coastal Forests and/or Eastern Arc forests and/or a few other East African forests

\* Recorded in vegetation plots

\*\* Recorded in regeneration sub-plots

\*\*\* Recorded through opportunistic botanical collection

Kazimzumbwi Forest Reserve encompasses a diverse assemblage of vegetation communities and a rich floral and faunal species diversity. The reserve comprises a mosaic of closed dry forest, *Brachystegia* forest, scrub, woodland, wooded grassland and riverine/swamp forest. The relatively low number of forest dependent species, and subsequently high number of ecological generalists, is thus to be expected.

Thirty-two species of plant and thirty species of animals recorded in Kazimzumbwi Forest Reserve are restricted in range and are considered endemics. The link between endemism and forest-dependency is demonstrated within all taxa surveyed. The liane *Millettia puguensis* is endemic to the Pugu Hills and the tree species *Baphia puguensis* is endemic to the Pugu Hills and Gongolamboto area. The record of the Montane agama *Agama montana* alters the endemic status of this species which has previously only been recorded in selected Eastern

Arc forests. If the identification of the frog *Leptopelis barbouri* is verified, the record in Kazimzumbwi Forest Reserve will also represent a range extension for this species, again previously only recorded within selected Eastern Arc forests. The butterfly *Pentila rondo*, considered endemic to the Rondo Plateau, was tentatively identified within the reserve, thus potentially representing another species range extension.

A high number of species recorded in Kazimzumbwi Forest Reserve have not previously been found in either the reserve or Coastal Forests in general. This reflects the lack of attention given to Coastal Forests in past biological inventory work, which has instead often been concentrated in the Eastern Arc mountains.

The habitats and species of Kazimzumbwi Forest Reserve were found to be under pressure from pole and timber extraction, charcoal production, fire, animal trapping, cultivation and the presence of footpaths. Certain tree species appear to have been targeted for pole and timber extraction, charcoal production and *makonde* carving. Important species such as *Milicia excelsa* and *Dalbergia melanoxylon* are now considered rare within the reserve.

It is hoped that the results of this survey work will be used by those working at all levels to ensure the protection of this extremely biologically rich but currently threatened reserve.

## FOREWORD

Coastal Forest is thought to have once covered the whole of the eastern seaboard of Africa. Today only some 250 patches of forest are left, covering just 3200 km<sup>2</sup>. Coastal Forests are considered one of the richest forest types in Africa, containing large numbers of endemic species. Among these endemics are 550 plants, 8 mammals, 9 birds, 26 reptiles, 2 frogs, 79 butterflies, more than 89 snails and many more than 20 molluscs. Coastal Forests have gained global recognition as being part of one of 25 Global Biodiversity Hotspots (Conservation International). Collectively, these 25 Hotspots cover barely 1.4 % of the planet's land area but account for approximately 44 % of all vascular plant species and 35 % of four major vertebrate groups. Combined with Eastern Arc forests, Coastal Forests contain the highest levels of species endemism per unit area of remaining intact natural vegetation in the world.

Coastal Forests however epitomise the difficulties of conservation. They are small and highly fragmented patches surrounded by impoverished rural communities with a high and growing demand for and dependence on forest resources. Many of the isolated forest patches have exceptional levels of localised endemism, making prioritisation for conservation difficult.

The Coastal Forest Research Programme of Frontier Tanzania was initiated in 1989 to improve the poor knowledge of Coastal Forest status, distribution and biological character. Over the following six years the Programme gathered information on 25 Coastal Forests stretching the length of Tanzania. After gaining considerable experience in survey work of Tanzania's Eastern Arc forests, the Forest Research Programme of Frontier Tanzania subsequently returned to study additional Coastal Forests. The survey methods currently employed have been standardised and aim to provide systematic baseline information on the biological values of even more Coastal Forests. The results given in this report are hereby presented to conservationists and foresters to aid the sustainable long-term development of Tanzania's Coastal Forests.

The Programme involved locally employed Field Assistants and Forest Officers, staff from the University of Dar es Salaam and Frontier Tanzania, and an international network of taxonomists and other experts. This report is the result of the efforts of these many people and they are all thanked for their hard work and enthusiasm. It is hoped that the culmination of their work and the publication of this report will help in some way to ensure the future of the unique Coastal Forests of East Africa.

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### MANAGEMENT

#### FRONTIER-TANZANIA

Managing Director of SEE: Eibleis Fanning  
 Development Programme Manager: Elizabeth Humphreys  
 Director of Research: Dr. D. Stanwell Smith  
 Operations Manager: Matthew Willson

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 Professor Iddi, Director of Forestry and Beekeeping  
 Dr. Kilahama, Tanzania Forest and Conservation Project

### FIELD RESEARCH

#### FRONTIER-TANZANIA

Project Manager: Nicola Beharrell  
 Research Co-ordinator: Susannah Hall  
 Assistant Research Co-ordinators: Sam Staddon, Adam Murphy  
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### REPORT WRITING

Authors: Sam Staddon, Susannah Hall, Albert Ntemi and Adam Murphy.

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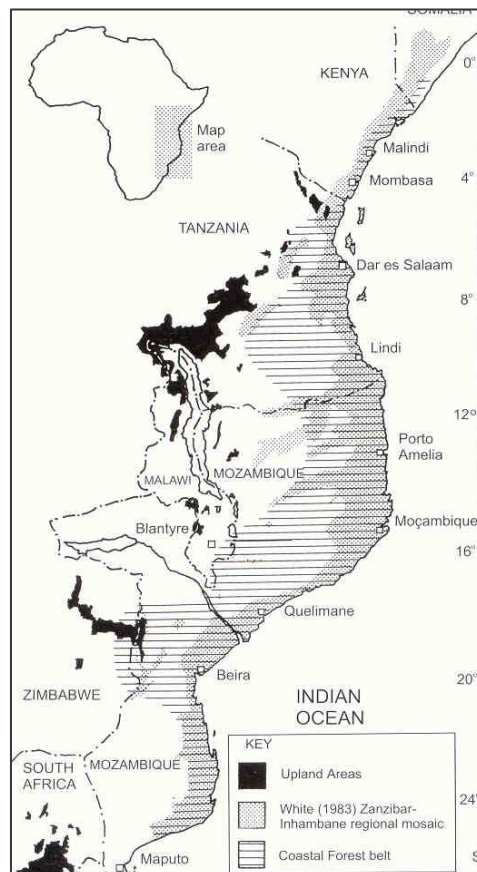
## 1. INTRODUCTION

### 1.1 INTRODUCTION TO COASTAL FORESTS

'Eastern African Coastal Forests' (hereafter called Coastal Forests) are synonymous with the Swahili regional centre of endemism and the Swahili/Maputaland regional transition zone (*sensu* Clarke 2000). The forests cover an area of 3167km<sup>2</sup> within six countries located between 1° North and 25° South and 34-41° East (Burgess, Clarke & Rodgers 1998). Much of the confusion and debate surrounding their geographical distribution, their biological affinities and the main vegetation formation type to which they belong has been clarified by Clarke (2000).

#### 1.1.1 LOCATION AND EXTENT

The Swahili regional centre of endemism and the Swahili/Maputaland regional transition zone are derived from the Zanzibar-Inhambane regional mosaic phytochoria. This vegetation block is recognised as a distinct area of plant endemism, and is found along the coastal strip of eastern tropical Africa (between the equator and Limpopo River), about 200-300km inland of the Indian Ocean (Figure 1). Approximately 35% of larger woody plants are endemic to the area (Clarke 2000). In recognition of botanical collections and taxonomic studies that confirmed a high number of endemic plant species in the north of the region however, Clarke (1998) redefined the phytochoria. He enlarged its area and divided it into the 'Swahilian regional centre of endemism' (to the north of Mocambique town) and the 'Swahilian/Maputaland regional transition zone' (to the south). The term 'Swahilian region *sensu lato*' encompasses both of these divisions and it is this region with which Coastal Forests are synonymous.



**Figure 1** Extent of major upland areas in eastern and south-eastern Africa, the Zanzibar-Inhambane regional mosaic (*sensu* White, 1983a and b), and the Coastal Forest belt as defined in this Chapter (which encompasses the Swahilian regional centre of endemism and the Swahilian/Maputaland regional transition zone). Taken from Burgess and Clarke, 2000.

Coastal Forests can be found between sea level and 1100m a.s.l. and experience a tropical monsoon climate of the Indian Ocean with a unimodal (south of Dar es Salaam) or bimodal (north of Dar es Salaam) mean annual rainfall of 510 to 2000mm (Clarke 2000).

At least 194 patches of Coastal Forest known to cover a combined area of 3167km<sup>2</sup>; 2km<sup>2</sup> within Somalia, 660km<sup>2</sup> within Kenya, 696.6km<sup>2</sup> within Tanzania, 1790km<sup>2</sup> within Mozambique, 16km<sup>2</sup> within Malawi and 2.88km<sup>2</sup> within Zimbabwe (Burgess, Clarke & Rodgers 1998). This could well be the smallest forest coverage of any major forest type in Africa. The majority of Coastal Forest patches, of which there may be over 250 in total, are  $\leq 20$ km<sup>2</sup>. The largest patch is in Kenya; the Arabuko-Sokoke forest, covering 370km<sup>2</sup>. Forest patches may be separated by less than 1km and up to 10's of kms (Burgess *et al.* 2000) by farms, savanna and bushland, some of which is natural, some unnatural. Within Tanzania, Coastal Forest formerly covered large areas of the coast, inland to the base of the Eastern Arc Mountains. Clearance of land for agriculture and sisal estates has led to a reduction in Coastal Forest cover, notably around Tanga and Dar es Salaam (Burgess *et al.* 2000).

### 1.1.2 VEGETATION TYPES

Coastal Forests comprise a mosaic of unique habitat types including Dry Forest, Coastal Scrub, Coastal *Brachystegia* forest, Riverine/Groundwater/Swamp Forest and Afromontane transitional Forest. An estimated 1356 plant species and 33 genera are endemic to the Swahilian region *sensu lato* (Clarke 2000). Just 3.4% of Coastal Forest and Guineo-Congolian forests florulas are shared, although phylogenetic evidence reveals Coastal Forests to be more strongly linked to these forests than Eastern Arc forests with which Coastal Forests grade with altitude (Clarke, Vollesen & Mwasumbi 2000, Clarke 2000).

### 1.1.3 ENDEMISM

Research since the mid 1980's has shown that the Coastal Forests of eastern Africa are one of the richest tropical forest types in Africa (Burgess & Clarke 2000). Approximately 550 plant species, 8 mammal species, 9 bird species, 26 reptile species, 2 frog species, 79 butterfly species, more than 86 snail species and many more than 20 millipede species are restricted to Coastal Forests (Burgess, Clarke & Rodgers 1998, Burgess *et al.* 2000). Many Coastal Forest endemics have either a small distributional range, a scattered or disjunct range or are single-site endemics (Burgess, Clarke & Rodgers 1998). Most are considered paeleo-endemics, resulting from long isolation and more recent loss of habitat rather than neo-endemics which would exist as a result of recent evolution. The number of near-endemic species is also high, comprising species ranging beyond Coastal Forest to the Eastern Arc and/or other east African forests.

### 1.1.4 THREAT

Coastal Forests are widely recognised to have been formerly much more extensive (Clarke and Karoma, 2000). A combination of gradual climate dessication together with increasing human activity is thought to account for much of the loss of Coastal Forest during recent geological time (Clarke and Karoma, 2000). The most common uses of Coastal Forests include pole extraction, pitsawing, religious activities, medicinal plants and agriculture (Burgess and Muir, 1994). The Coastal Forests most heavily used are those closest to major centres of human population (e.g. close to Dar es Salaam), or in areas of expanding human populations and economic activity (e.g. coastal Kenya) (Burgess *et al.*, 2000). Such forests are also heavily threatened by the production of charcoal. Both local populations and outsiders extract wood and non-wood products from Coastal Forests, and in many cases these uses are so intense that they threaten the continued existence of the forests.

### 1.1.5 PROTECTION AND MANAGEMENT

At least in Kenya and Tanzania, the majority (c.80%) of Coastal Forests are under some form of government protection (Burgess *et al.* 2000). Within these countries 56 forests covering 1001km<sup>2</sup> (out of a total of 1386km<sup>2</sup>) have the status of Forest Reserve. Smaller numbers and areas of Coastal Forests have the status of National Park, National Reserve, National Monument (Kenya only), Game Reserve or Sacred forest. Within Tanzania, 21 forests covering 145km<sup>2</sup> are of no known status. Many Forest Reserves (gazetted during the colonial period before 1961) encompass a lot of non-Coastal Forest habitat, such as woodland or thicket that may act as buffer zones to the high forest areas. Some Forest Reserves are comprised entirely of woodland habitats along the coast and some contain plantations.

### 1.1.6 CONSERVATION

Coastal Forests epitomise the difficulty of conservation; they are small and highly fragmented patches surrounded by relatively impoverished rural communities, with a high and growing demand for and dependence on forest resources (Rodgers 2000). All forests are distinct and have high levels of local endemism, thus making prioritisation difficult. A set of criteria with which to rate forests in order that those of highest biodiversity conservation value are given priority has yet to be devised. A strategy to identify core and buffer zones within forests to enable local use of forest edge resources and environmental education at many levels is also lacking (Rodgers 2000). Projects run by governments, conservation partners including NGO's and local communities are however currently in place in many areas and have had patchy success.

### 1.1.7 PREVIOUS WORK

Previous work in Coastal Forests has generally used 1:50,000 Ordnance Survey maps, government Forestry Department records and fieldwork to assess the location, extent and legal status of various forests. As a result of the Civil War in Mozambique however, little remains known of its Coastal Forests (Burgess *et al.* 2000). In Tanzania work has been carried out by a variety of researchers including many from Dar es Salaam and those within the Frontier-Tanzania Coastal Forest Research Programme, run between 1980 and 1994, covering 25 Coastal Forests (see publications list at the end of this report). Much remains to be known however about the extent of Coastal Forest, its vegetation assemblages, the ecology and biogeography of its flora and fauna and the richness and diversity of different forest patches.

The *Coastal Forests of Eastern Africa* was published in 2000 (edited by Burgess and Clarke) and is a synthesis of information on Coastal Forests from various sources. It covers definitions, physical background, vegetation and status, biodiversity values and human and forest interactions. This text is considered the most current and complete work on Coastal Forests and thus its various chapters are frequently referenced in this report.

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## **2. AIMS AND OBJECTIVES**

### **2.1 AIMS**

To investigate the biodiversity and forest-use of Kazimzumbwi Forest Reserve and to collate and disseminate the resulting information.

### **2.2 OBJECTIVES**

- To sample both mature and regenerating tree and shrub species throughout the reserve using systematic sampling techniques at an intensity of 0.013%.
- To sample key faunal groups in representative habitats throughout the reserve using systematic sampling techniques; key faunal groups comprising mammals, reptiles, amphibians, butterflies, molluscs and millipedes.
- To supplement the information gathered through systematic techniques by the opportunistic collection of vascular plants, vertebrates and invertebrates.
- To conduct systematic surveys of forest-use and human impact throughout the reserve, focusing on levels of pole and timber cutting and the occurrence of other illegal activities.
- To produce a report presenting information resulting from the above work.

### 3. STUDY SITE

#### 3.1 GENERAL DESCRIPTION

Name:	Kazimzumbwi Forest Reserve Kisarawe District, Coastal Region, Tanzania
Area:	3550 hectares (35.5 km <sup>2</sup> )
Status:	Protective Forest Reserve Apparently gazetted in the 1930s (Lagrstedt, 1995) Declaration Order 306 of 24/6/1954; superseded by Cap. 389 – supp. 59 of 1959, p.62
Managed by:	Kisarawe District with donor support from Mimitu Yetu Project, CARE International and Wildlife Society of Tanzania (WCST)
Tenure:	Government land under district authority control
Maps:	Ordnance survey topographic maps 1: 50 000 series Y742 (DOS 422) Sheet 186/3 Kisarawe Edition 5-TSD/OSD 1987

#### 3.2 LOCATION

Lat/Long:	6°55' – 7°00' S 39°01' – 39°05' E
UTM:	05020 – 05094 92275 - 92353
Elevation:	120 –280 meters above sea level

Kazimzumbwi Forest Reserve is situated in the Pugu Hills, approximately 20 km south-west of Dar es Salaam and within 1 km of Pugu Forest Reserve (24 km<sup>2</sup>) (Figures 2 and 3). Together the two reserves form part of what was once a much larger forest block extending to within 10 km of Dar es Salaam. The TAZARA railway goes through the reserve, with a nearby station at Vigama on the western edge of the reserve.

#### 3.3 PHYSICAL FEATURES AND LAND USE

##### 3.3.1 SOILS

Red to brown sandy-clay soils overlay kaolinitic sandstone, with of pH range 5-6 predominate.

##### 3.3.2 CATCHMENT VALUES

One permanent stream arises from the forest reserve and provides a water supply for some of the local people. In the past (when forest was more extensive on the Pugu Hills) streams arising from the area used to supply all the water needed in Dar es Salaam.

### 3.3.3 RAINFALL AND TOPOGRAPHY

Kazimzumbwi FR is influenced by tropical East African oceanic temperatures that are slightly modified by altitude. Average annual rainfall of 1,236mm data at Kisarawe has been recorded for Kisarawe (Howell, 1981), falling principally from March to June.

### 3.3.4 VEGETATION

Kazimzumbwi FR and the neighbouring Pugu FR include part of what was once a much larger forest extending to within 10km of Dar es Salaam. According to the original gazettelement map, Pugu and Kazimzumbwi forests were contiguous in 1956, but had become separated by 1968 when aerial photos were taken of the area.

A previous Frontier-Tanzania survey (1991) found that forest vegetation covered 23.5 km<sup>2</sup> (2350 ha) of the reserve (67%), only 9 km<sup>2</sup> with a canopy cover greater than or equal to 40% (Clarke & Dickinson, 1995). Due to the varied topography, a number of vegetation types have been recognised in the Pugu Hills, comprising distinct 'wet' valley bottoms, 'dry' ridge tops and 'intermediate' valley side communities.

### 3.3.5 LAND USE

The close proximity of Kazimzumbwi FR to Dar-es-Salaam and its outlying populations mean that the forest reserve is under significant resource use pressure from local communities that are dependent on it. In recent years high intensity resource use has led to conflict between Forestry officials and local communities. Awareness of such pressures amongst the non-governmental organisation (NGO) community led to CARE International, World Conservation Society of Tanzania (WCST) and Tanzanian Forest Conservation Group (TFCG) collaboration in the Misitu Yetu Project. The project is involved with enhancing the capacity of communities and other civil society institutions to manage and benefit biodiverse forests of Eastern/Coastal Tanzania, in partnership with relevant departments of the government of Tanzania.

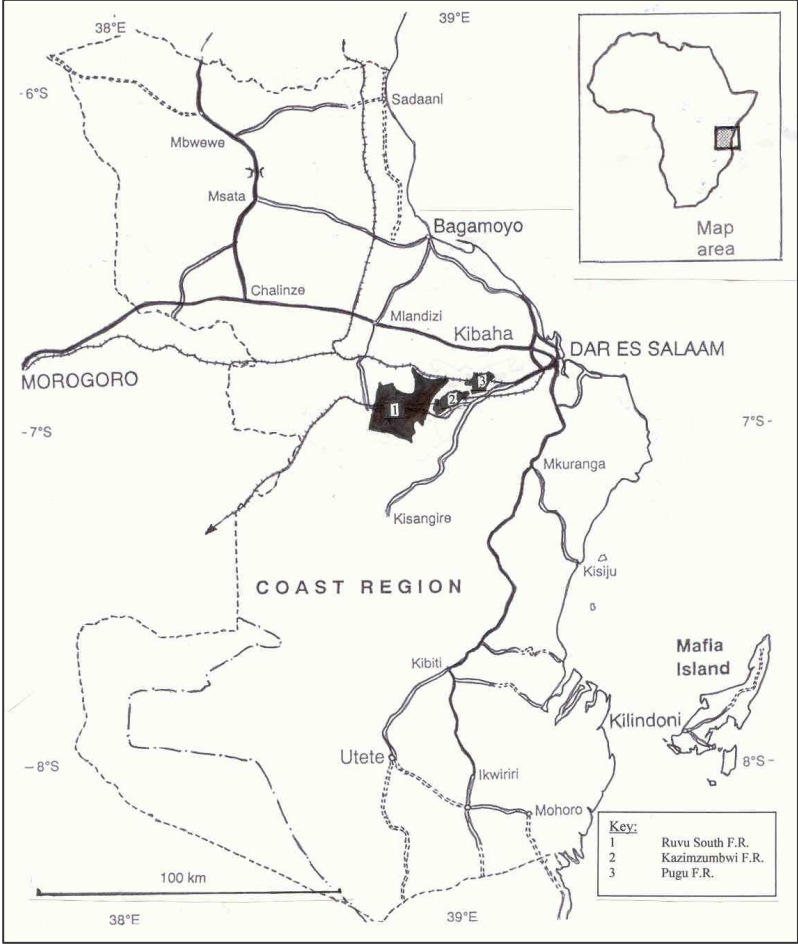


Figure 2 Location of Kazimzumwi and Pugu FRs in Tanzania.

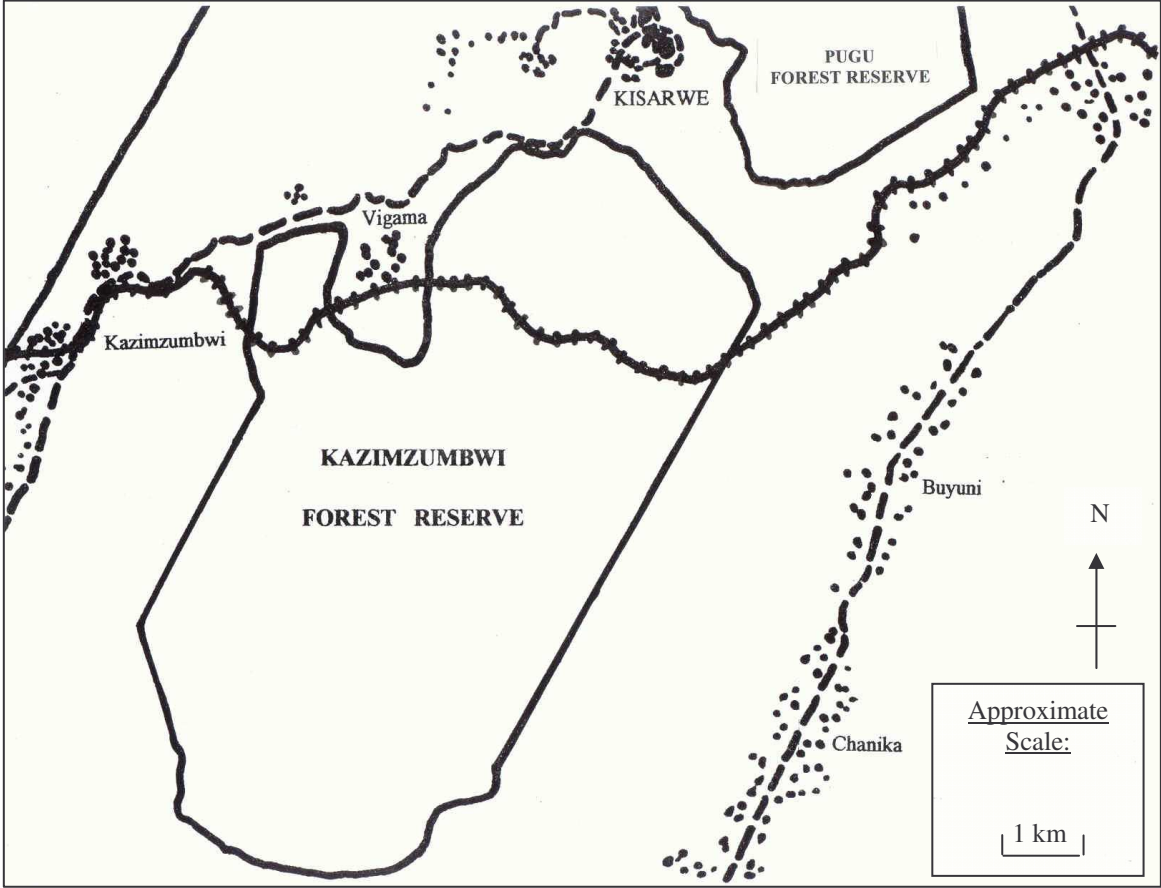


Figure 3 Location of Kazimzumwi FR in relation to surrounding towns and villages.

## 4. FLORAL DIVERSITY OF KAZIMZUMBWI FOREST RESERVE

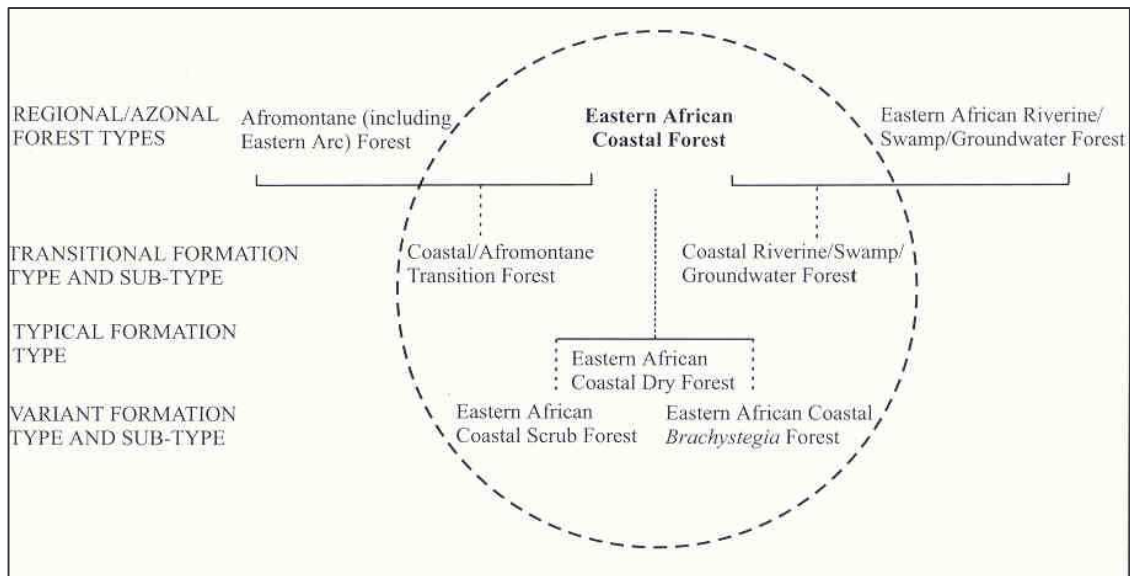
*Authors: Staddon, S. Ntemi, A.S., Hall, S.M. and Murphy, A.*

### 4.1 INTRODUCTION

Coastal Forests contain an estimated 3000 plant species in 750 genera (Clarke, Vollesen & Mwasumbi 2000). Based on theoretical values of species richness, this makes Coastal Forests less species rich than Guineo-Congolian forest but more so than Eastern Arc forests. The phylogenetic affinities of Coastal Forests are in fact closer to Guineo-Congolian forests than Eastern Arc forests. Coastal Forests may be relicts of the former pan-African lowland forests as genera dominating these forests are now limited to Coastal Forests and Guineo-Congolian forests, for example many Caesalpinioideae legumes (Clarke & Robertson 2000). Despite covering only c.1% of White's (1993) Zanzibar-Inhambane Regional Mosaic/Swahilian Region *sensu lato*, Coastal Forests contain 70% of the regions endemic plant species and 91% of its endemic genera. Of the regions endemic flora, 42% of species are forest dependent, as are 69% of genera (Clarke, Vollesen & Mwasumbi 2000).

The main vegetation formation type of Coastal Forests is 'forest'. This term is much misused however and therefore it is defined here as a continuous stand of trees 10-50m tall, comprising several layers or strata, with overlapping tree crowns, few lianes, obvious shrub layer, sparse ground layer and few grasses (*sensu* White (1983), after Clarke 2000). Coastal Forests comprise 'typical', 'sub-type', 'variant' and 'transition' vegetation formation types, as defined by Clarke (2000) and are summarized in Figure 4 and Appendix 1.

Botanical collection and investigation in East Africa started at the end of the 18<sup>th</sup> Century, with a shift in focus from Mozambique to Tanzania and Kenya with European colonisation (Clarke, Vollesen & Mwasumbi 2000). The 1980's and 1990's saw an increased effort in botanical work within Coastal Forests, however it was neither complete nor comprehensive. There remains much to be learnt about the floristic composition and ecology of Coastal Forests; wherein there is still scope to discover new species (Clarke, Vollesen & Mwasumbi 2000).



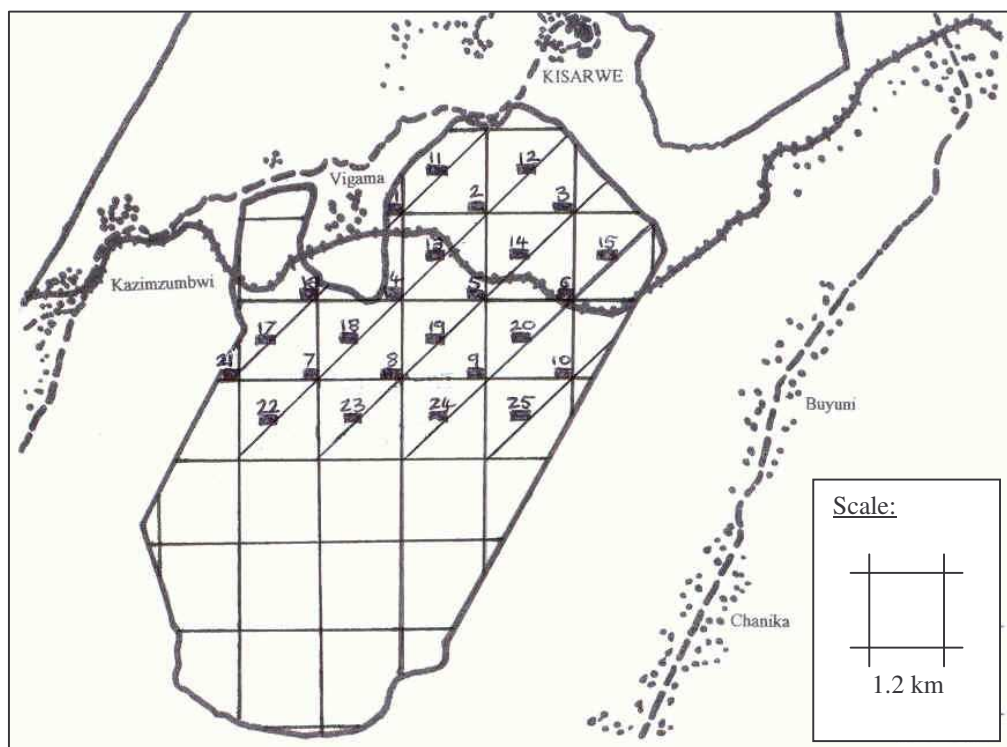
**Figure 4** Relationships between the different kinds of eastern African Coastal Forest, as well as to other regional and azonal forests. Eastern African Coastal Forest additionally merges with Maputaland-Pondoland forest in southern Mozambique and northern Natal, but forest of this type is not included here since it should be included as a transitional formation belonging to the Maputaland-Pondoland regional mosaic. Taken from Burgess and Clarke, 2000.

## 4.2 AIMS

The aim of this study was to survey both mature and regenerating trees and shrubs within Kazimzumbwi FR in order that they may be assessed in terms of species richness, species diversity, forest dependence, endemic status and conservation concern. In order to produce a comprehensive woody-plant checklist, opportunistic collections were also made.

## 4.3 METHODS

The flora of Kazimzumbwi FR was surveyed using a combination of systematic vegetation plots, regeneration sub-plots and opportunistic botanical collections. For detailed research aims, objectives and methods see *Methodology Report* (SEE 1998).



**Figure 5** Position of vegetation plots and disturbance transect lines in Kazimzumbwi FR.

### 4.3.1 VEGETATION PLOTS

Quantitative vegetation analysis was carried out using a 50m x 20m plot as a sampling unit. Plots were arranged on a 0.6km x 1.2km grid system (0.6km north-south, 1.2km east-west), with plots located in the south-east corner of each grid (Figure 6). Using a systematic grid would allow all habitats and vegetation types to be sampled. The grid system was superimposed on a map of the forest reserve and plot locations (grid references) calculated.

Plots were located in the field by following a compass bearing and using a hand-held GPS unit when nearby. Plots were aligned north-south 20m and east-west 50m using a compass and were temporarily delimited using ropes. The dbh (diameter at breast height; 1.3m) of all live trees or shrubs of  $\geq 10$ cm was measured. All stems of multi-stemmed individuals were measured

individually and recorded if the total was  $\geq 10$  cm. The dbh of buttressed trees was measured 1.3m above the buttress and estimated if out of reach. Fallen trees were recorded if still alive. Vines, lianas and dead individuals were not recorded. Each tree or shrub was identified by a botanist and by vernacular name when possible. All individuals were marked using paint with the plot number, a line at breast-height and an individual unique number. Plots demarcation was semi-permanent so that they may be visited by botanists for identification purposes and may offer the potential for monitoring activities. Habitat notes referring to altitude, topography and slope were taken for each plot.

#### **4.3.2 REGENERATION PLOTS**

Regeneration was analysed quantitatively using the grid system of vegetation plots as a basis. A plot 6m x 6m placed in approximately the centre of each 50m x 20m vegetation plot was the sampling unit. All regenerating trees or shrubs of <10cm dbh were counted, recording seedlings (1-10cm dbh) and saplings (<1cm dbh). Each individual was identified by a botanist but not marked using paint; thus plots were temporary. Again, vines, lianas and dead individuals were not recorded. Habitat notes referring to ground cover, cover dominance, soil colour and soil texture were taken for each plot.

#### **4.3.3 OPPORTUNISTIC BOTANICAL COLLECTION**

Opportunistic collection of botanical material was made throughout the reserve and throughout the survey period. This would allow species present in the reserve but not represented within vegetation or regeneration plots to be recorded. Particular effort was put into collecting fertile material as flowers or fruit aid greatly in the identification of plant species.

In order to verify the identification of plant species recorded in vegetation plots, regeneration plots and opportunistically, multiple specimens (up to a maximum of five) were taken whenever necessary. All collection techniques were adopted as elaborated in Kakwaro (1997). Specimens were pressed in the field and identified by the botanist at the University of Dar es Salaam (UDSM) herbarium with the aid of technical advice, dried specimens and the *Flora of Tropical East Africa* (FTEA). Specimen duplicates were deposited in the UDSM herbarium and sent to the National Herbarium of Tanzania in Arusha, Missouri Botanical Gardens (USA) and Kew Botanical Gardens (UK) for verification and storage.

## 4.4 RESULTS

Twenty-three vegetation plots were established throughout the reserve, covering a total area of 2.3ha representing a sampling intensity of 0.06% of the total area of the reserve. Twenty-three regeneration plots were also established, covering a total area of 828m<sup>2</sup> representing a sampling intensity of 3.6% of the total area of the vegetation plots.

In total over 99% of species were identified to family, 99% to genus and 88% to species. Few trees were flowering or fruiting during the survey period and thus many sterile specimens were collected which led to some problems in identification to species for all specimens.

### 4.4.1 VEGETATION PLOTS

In total, 785 individuals were recorded within vegetation plots in Kazimzumbwi FR. These represented 37 families, 82 genera and 111 species (Table 2).

**Table 2** Provisional list of tree and shrub species recorded within vegetation plots in Kazimzumbwi FR. (Plant growth form, habitat and distribution data cannot be given for species identified to genera or family only).

Species	Local name	Plant growth form	Habitat	Distribution	Data source
<b>ANACARDIACEAE</b>					
<i>Lannea schweinfurthii</i> Thwaites	Mjengaua	T,S	F,W,B	W	a,c
<i>Lannea</i> sp.	-	-	-	-	-
<i>Ozora obovata</i> (Oliv.) R. & A. Fernandes	Mgombakirangu	T,S	F,W,B,T	K7,T3,6,8, Maf,MN,MZ, MMS,MLM, MT,S.Zim	a,b
<i>Sorindeia madagascariensis</i> DC.	Mhilihili	T,S	F	W	c
<b>ANNONACEAE</b>					
<i>Annona arenaria</i>	Mgwaza	?	?	?	-
<i>Annona senegalensis</i> Pers.	Mtopetope	T,S	F,W,T,G	W	c
<i>Xylopia mwasumbi</i>	-	?	?	?	-
<i>Xylopia parviflora</i> (A. Rich) Benth.	Mlawilila	T,S	RF,FE,W,T	W	c
<b>APOCYNACEAE</b>					
<i>Carissa tetramera</i> (Sacleux) Stapf	Mkalakala	S	W,B,T	W	c
<i>Hunteria zeylanica</i> (Retz.) Thwaites	-	T,S	F,T	W	c
<b>BALANITACEAE</b>					
<i>Balanites wilsonia zimmermannii</i> (Bark) Polhill	-	?	?	?	-
<i>Balanites wilsoniana (maughamii)</i> Dawe & Sprague	-	T,S	F,T	K6,7,T3,6,8	b
<b>BIGNONIACEAE</b>					
<i>Fernandoa magnifica</i> Seem	-	T,S	F	W	c
<i>Markhamia zanzibarica</i> (DC.) K. Schum.	Mhonongo	T,S	F,RF,W,B	W	c
<b>BOMBACEAE</b>					
<i>Bombax rhodognophalon</i> K. Schum.	Mwale	T	W,WG,F, T,B	W	a,b
<b>BORAGINACEAE</b>					
<i>Ehretia bakeri</i> Britten	Mbunduki	T,S	F,B,T	K7,T2,3,6,8,P, extends inland	b,c
<i>Ehretia litoralis</i>	-	?	?	?	-
<b>BUSERACEAE</b>					
<i>Comiphora</i> sp.	-	-	-	-	-

Table 2 continued.

Species	Local name	Plant growth form	Habitat	Distribution	Data source
<b>CAPPARIDACEAE</b>					
<i>Boscia salicifolia</i> Oliv. ^	Mvuti	T	?	W	d
<b>CELASTRACEAE</b>					
<i>Maytenus undata</i> (Thunb.) Blakelock	-	T,S	F,RF,W,B	W	c
<i>Mystroxylon aethiopicum</i> (Thunb.) Loes. ^	Mlimbolimbo/ Ulimbo	T,S	F,FE,W, T,G	W	d
<b>CHRYSOBALANACEAE</b>					
<i>Parinari cuetifolia</i> Benth.	Mbula	T	W,B,G	W	c
<b>COMBRETACEAE</b>					
<i>Combretum molle</i> G.Don	Mulama n'gombe	T	WG,B	W	a
<i>Pteleopsis myrtifolia</i> (Laws.)Engl.& Diels	Ngovu	T,S	F,RF,W, B,WG	W	a
<b>CONNARACEAE</b>					
<i>Bryoscarpus orientalis</i> (Baill.) Baker	Kisogo	T,S	FE,W,B	W	c,d
<b>DICHAPETALACEAE</b>					
<i>Dichapetalum edulis</i> Engl.	Mzikoziko	L,S	F,T	T8,MN	b
<i>Dichapetalum madagascariense</i> Poir	Mkomamene	L,S	F,B	W	c
<i>Dichapetalum stuhlmannii</i> Engl.	Mkomamene/ Mgombakilanga	S	F,RF,B,T, G	W	c
<b>EBENACEAE</b>					
<i>Diospyros loureiriana</i> ssp. <i>rufescens</i> G.Don	-	T,S	F,W	K7,T3,6,8, MN,MZ,MT,M MS,MSS, E.Zim,S.Zim	b
<i>Diospyros verrucosa</i> Hiern	Mburuzu	T,S	F,G,T	T6,8,MN, MZ,MMS	a,b
<i>Diospyros</i> sp. nov.	Mnaki	-	-	-	-
<i>Diospyros</i> sp.	Mnaki	-	-	-	-
<i>Euclea natalensis</i> A.DC. ^	-	?	?	W	d
<b>EUPHORBIACEAE</b>					
<i>Alchornea hirtella</i> Benth. ^	-	S	?	W	d
<i>Drypetes</i> sp.	Mkulyungu	-	-	-	-
<i>Magaritaria discoides</i> (Baill.) Webster	Msakulakwale	T,S	F,BW,T	W	a
<i>Mildebraedia</i> sp.	-	-	-	-	-
<i>Pseudolachnostylis maprouneifolia</i> Pax.	Msolo	T,S	BW,W,B	W	a
<i>Sapium triloculare</i> Pax & K.Hoffm.	-	T,S	F,W	K7,T6,8	b,c
<b>FLACOURTIACEAE</b>					
<i>Flacourtia indica</i> (Burm.f.) Merrill ^	Mchawa	T,S	W,WG,B	W	d
<i>Ludia mauritiana</i> Gmelin	Myunguyungu	T,S	F,B	W	c
<i>Oncoba routledgi</i> Sprague	Mgoo	S	?	W	c
<i>Rawsonia lucida</i> Harv.& Sond. ^	Mlawilia	S	?	W	d
<b>GUTTIFERAE</b>					
<i>Garcinia volkensii</i> Engl. ^	-	T	?	W	d
<b>HYMENOCARDIACEAE</b>					
<i>Hymenocardia ulmoides</i> Oliv.	Mtete	T,S	F,B,T	W	c

Table 2 continued.

Species	Local name	Plant growth form	Habitat	Distribution	Data source
LEGUMINOSAE – CAESALPINACEAE					
<i>Azelia quazensis</i> Welw.	Mkongo	T	F,W,T	W	c
<i>Brachystegia spiciformis</i> Benth.	Myombo	T	FE,W,B,T	W	c
<i>Cassia abbreviata</i> Oliv.	Mkundekunde	T,S	W,B,G	W	c
<i>Cassia petersiana</i> Bolle	Mkundekunde	T,S	F,RF,FE, W,B	W	c
<i>Cassia siamea</i> Lam.	Mkasia	T	Planted	Introduced	c
<i>Cynometra webberi</i> Bak.f.	Mhamvi	T	F,W	K7,T3,6,8	b,c
<i>Cynometra</i> sp.	-	-	-	-	-
<i>Dialium holstii</i> Harms	Mtebeti	T	F,W	K7,T3,6,7,8, Maf,MN	b,c
LEGUMINOSAE – CAESALPINACEAE					
<i>Hymenaea verrucosa</i> Gaertn.	Mnangu	T	F,W,B	W	c
<i>Tamarindus indica</i> L.	Ukwaju	T	W,B,G	W	c
LEGUMINOSAE – MIMOSACEAE					
<i>Albizia gummifera</i> (J.F.Gmel) C.A.Sm. ^	Mkenge kigozi	T	F	W	d
<i>Albizia petersiana</i> (Bolle) Oliv.	Mkenge	T	F,RF,W	W	c
<i>Albizia versicolor</i> Oliv.	Mtanga	T	Not forest	W	c
<i>Albizia</i> sp.	-	-	-	-	-
<i>Dichrostachys cinerea</i> (L.) Wight & Arn.	Mkongowe/ Kigulagembe	T,S	FE,B,T, G,Wa	W	c
LEGUMINOSAE – PAPILIONACEAE					
<i>Baphia kirkii</i> Baker	Mkuruti	T	F,T,W	T3,6,Maf,MSS	b,c
<i>Baphia puguensis</i> Brummitt	Mdangalalila	T,S	F	Endemic to Pugu Hills & Gongolamboto	b,c
<i>Craibia</i> sp.	-	-	-	-	-
<i>Milletia usaramensis</i> Taub.	Mhamvi	T,S	F,G	W	c
LEGUMINOSAE					
Unknown sp.	-	-	-	-	-
LOGANIACEAE					
<i>Strichynos</i> sp.	Mtonga	-	-	-	-
MALVACEAE					
<i>Abutilon</i> sp.	Mkozelambewa	-	-	-	-
MELIACEAE					
<i>Pseudobersama mossambicensis</i> (Sim.) Verdc.	-	T	F	W	c
<i>Trichilia</i> sp.	-	-	-	-	-
MORACEAE					
<i>Dorstenia</i> sp.	-	-	-	-	-
<i>Melicia excelsa</i> (Welw.) C.C.Berg	Mvule	T	F,Wa	W	c
<i>Mesogyne insignis</i> Engl. ^	Mkongolo	S	?	W	d
<i>Trilepsium madagascariensis</i> DC.	-	T	F	W	c
MYRTACEAE					
<i>Syzygium cumini</i> (L.) Skeels ^	-	?	?	W	d

Table 2 continued.

Species	Local name	Plant growth form	Habitat	Distribution	Data source
<b>OCHNACEAE</b>					
<i>Ochna thomasiana</i> Engl. & Deils.	Mkumbi	T,S	F	K7,T3,6,P	b,c
<b>OLACACEAE</b>					
<i>Ximenia americana</i> L. ^	-	T	?	W	d
<b>RUBIACEAE</b>					
<i>Canthium bibracteata</i>	Mshadapori/Mkongenge ?	?	?	-	-
<i>Canthium oligonocarpum</i> Hiern. ^	Mkongenge/Mshadapori	S	?	W	d
<i>Canthium</i> sp.	-	-	-	-	-
<i>Coffea</i> sp.	Mbinibilizigwi	-	-	-	-
<i>Lamprothamnus zangubarensis</i> Hiern	-	T,S	F,W,B,T	Som,K1,7,T3,6,8,Maf	b
<i>Leptactina hexamera</i>	-	-	?	?	-
<i>Pyrostria bibracteata</i> (Baker) Cavaco ^	Mkongenge	S	?	W	d
<i>Sericanthe</i> sp.	-	-	-	-	-
<i>Tarrena</i> sp.	-	-	-	-	-
Unknown sp.	-	-	-	-	-
<b>RUTACEAE</b>					
<i>Toddaliopsis sansibarensis</i> (Engl.) Engl.	-	T,S	F,B	Z-I Near Endemic	c
<i>Vepris ferrugiana</i>	-	?	?	?	-
<i>Vepris lanceolata</i> (Lam.) G.Don	-	S	T	W	c
<i>Zanthoxylum holtzianum</i> (Engl.) Waterm.	Mnungunungu	T,S	F,W,B,T	S.Som,K7,T3,6,8,P,MN	b,d
<b>SAPINDACEAE</b>					
<i>Allophylus</i> sp.	-	-	-	-	-
<i>Blighia unijugata</i> Baker	-	T	F,RF,G	W	c
<i>Hypocoelum foliosum</i> (Hiern) Bullock	Mbunguru	T,S	W,B,Ro,S	W	c
<i>Hypocoelum foliosum</i> ssp. <i>mombasanse</i>	Mbunguru	-	-	-	-
<i>Hypocoelopsis africana</i> F.G.Davies	-	T	F,T	K7,T6,8	c
<b>SAPOTACEAE</b>					
<i>Bequaertiodendron magalimontanum</i> (Sond.) Heine & Hemsl	Mgerezi/Msoteladako	T,S	RF,W	W	c
<i>Manilkara sansibarensis</i> (Engl.) Dubard	Mtunda	T	F,W,B	K7,T3,6,Z,P,Maf,MN	b,c
<i>Manilkara sulcata</i> (Engl.) Dubard	Mchedi	T	F,W,B,T	K1,4,7,T3,6,Z,P,Maf	b,c
<i>Synsepalum brevipes</i> (Synonym: <i>Pachystela brevipes</i> (Baker) Engl.)	Mgelezi	T	-	W	d
<b>STERCULIACEAE</b>					
<i>Nesogordnia holtzii</i> (Engl.) Capuron	Mvimbatitwi	T,S	F,W,T	K7,T3,6,7,8,MZ,Maf	c
<b>TILIACEAE</b>					
<i>Grewia bicolor</i> Juss.	Mkole (mweupe)	T,S	F,FE,W,B,T	W	c
<i>Grewia conocarpa</i> K.Schum.	Mkole	T,S	F,T	T6,8,Z,MN	b,c
<i>Grewia leptopus</i> Ulbr.	Mkole (b'wambwa)	S	F,T	T6,8	b,c
<i>Grewia microcarpa</i> K.Schum.	Mkole	T,S	RF,FE,W,B	W	c

Table 2 continued.

Species	Local name	Plant growth form	Habitat	Distribution	Data source
VERBENACEAE					
<i>Vitex ferruginea</i> Schumach. & Thonn.	Mpuya	T	F	W	c
<i>Vitex ferruginea</i> ssp. <i>ferruginea</i> (var. <i>amboniensis</i> ) Schumach. & Thonn.	-	T	F	W	c
<i>Vitex bunguensis</i>	Mpuya	?	?	?	-
<i>Vitex zanzibarensis</i> Vatke	Mpuya	S	F,B,T	K7,T3,6,8	c
VIOLACEAE					
<i>Rinorea angustifolia</i> (Thou.) Baill.	Mnyakaegele	T	F	W	c
<i>Rinorea ilicifolia</i> (Oliv.) Kuntze	Mjamwofu	T,S	F	W	c
Unknown sp.	-	-	-	-	-

### KEY TO ABBREVIATIONS IN BOTANICAL TABLE 1

#### NEW RECORDS

^ Species not previously recorded in Coastal Forests (those not in Clarke, Vollesen & Mwasumbi (2000) or Clarke (1995)).

#### PLANT GROWTH FORM

T – tree, S – shrub, C – Climber, H – Herb.

**HABITAT** (after Clarke, Vollesen & Mwasumbi (2000)).

F – Forest, FE – Forest Edge, RF – Riverine Forest, W – Woodland, BW – *Brachystegia* Woodland, B – Bushland, T – Thicket, G – Grassland, WG – Wooded Grassland, S – Swamp, Wa – Wasteland/Cultivation, Ro – Rocks .

**DISTRIBUTION** (after Clarke, Vollesen & Mwasumbi (2000) and Clarke (1995) – as in FTEA and FZ).

Som – Somalia, K – Kenya, T – Tanzania, Z – Zanzibar Island, P – Pemba Island, Maf – Mafia Island, Moz – Mozambique, MN – Mozambique, Niassa Province, MZ – Mozambique, Zambesia Province, MMS – Mozambique, Sul do Save/Gaza-Inhambane Province, MLM – Mozambique, Lourenco Marques/Maputo Province, MT – Mozambique, Tete Province, Mal – Malawi, S.Mal – Southern Malawi, Zim – Zimbabwe, E.Zim – Eastern Zimbabwe, S.Zim – Southern Zimbabwe, Z-I Near Endemic – Zanzibar-Inhambane Regional Mosaic Near Endemic.

#### DATA SOURCE

a – Flora of Tropical East Africa (FTEA) (Turill & Milne-Redhead *et al.* 1952-), b – Clarke, Vollesen & Mwasumbi (2000), c – Clarke (1995), d – List of East African Plants (LEAP) (Knox 2000), e – Flora Zambesica (FZ) (Exell & Wild *et al.* 1960-).

The most abundant tree or shrub species recorded in vegetation plots were *Cassia siamea* (6.37% of all trees recorded), *Grewia conocarpa* (5.48% of all trees recorded), *Rinorea angustifolia* (4.71% of all trees recorded), *Albizia petersiana* (4.59% of all trees recorded), *Bequartiodendron magalismontanum* (4.46% of all trees recorded) and *Manilkara sansibarensis* (4.46% of all trees recorded)<sup>1</sup>. All other 105 species accounted for <4% of all trees recorded each, with 81 species (73%) accounting for <1% of all trees recorded each.

The most widespread species within vegetation plots was *Diospyros verrucosa*, which was recorded in 12 of the 23 vegetation plots. *Lannea schweinfurthi* and *Albizia petersiana* were recorded in 11 plots, *Xylopiya parviflora*, *Grewia conocarpa* and *Hymenocardia ulmoides* were recorded in nine plots, and *Bequartiodendron magalismontanum* and *Manilkara sulcata* were recorded in eight plots.

The mean number of trees recorded per plot was  $32.8 \pm 16.5$  (n = 23), which when extrapolated is equivalent to  $328 \pm 165$  trees ha<sup>-1</sup>. The mean number of species recorded per plot was  $13.4 \pm 4.3$

<sup>1</sup> These figures are based on the number of individuals of each species and not the basal area, although it is possible that this may offer a more accurate picture of dominance.

(n = 23). The ratio of trees per plot to species per plot ranges from 16:14 (1.14) to 76:8 (9.50), demonstrating that species dominance varies greatly between plots. This is thought to be a result of the high diversity of vegetation types throughout the reserve, for example the data for the first ratio comes from a vegetation plot situated in Mixed dry Coastal Forest whilst the latter comes from a plot situated in an old *Cassia* sp. plantation.

Thirteen species recorded in the vegetation plots (12% of all species) represent new records for Coastal Forests, i.e. they do not appear in florulas given by Clarke, Vollesen and Mwasumbi (2000) (a list of plant species endemic to the Swahilian Regional Centre of Endemism *sensu lato*) or Clarke (1995) (a checklist of vascular plants from 13 Coastal Forests). All are widespread tree or shrub species in families already represented in Coastal Forests.

Eleven species recorded in the vegetation plots (10% of all species) are considered forest dependent species. These include species confined to 'forest', *Brachystegia* Forest and Riverine Forest, as Burgess and Clarke (2000) present these as major vegetation types within Coastal Forests.

One species recorded in the vegetation plots (<1%) is endemic to the Pugu Hills and Gongolamboto; *Baphia puguensis*. Twenty-one species (19%) are endemic to the Swahilian Regional Centre of Endemism *sensu lato*. Kazimzumbwi FR is in region T6 as defined by the FTEA (see Table X for an explanation of abbreviations) and of these 21 species one is confined to T6 and 8; *Grewia leptopus*, two to K7 and T3 and 8; *Sapium triculare* and *Hyplocoelopsis africana*, and three to a combination of K7, T3, 6 and 8 and Pemba; *Cynometra webberi*, *Ochna thomasiana* and *Vitex zanzibarensis*. All other species are distributed in over 4 regions. *Dichapetalum edulis* has previously only been recorded from T8 and Mozambique (Niassa Province), thus the record in Kazimzumbwi FR represents a range extension for this species.

#### 4.4.2 REGENERATION PLOTS

In total, 224 individuals were recorded in regeneration plots in Kazimzumbwi FR. These represented 22 families, 31 genera and 42 species (Table 3). Of these, three families, seven genera and 11 species were recorded solely in regeneration plots i.e. were not recorded in vegetation plots.

**Table 3** Tree and shrub species recorded within regeneration plots in Kazimzumbwi FR. Overlap exists between this list and that presented in Table 2, although those species solely occurring in regeneration plots are highlighted with an \*. (Plant growth form, habitat and distribution data cannot be given for species identified to genera or family only).

Species	Local name	Plant growth form	Habitat	Distribution	Data source
ANACARDIACEAE					
<i>Lannea</i> sp.	-	-	-	-	-
<i>Sorindeia madagascariensis</i> *	-	T	F	W	d
APOCYNACEAE					
<i>Carissa tetramera</i> (Sacleux) Stapf	Mkalakala	S	W,B,T	W	c
BIGNONIACEAE					
<i>Markhamia zanzibarica</i> (DC.) K.Schum.	Mhonongo	T,S	F,RF,W,B	W	c
CLUSIACEAE					
<i>Garcinia volkensii</i> Engl. *	-	T,S	F	W	c
COMBRETACEAE					
<i>Combretum molle</i> G.Don ^	Mulama n'gombe	T	WG,B	W	a
EBENACEAE					
<i>Diospyros verrucosa</i> Hiern	Mburuzu	T,S	F,G,T	T6,8,MN, MZ,MMS	a,b
<i>Diospyros</i> sp.	-	-	-	-	-
EUPHORBIACEAE					
<i>Magaritaria discoides</i> (Baill.) Webster	Msakulakwale	T,S	F,BW,T	W	a
<i>Mildebradia</i> sp.	-	-	-	-	-
HYMENOCARDIACEAE					
<i>Hymenocardia ulmoides</i> Oliv.	Mtete	T,S	F,B,T	W	c
LEGUMINOSAE – CAESEALPINACEAE					
<i>Cassia abbreviata</i> Oliv.	Mkundekunde	T,S	W,B,G	W	c
<i>Cynometra webberi</i> Bak.f.	Mhamvi	T	F,W	K7,T3,6,8	b,c
LEGUMINOSAE – MIMOSACEAE					
<i>Albizia petersiana</i> (Bolle) Oliv.	Mkenge	T	F,RF,W	W	c
OCHNACEAE					
<i>Ochna thomasiana</i> Engl.& Deils.	Mkumbi	T,S	F	K7,T3,6,P	b,c
PITTOSPORACEAE					
<i>Pittosporum</i> sp. *	-	-	-	-	-
RUBIACEAE					
<i>Canthium bibracteata</i>	Mshadapori/Mkonge	-	-	-	-
<i>Canthium</i> sp.	-	-	-	-	-
<i>Canthium oligonocarpum</i> Hiern. ^	Mkonge/ Mshandapori	S	?	W	d
<i>Tricalysia</i> sp. *	-	-	-	-	-
RUTACEAE					
<i>Vepris</i> sp.	-	-	-	-	-

Table 3 continued.

Species	Local name	Plant growth form	Habitat	Distribution	Data source
<b>SALVADORACEAE</b>					
<i>Dobera loranthifolia</i> (Warb.) Harms *	-	T	F,T,G	S.Som,K1,4,7,T 3,6,8,MN,MZ	b,c
<b>SAPINDACEAE</b>					
<i>Haplocoelum foliosum mombasense</i> (Hiern) Bullock	Msungura	T,S	W,B,Ro,S	W	c
<i>Lecaniodiscus fischeri</i> *	-	-	-	-	-
<i>Lecaniodiscus</i> sp. *	-	-	-	-	-
<b>SAPOTACEAE</b>					
<i>Bequaertiodendron magalimontanum</i> (Sond.) Heine & Hemsl	Mgerezi/ Msoteladako	T,S	RF,W	W	c
<i>Manilkara sansibarensis</i> (Engl.) Dubard	Mtunda	T	F,W,B	K7,T3,6,Z,P, Maf,MN	b,c
<i>Manilkara sulcata</i> (Engl.) Dubard	Mchedi	T	F,W,B,T	K1,4,7,T3,6, Z,P,Maf	b,c
<i>Synsepalum ceraciferum</i> *	-	-	-	-	-
Unknown sp.	-	-	-	-	-
<b>STERCULIACEAE</b>					
<i>Cola</i> sp. *	-	-	-	-	-
<i>Nesogordnia holtzii</i> (Engl.) Capuron	Mvimbatitwi	T,S	F,W,T	K7,T3,6,7,8, MZ,Maf	c
<b>TILIACEAE</b>					
<i>Grewia conocarpa</i> K.Schum.	Mkole	T,S	F,T	T6,8,Z,MN	b,c
<i>Grewia goetzeana</i> K.Schum *	-	T,S	F,RF,FE,W, G	T3,6,8	b,c
<i>Grewia holtzii</i> Burret *	-	T,L,S	F,FE,W,B,T	S.Som,K7,T3, 6,8,Z,MN	b,c
<i>Grewia microcarpa</i> K.Schum.	Mkole	T,S	RF,FE,W,B	W	c
<i>Grewia</i> sp.	-	-	-	-	-
<b>VERBENACEAE</b>					
<i>Vitex puguensis</i>	-	-	-	-	-
<b>VIOLACEAE</b>					
<i>Afroscesalia</i> sp.	-	-	-	-	-
<i>Rinorea ilicifolia</i> (Oliv.) Kuntze	Mjamwofu	T,S	F	W	c
<i>Rinorea</i> sp.	-	-	-	-	-
Unknown sp.	-	-	-	-	-

**KEY TO ABBREVIATIONS IN BOTANICAL TABLE 2****NEW RECORDS**

^ Species not previously recorded in Coastal Forests (those not in Clarke, Vollesen & Mwasumbi (2000) or Clarke (1995)).

**PLANT GROWTH FORM**

T – tree, S – shrub, C – Climber, H – Herb

**HABITAT** (after Clarke, Vollesen & Mwasumbi (2000)).

F – Forest, FE – Forest Edge, RF – Riverine Forest, W – Woodland, BW – *Brachystegia* Woodland, B – Bushland, T – Thicket, G – Grassland, WG – Wooded Grassland, S – Swamp, Wa – Wasteland/Cultivation, Ro – Rocks.

**DISTRIBUTION** (after Clarke, Vollesen & Mwasumbi (2000) and Clarke (1995) – as in FTEA and FZ).

Som – Somalia, K – Kenya, T – Tanzania, Z – Zanzibar Island, P – Pemba Island, Maf – Mafia Island, Moz – Mozambique, MN – Mozambique, Niassa Province, MZ – Mozambique, Zambesia Province, MMS – Mozambique, Sul do Save/Gaza-Inhambane Province, MLM – Mozambique, Lourenco Marques/Maputo Province, MT – Mozambique, Tete Province, Mal – Malawi, S.Mal – Southern Malawi, Zim – Zimbabwe, E.Zim – Eastern Zimbabwe, S.Zim – Southern Zimbabwe, Z-I Near Endemic – Zanzibar-Inhambane Regional Mosaic Near Endemic.

**DATA SOURCE**

a – Flora of Tropical East Africa (FTEA) (Turill & Milne-Redhead *et al.* 1952-), b - Clarke, Vollesen & Mwasumbi (2000), c – Clarke (1995), d – List of East African Plants (LEAP) (Knox 2000), e – Flora Zambesica (FZ) (Exell & Wild *et al.* 1960-).

The most abundant regenerating tree or shrub species recorded in regeneration plots were *Lecaniodiscus fischeri* (12.5% of all trees recorded), *Lecaniodiscus* sp. (10.71% of all trees recorded), *Rinorea ilicifolia* (6.70% of all trees recorded), *Diospyros verrucosa* (5.80% of all trees recorded), *Rinorea* sp. (4.91% of all trees recorded), *Tricalysia* sp. (4.91% of all trees recorded), *Manilkara sulcata* (4.46% of all trees recorded)<sup>2</sup>. All other 42 species accounted for <4% of all trees recorded each, with 25 species (60%) accounting for <2% of all trees recorded each.

The most widespread species in regeneration plots was *Rinorea ilicifolia*, which was recorded in five of the 21 plots. *Diospyros verrucosa* was recorded in four plots and *Rinorea* sp., *Manilkara sulcata*, *Lecaniodiscus* sp. and *Diospyros* sp. were each recorded in three plots.

The species not also recorded in vegetation plots are trees or shrubs from a variety of habitats, including one forest dependent species. Three are known to be endemic to the Swahilian Regional Centre of Endemism *sensu lato*. None are pioneer or exotic species.

The mean number of regenerating trees recorded per plot was  $9.7 \pm 7.8$  ( $n = 21$ ), which when extrapolated is equivalent to  $2694 \pm 2167$  regenerating trees  $\text{ha}^{-1}$ . The mean number of species recorded per plot was  $2.9 \pm 1.6$  ( $n = 21$ ). The ratio of trees per plot to species per plot ranges from 3:3 or 1:1 (1.00) to 31:2 (15:5), demonstrating that species dominance varies greatly between regeneration plots. As within vegetation plots, this is thought to be due to the high diversity of vegetation types within the reserve. The data for the first ratios comes from regeneration plots situated in Mixed dry Coastal Forest (3:3) and *Brachystegia* Forest (1:1) for example, whilst the latter comes from a plot dominated by the most abundant regenerating species *Lecaniodiscus fischeri*.

Two species recorded in the regeneration plots (5%) represent new records for Coastal Forests, i.e. they do not appear in florulas given by Clarke, Vollesen and Mwasumbi (2000) or Clarke (1995). Both of the species, *Combretum molle* and *Canthium olingonocarpum*, were however also recorded in the vegetation plots.

Three species (7%) recorded in the regeneration plots are considered forest dependent species. As for the vegetation plot analysis, these include species confined to ‘forest’, *Brachystegia* Forest and Riverine Forest. One of these species, *Garcinia volkensii*, is not recorded in the vegetation plots.

Ten species (24%) recorded are endemic to the Swahilian Regional Centre of Endemism *sensu lato*. Of these 10 species, one is confined to T3, 6 and 8; *Grewia goetzeana*, and two are confined to four of the five regions K7, T3, 6 and 8 and Pemba Island; *Cynometra webberi* and *Ochna thomasiana* (again, see Table X for an explanation of abbreviations). The rest are confined to more than four regions. Three of these 10 species are not recorded in the vegetation plots; *Dobera loranthifolia*, *Grewia holtzii* and *G. goetzeana*.

<sup>2</sup> These figures are based on the number of individuals of each species and not the basal area, although it is possible that this may offer a more accurate picture of dominance; it may not however be possible for regenerating trees.

#### 4.4.3 OPPORTUNISTIC BOTANICAL COLLECTION

Twenty-six families, 43 genera and 50 species were recorded through opportunistic collections made throughout Kazimzumbwi FR (Table 4). Of these, 11 families, 35 genera and all 50 species were recorded solely through opportunistic collection i.e. they were not recorded within either vegetation or regeneration plots.

**Table 4** Opportunistic plant species recorded in Kazimzumbwi FR. (Plant growth form, habitat and distribution data cannot be given for species identified to genera or family only).

Species	Local name	Plant growth form	Habitat	Distribution	Data source
<b>ACANTHACEAE</b>					
<i>Justicia heterocarpa</i> T.Anderson ^	-	?	?	W	d
<i>Pseudoranthemum tunicatum</i> (Afzel.) Milne-Redh	-	H	F,T,S	W	c
<b>AGAVACEAE</b>					
<i>Agava sisalana</i> Perr. & Engelm.	-	-	-	Introduced	d
<b>ANACARDIACEAE</b>					
<i>Lanea stuhlmanii</i> (Engl.) Engl.	Mjengaua	T,S	F,W,B,WG	W	a
<i>Mangifera indica</i> L.	-	T	Cultivation	Naturalised	c
<i>Rhus longipes</i> var. <i>longipes</i> Engl.	-	T,S	F,FE,B	W	c
<i>Rhus</i> sp.	-	-	-	-	-
<b>ANNONACEAE</b>					
<i>Ophrypetalum odoratum</i> Deils	-	T,S	F,W	K7,T3,6,8	b,c
<b>ARAUCARIACEAE</b>					
<i>Araucaria</i> sp.	-	-	-	Introduced	-
<b>ASTERACEAE</b>					
<i>Brachyllaena melanoxydon</i> O.Hoffm.	-	T	FE,W,B	W	c
<b>CELASTRACEAE</b>					
<i>Salacia madagascariensis</i> (Lam.) DC.	-	L,S	RF,W,B,T	W	c
<b>COMBRETACEAE</b>					
<i>Combretum schumannii</i> Engl.	-	T,S	F,W,G	W	c
<i>Combretum</i> sp.	-	-	-	-	-
<b>CYPERACEAE</b>					
<i>Cyperus</i> sp.	-	Sedge	-	-	-
<b>EUPHORBIACEAE</b>					
<i>Manihot glaziovii</i> Mull.Arg. ^	-	S	?	Introduced	d
<b>FLACOURTIACEAE</b>					
<i>Casearia glandiiformis</i> Mast.	-	T,S	F,RF,FE,W,B	W	c
<i>Xylothea tettensis</i> var. <i>fessistyla</i> (Klotzsch) Gilg.	-	T,S	Not forest	K7,T3,6,8,Z, Maf,N.Mal, S.Mal,MN,MZ, MMS,MT	c
<b>LABIATAE</b>					
<i>Tectona grandis</i> L.f.	-	T	-	Introduced	
<i>Tinnea aethiopica</i> Kotschy ex Hook f.	-	S	F	W	c,d

Table 4 continued.

Species	Local name	Plant growth form	Habitat	Distribution	Data source
LEGUMINOSAE – PAPILIONACEAE					
<i>Crotalaria goodiiiformis</i> Vatke	-	S	F,FE,W,B, G,WA	W	c
<i>Dalbergia melanoxylon</i> Guill. & Perr ^	-	S	?	W	d
<i>Milletia impressa</i> Harms	-	L	FE,G	W	c
<i>Milletia puguensis</i> Gillet	-	L	F	Endemic to Pugu Hills	b
<i>Pterocarpus angolensis</i> DC. ^	Mninga	T	?	W	d
LOGANIACEAE					
<i>Mostuea brunonis</i> var. <i>brunonis</i> Didr.	-	L,S	F,RF,W,B,T	W	c
<i>Strychnos madagascariensis</i> Poir.	-	T,S	F,RF,W,B,T	W	c
LORANTHACEAE					
<i>Loranthus</i> sp.	-	-	-	-	-
MRYTACEAE					
<i>Eucalyptus</i> sp.	-	T	-	Introduced	-
<i>Syzygium cordatum</i> Hochst. Ex Krauss	-	T	RF	W	c
OCHNACEAE					
<i>Ochna mossambicensis</i> Klotzsch	Mkumbi	T,S	F,W,BW,B	K7,T3,6,8,Z, Maf,MN,MZ, MMS,S.Zim, E.Zim	b,c
OLEACEAE					
<i>Jasminum</i> sp.	-	-	-	-	-
PANDANACEAE					
<i>Pandanus rabaiensis</i> Rendle	-	T	F,S	K7,T3,6,7,Z,P	b,c
PINACEAE					
<i>Pinus patula</i>	-	T	-	Introduced	-
RUBIACEAE					
<i>Agathisanthemum bojeri</i> Klotzsch	-	S,H	FE,W,B,T,Wa	W	c
<i>Aidia micrantha</i> (K.Schum.) F.White ^	-	T	?	W	d
<i>Gardenia transvenulosa</i> Verdc.	Kitang'ombe	T,S	F,W,B	K7,T3,6,8,Z	b,c
<i>Heinsia crinata</i> (Afz.) G.Taylor	-	T,S	FE,B	W	c
<i>Polysphaeria multifolia</i> Hiern	-	T,S	F,W,B,T,Wa	W	c
<i>Polysphaeria parvifolia</i> Hiern	-	T,S	F,W,B,T,Wa	Z-I Near Endemic (inc. Somalia)	c
<i>Psychotria pumila</i> var. <i>pumila</i> Hiern ^	-	S	?	?	d
<i>Psychortia</i> sp.	-	-	-	-	-
<i>Rothmania macrosphon</i> (Engl.) Bridson	-	T,S	F	K7,T3,6,8	b
SAPINDACEAE					
<i>Allophylus rubifolius</i> (A.Rich) Engl.	-	T,S	F,RF,W,B,T	W	c
STERCULIACEAE					
<i>Dombeya kirkii</i> Mast. ^	Msosowana	T	?	W	d
TILIACEAE					
<i>Triumfetta rhomboidea</i> Jacq.	-	S,H	F,B,G,W	W	c
<i>Triumfetta</i> sp.	-	-	-	-	-
ULMACEAE					
<i>Trema orientalis</i> (L.) Bl.	-	T,S	F	W	c

Table 4 continued.

Species	Local name	Plant growth form	Habitat	Distribution	Data source
VERBENACEAE					
<i>Clerodendron cephalanthum cephalanthum</i> Oliv.	-	S	F,FE,?W,?B	W	c
<i>Lantana camara</i> L.	-	S	F,FE,B,T,Wa	Introduced	c
<i>Lantana virbunoides</i> (Forssk.) Vahl	-	S	FE,W,B,T	W	c

**KEY TO ABBREVIATIONS IN BOTANICAL TABLE 3****NEW RECORDS**

^ Species not previously recorded in Coastal Forests (those not in Clarke, Vollesen & Mwasumbi (2000) or Clarke (1995)).

**PLANT GROWTH FORM**

T – tree, S – shrub, C – Climber, H – Herb.

**HABITAT** (after Clarke, Vollesen & Mwasumbi (2000)).

F – Forest, FE – Forest Edge, RF – Riverine Forest, W – Woodland, BW – *Brachystegia* Woodland, B – Bushland, T – Thicket, G – Grassland, WG – Wooded Grassland, S – Swamp, Wa – Wasteland/Cultivation, Ro – Rocks

**DISTRIBUTION** (after Clarke, Vollesen & Mwasumbi (2000) and Clarke (1995) – as in FTEA and FZ).

Som – Somalia, K – Kenya, T – Tanzania, Z – Zanzibar Island, P – Pemba Island, Maf – Mafia Island, Moz – Mozambique, MN – Mozambique, Niassa Province, MZ – Mozambique, Zambesia Province, MMS – Mozambique, Sul do Save/Gaza-Inhambane Province, MLM – Mozambique, Lourenco Marques/Maputo Province, MT – Mozambique, Tete Province, Mal – Malawi, S.Mal – Southern Malawi, Zim – Zimbabwe, E.Zim – Eastern Zimbabwe, S.Zim – Southern Zimbabwe, Z-I Near Endemic – Zanzibar-Inhambane Regional Mosaic Near Endemic.

**DATA SOURCE**

a – Flora of Tropical East Africa (FTEA) (Turill & Milne-Redhead *et al.* 1952-), b – Clarke, Vollesen & Mwasumbi (2000), c – Clarke (1995), d – List of East African Plants (LEAP) (Knox 2000), e – Flora Zambesica (FZ) (Exell & Wild *et al.* 1960-).

Seven species recorded opportunistically (14%) represent new records for Coastal Forests, i.e. they do not appear in florulas given by Clarke, Vollesen and Mwasumbi (2000) or Clarke (1995). All are trees or shrubs with widespread distributions.

Five species (10%) recorded through opportunistic collection are considered forest dependent species. As for the vegetation plot and regeneration plot analysis, these include species confined to ‘forest’, *Brachystegia* Forest and Riverine Forest. One of these species is the endemic *Milletia puguensis* whilst others include the introduced *Tectona grandis* (teak) and the pioneer species *Trema orientalis*.

One species (2%) recorded through opportunistic collection is endemic to the Pugu Hills; the liane *Milletia puguensis*. Seven species (14%) are endemic to the Swahilian Regional Centre of Endemism *sensu lato*. Of these 7 species, two are confined to the regions K7, T3, 6 and 8; *Ophrypetalum odoratum* and *Rothmania macrosphon*, and the rest to more than four regions (see Table 3 for an explanation of abbreviations).

#### 4.4.4 VEGETATION TYPES

Several vegetation types were recognised across the reserve, varying in species diversity and abundance and physical structure; especially canopy cover.

##### **Closed Dry Forest**

Dominated by big tall trees of *Dialium holtzii*, *Hymanaea verrucosai*, *Pteleopsis madagascariensis*, *Diospyros* sp., *Albizia petersiana*, *Manilkara sansibarensis* and *Haplocoelopsis africana*, forming a closed canopy. The forest shrub *Rinorea angustifolia* dominated the shrub layer in this vegetation type.

##### **Brachystegia Forest**

Characterized by big tall trees of *Brachystegia spiciformis*, *Albizia versicolor* and *Lannea schweinfurthii*, forming a closed canopy. Lianes and vines were scarce to absent and shrubs scarce to frequent, rendering this vegetation type resistant to fire.

##### **Scrub,Thicket/Bush**

Common in the northern part of the reserve (north of the railway), characterized by the presence of *Baphia puguensis*, *Dichapetalum stuhlmannii*, *Xylopia* sp., *Rawsonia lucida*, *Maytenus* sp. vines with thorns of *Caesalpinia* species and the endemic liane *Milletia puguensis*.

##### **Open Woodland**

Common in the central part of the reserve (south of the railway), dominated by *Manilkara sulcata*, *Magaritaria discoidea*, *Hymenocardia ulmoides*, *Annona senegalensis*, *Ochna thomasiana* and many *Acacia* species.

##### **Wooded Grassland**

Common in the north-west of the reserve (north of the railway), dominated by *Maprounea* sp., *Ochna thomasiana*, *Parinari cuetifolia*, *Dalbergia melanoxylon* and many Rubiaceae shrubs mixed with different grass species.

##### **Open areas**

Areas mainly covered by grasses and small herbs such as *Agathisanthum bojeri*, *Crotolaria* sp. and *Indigofera* sp.. On transect C (see Figure X) there was an open area covered by vines, climbers and lianes of *Milletia puguensis*, *Jusminum* sp., although it was difficult to tell why there were no standing trees.

##### **Swamp or Riverine Forest**

Occurring in small patches in the central part of the reserve along the River Mzumbwi (south of the railway), containing mono-dominant stands of *Pandanus rabaiensis*. This vegetation type has a closed canopy

##### **Edge forest**

Found along the railway (which has created large open areas 50m either side), along forest borders and near to plantations. Dominated by *Bridelia cathartica*, *Sapium ellipticum*, *Mgaritaria discoidea*, *Annona senegalnsis* and *Combretum* sp.. Different grass and herb species predominate.

##### **Plantation forest**

Old trial or experimental plots of *Araucaria* sp. and *Pinus patula*, and plantations of *Cassia siamea* and *Tectona grandis* were observed within the forest.

## 4.5 DISCUSSION

Kazimzumbwi FR encompasses a diverse assemblage of vegetation communities and a rich species diversity (Table 5).

**Table 5** Summary of plant diversity recorded in Kazimzumbwi FR. (The numbers given for regeneration plots and opportunistic collection do not include those already given for vegetation plots i.e. they are additional).

Taxon	Number of families	Number of genera	Number of species	Species not previously recorded in Kazimzumbwi FR	Forest dependent species	Endemic to Swahilian Regional Centre of Endemism
Vegetation plots	37	82	111	13 (12%)	11 (10%)	21 (19%)
Regeneration plots	3	7	11	0	1 (10%)	3 (27%)
Opportunistic collection	11	35	50	7 (14%)	5 (10%)	8 (16%)
Totals	51	124	172	20 (12%)	17 (10%)	32 (19%)

### 4.5.1 BOTANICAL RICHNESS AND DIVERSITY

Through systematic vegetation sampling, 122 plant species were recorded within Kazimzumbwi FR. An additional 50 species were recorded through opportunistic collection and thus 172 species were recorded in total. All species recorded through systematic vegetation sampling were trees or shrubs and only 9% of species recorded through opportunistic collection were lianes (or shrubs) and 9% were herbs (or shrubs). There is therefore great potential to record many more lianes, herbs and also climbers, epiphytes and parasitic plants within the reserve. Calculations by Whittaker (1960) on the alpha diversity (within community) of vascular plants would suggest that each Coastal Forest is home to between 300 and 800 species (Clarke, Vollesen & Mwasumbi 2000). Comparing forests based on their species lists is prone to errors due to uneven and biased collection, with emphasis placed on easily identified species (Clarke & Robertson 2000). The total number of species within Kazimzumbwi FR is however expected to be high and be comparable with the figures given by Whittaker.

Of the species recorded within vegetation plots, only *Grewia conocarpa* and *Bequartiodendron magalimontanum* were amongst both the most abundant and widespread. Other species, such as *Cassia siamea*, were abundant but not widespread. All 50 records of this species were made in a vegetation plot located in an old plantation for example. Species recorded within regeneration plots revealed a greater degree of overlap between the most abundant and widespread species. *Rinorea* sp., *Diospyros* sp., *Manilkara sulcata* and *Lecaniodiscus* sp. were all amongst the most abundant and widespread species. Little overlap was apparent between the most abundant species in vegetation plots and regeneration plots. Only *Rinorea* sp. was amongst the most abundant species in both plot types. *Diospyros verrucosa* and *Manilkara sulcata* were amongst the most widespread species recorded within both vegetation plots and regeneration plots, thus again the degree of overlap is low. The dominant species within mature and regenerating vegetation within Kazimzumbwi FR is thus variable, in terms of both numbers of individuals and spatial extent.

It is common for Coastal Forest canopies to be dominated by a few species; five species may for example account for 80% of canopy trees in any 1 ha block (Clarke & Robertson 2000). This contrasts to rainforests but compares to other lowland African forests where monospecific dominance is common. When compared to the figure given above, monospecific dominance

within Kazimzumbwi FR was found to be low. Overall within vegetation plots, the five most common species accounted for only 25% of all individuals recorded. This figure does however include all trees of a dbh of 10cm or over; thus it is not confined to canopy trees, and is not confined to trees within any 1ha block. Calculations based on the number of trees and species per plot (vegetation and regeneration) in this study revealed the vegetation of Kazimzumbwi FR to vary greatly in its degree of monospecific dominance. Those plots with the highest mono-specific dominance were dominated by a few species such as *Cassia siamea* or *Lecaniodiscus fischeri*. These figures are based on the number of individuals however and abundance does not necessarily reflect dominance, especially when considering canopy dominance. Of those species found to be most abundant within vegetation plots, only *Manilkara sansibarensis* and *Albizia petersiana* are canopy trees whilst *Cassia siamea* is a plantation species and *Rinorea angustifolia* a dominant forest shrub. Calculations based on basal area could possibly yield interesting results, however qualitative observations of dominance amongst species would appear to provide good, but possibly subjective, results. These conclude that dominance is spread between 5-7 species within each vegetation type and thus a few species do in fact dominate most of the vegetation types encountered.

Many vegetation types were recognised within Kazimzumbwi FR, the various characteristics of which reflect those of Coastal Forest vegetation types as described by Clarke and Robertson (2000) fairly well. The Coastal Forest vegetation types of 'Mixed Dry Forest', '*Brachystegia* Forest' and 'Swamp Forest' are all represented within Kazimzumbwi FR. The existence of the latter of these is particularly important, as freshwater swamp conditions, and thus Swamp Forest, are rare in Coastal Forests (Clarke & Robertson 2000). The 'scrub/thicket/bush' and 'edge forest' vegetation types recorded in Kazimzumbwi FR do not correspond well with any of the vegetation types listed by Clarke and Robertson (2000), and rather contain species from all of them. This can be explained as variation in plant communities is continual through space (and time) and thus the strict definition of vegetation types is not always appropriate. Such areas were previously disturbed by human activity (refer to section 5 for more detail).

Altitude varies little within Coastal Forests and thus factors other than this are important in determining their vegetation communities (Clarke, Vollesen & Mwasumbi 2000). Climate, soil, geology, geomorphology, human disturbance, aspect, historical factors and even termites may all effect forest assemblages. Any number of these factors could be important in determining vegetation communities within Kazimzumbwi FR, but human disturbance is considered to be particularly important. *Brachystegia* forest, scrub forest, wooded grassland, grassland, open areas and edge forest are all habitats potentially resulting from human activities. *Brachystegia* forest may result from past clearance and subsequent soil degradation, scrub forest from regeneration after clearance and/or burning, wooded grassland and grasslands from widespread and frequent fire-burning by early humans, open areas from selective logging and edge forest through activities such as railway construction (see Clarke 2000, Clarke and Robertson 2000). Topography is also considered to be an important determining factor, particularly with regard to the extent of vines, through its' link to the availability of water resources.

#### 4.5.2 'NEW RECORDS'

Combining the species recorded systematically and through opportunistic collection, 20 species (12%) recorded within Kazimzumbwi FR have not previously been recorded in Coastal Forests (based on florulas given by Clarke, Vollesen and Mwasumbi (2000) and Clarke (1995)). All of these species have widespread distributions and are from families already represented within Coastal Forests. The botanical collection and study of Coastal Forest is far from complete and thus these findings are particularly important.

### 4.5.3 FOREST DEPENDENCY

Seventeen species (10%) recorded in Kazimzumbwi FR are considered to be forest dependent. For the purposes of this study this was taken to include *Brachystegia* Forest and Riverine Forest (including Swamp Forest), as Clarke and Robertson (2000) present these as main vegetation types within Coastal Forests. Twelve of these 17 species were recorded through systematic sampling and five through opportunistic collection.

The majority of forest dependent species were recorded within three or less plots, although the near-endemic species *Baphia puguensis* was recorded in six of the 23 vegetation plots (26%). The majority of forest dependent species were represented by only one individual. *Ochna mossambicensis* (also near-endemic) was however represented by eight individuals, *Baphia puguensis* by 10 individuals, *Albizia gummifera* by 11 individuals and *Rinorea angustifolia* by 37 individuals.

Large areas of Kazimzumbwi FR comprise habitats other than forests and thus the low number of forest dependent species and consequently high number of ecological generalists is to be expected. The dominance of ecological generalists in Coastal Forests in general is attributed to the small size of forest patches and the fact that they are surrounded by open habitats and are dry for large parts of the year (Burgess *et al.* 2000).

### 4.5.4 ENDEMISM

Thirty-two (19%) of the 172 species recorded in Kazimzumbwi FR are endemic to the Swahilian Regional Centre of Endemism *sensu lato*, including two species (1%) that are endemic to the Pugu Hills (and Gongolamboto in one case). Twenty-four of these 32 species were recorded through systematic sampling and eight through opportunistic collection. Twelve species in total are endemic to the Pugu Hills, including the two recorded during this work. The regional endemic *Dichapetalum edulis* has previously only been recorded from T8 and Mozambique (Niassa Province), thus the record in Kazimzumbwi FR (recorded within vegetation plots) represents a range extension for this species.

Approximately half of the regional endemic species within Kazimzumbwi FR were recorded in only one or two plots. *Dialium holtzii* and *Manilkara sulcata* were however recorded in eight plots, *Grewia conocarpa* in nine plots, *Manilkara sansibarensis* in 11 plots and *Diospyros verrucosa* in 12 plots. Almost half of the regional endemic species were represented by only one or two individuals. *Hyplocoelopsis africana* was however represented by 24 individuals, *Diospyros verrucosa* by 30 individuals, *Manilkara sansibarensis* by 35 individuals and *Grewia conocarpa* by 43 individuals.

The family Rubiaceae contributes 14.3% of Coastal Forest regional endemic species, with many others from the families Leguminosae, Euphorbiaceae, Acanthaceae, Annonaceae, Asclepiadaceae, Cucurbitaceae, Poaceae, Vitaceae, Asteraceae and Verbenaceae (Clarke, Vollesen & Mwasumbi 2000). Rubiaceae and Leguminosae were important families for regional endemic species recorded in Kazimzumbwi FR, along with Sapotaceae and Tiliaceae. *Diospyros*, *Tricalysia*, *Grewia*, *Combretum* and *Ochna* are genera containing many regional endemic species in both Coastal Forests in general and Kazimzumbwi FR.

The majority of Coastal Forest regional endemic species are to be found in fire-excluded habitats, thus not woodlands or grasslands (Clarke, Vollesen & Mwasumbi 2000). In Kazimzumbwi FR, regional endemic species were recorded in all vegetation plots except one (Plot 1). This plot was located in Wooded Grassland disturbed by fire as little as one year before the survey fieldwork.

#### 4.5.5 REGENERATION

Forty-two species within 31 genera and 22 families were recorded in regeneration plots within Kazimzumbwi FR. Thirty-one of these species (74%) were also recorded in vegetation plots, along with 24 genera (78%) and 19 families (86%). The similarity of species composition between regeneration plots and vegetation plots was thus high. This indicates that the majority of regeneration within Kazimzumbwi had the potential to contribute to the forest canopy and understorey when mature. This would indicate a stable, or climax, non-pioneer forest community.

Eleven species were recorded in regeneration plots alone. These are trees or shrubs typical of a variety of habitats, however one species, *Garcinia volkensii*, is forest dependent. Three species are known to be endemic to the Swahilian Regional Centre of Endemism *sensu lato*; *Dobera loranthifolia*, *Grewia goetziana* and *G. holtzii*. None of the 11 species are considered pioneer or secondary growth species.

Low amounts of regeneration (up to a certain point) may indicate a stable forest community or one that has suffered limited disturbance. Brown (1998) for example demonstrated that due to patchy canopy clearance areas of high disturbance in forest habitats tend to have a high amounts of regenerating species (Frontier-Tanzania 2001b). Previous Frontier-Tanzania Forest Research Project work in the Udzungwa Mountains used the same methods as employed in the current study to work on regeneration in two Forest Reserves. This work revealed a significantly higher number of regenerating trees and shrubs within the more heavily disturbed New Dabaga/Ulangambi Forest Reserve (NUDFR) when compared to the less disturbed and more stable forest community within West Kilombero Scarp Forest Reserve (WKSFR) (Frontier-Tanzania 2001b,c). The same methods were also employed by Frontier-Tanzania Forest Research Programme whilst working in Ruvu South Forest Reserve (RSFR) (Frontier-Tanzania *unpubl.*) and thus comparisons can be made between all three reserves and Kazimzumbwi FR. It should be noted however that the vegetation types of the Udzungwas (within the Eastern Arc) and RSFR and Kazimzumbwi FR (within Coastal Forest) are different. The figures given are also based on means about which, at least in Kazimzumbwi FR, there is much variation. Due to a lack of other comparative data however, these figures were tentatively used a basis for discussion. The number of regenerating trees and shrubs recorded within a 3m x 3m plot in NUDFR was 18.0, in WKSFR was 6.1, in RSFR was 2.9 and in Kazimzumbwi FR was 2.4. The abundance of regeneration within both RSFR and Kazimzumbwi FR is thus lower than that in either WKSFR or NUDFR, but closest to that in WKSFR. This reserve was deemed to comprise a stable forest community based on the low amount of regeneration and the fact that they have low numbers of secondary or pioneer species. RSFR and Kazimzumbwi FR also contain low numbers of secondary and pioneer species and thus may also be deemed to comprise stable forest communities.

#### 4.5.6 THREATS

Certain plant species recorded within Kazimzumbwi FR have been recognised as at threat from activities such as pitsawing, charcoal burning and the collection of wood for building and carving. Based on local information and personal observation it was noted that pitsawing is targeted towards valuable timber species such as *Brachystegia spiciformis*, *Milicia excelsa*, *Azelia quazensis* and *Pterocarpus angolensis*. Mature *M. excelsa* were considered uncommon in the forest and *B. spiciformis* is currently cut as an alternative. Charcoal burning is directed at hardwood species such as *Parinari cuetifolia*, *Annona senegalensis*, *Dichrostachys cinerea*, *Ochna thomasiana* and *Manilkara sulcata*. These activities are considered to pose a serious threat to these species, particularly as no management is taking place in the form of regeneration encouragement. Pole cutting for building materials is also considered a serious problem within Kazimzumbwi FR as selected young tree species are targeted. Those species under pressure

include *Baphia puguensis*, *Nesogordonia holtzii*, *Diospyros* sp. and *Ludia mauritiana*. The former of these species is endemic to the Pugu Hills and thus any threat to it is of particular concern. *Makonde* carving has endangered the black wood species *Dalbergia melanoxylon*. This species is currently particularly rare within the reserve and *Annona senegalensis* is used as an alternative. It is thought that if not controlled, the making of animal traps from *Rinorea angustifolia* may effect this evergreen shrub. Bushfires are also a problem within Kazimzumbwi FR, particularly for easily combustible shrubs and herbs during dry season periods. According to the *Coastal Forest Medicinal Plant Checklist* (Mathews 1993) many shrubs and herbs found within Kazimzumbwi FR are of great medicinal value, thus bushfires threaten not only the biological value but also the medicinal and commercial value of the reserve.

A number of exotic and pioneer species were recorded in Kazimzumbwi FR. Plantations and trial plots of the timber species *Eucalyptus* sp., *Tectona grandis*, *Pinus patula* and *Cassia siamea* were observed, although these species tended to be confined to such areas. *Cassia siamea* is also planted to mark parts of the northern border of the reserve however. Exotic species and pioneer species such as *Araucaria* sp. and *Trema orientalis* (respectively) were observed within wooded grasslands near to the forest border in the north of the reserve. Another exotic species, *Magnifera indica*, was recorded in an area of *Brachystegia* Forest in the west of the reserve whilst the pioneer species *Lantana camara* was recorded throughout the Dry Mixed Forest but only found regenerating in gap areas and forest edge. Based purely on qualitative observational data, the threat of 'invasion' by both exotic and pioneer species is however not currently considered serious.

## 4.6 CONCLUSIONS

Kazimzumbwi FR clearly contains a highly heterogeneous and diverse assemblage of plant communities, including many forest dependent species, species endemic to both the Pugu Hills and the Swahilian Regional Centre of Endemism *sensu lato*, and species not previously recorded within Coastal Forests. Through information based on regeneration and the presence of pioneer species within the reserve, the forest overall is considered to be in a stable, climax state. Based on qualitative observational data alone, exotic and introduced species present within the reserve are not currently considered to pose a threat to the native vegetation. Certain species are however threatened by various human activities that have the potential to indirectly affect plant diversity and vegetation communities in general.

Certain species found within Coastal Forests are considered 'anthropogenic endemics' (*sensu* Gentry 1996); those with distributions that are an artefact of the loss of former habitat through human disturbance and destruction (Clarke, Vollesen & Mwasumbi 2000). The island-like nature of Coastal Forests is cause for concern for the long-term viability of its rare species (Clarke, Vollesen & Mwasumbi 2000). Considering these facts along with that of the botanical richness and diversity within Kazimzumbwi FR, management plans are clearly required to safeguard the reserve's future. Closer investigation of forest products is urgently needed in order to identify from where they are taken and therefore where conservation measures should be directed. In order to ensure sustainable utilisation of forest resources, intensive joint patrolling involving villagers and environmental education within surrounding villages should also be encouraged. Lastly, further research and intensive collection focusing on herbs and lianes is needed in order to produce a comprehensive checklist of Kazimzumbwi FR flora.

## 5. FOREST USE AND HUMAN IMPACT

*Authors: Hall, S.M., Staddon, S. and Murphy, A.*

### 5.1 INTRODUCTION

The small fragmented nature of Coastal Forests, surrounding growing impoverished rural communities with increasing demands on forest resources, and a lack of adequate protection mean that biodiversity is seriously under threat.

Kazimzumbwi epitomises the problems facing forests near Dar es Salaam. Almost all trees of commercial value were removed during commercial logging activities, according to local sources ending in 1980. Timber is the top ranking perceived value of forest products for young men surrounding Kazimzumbwi FR (Lagerstedt 1995 and Mwamfupe 1997).

A long history of non-timber exploitation also exists within Kazimzumbwi FR including charcoal production, cultivation, pole extraction, fuelwood collection, hunting and collection of medicinal and food plants. An extensive network of resource collection trails covers the forest.

Charcoal production was common in the forest reserve until 1991 when forest guards were employed by the Wildlife Conservation Society of Tanzania (WCST) to address these illegal activities. Charcoal has been shown to be the second ranking perceived value of forest products for men, young men and women surrounding Kazimzumbwi FR (Lagerstedt 1995 and Mwamfupe 1997). Logging for the production of charcoal, possibly combined with logging for firewood, removed virtually all trees from some areas (Clarke & Dickinson 1995).

Building materials have been collected from Kazimzumbwi FR for local use, and poles recorded as having been collected commercially for sale in Dar es Salaam (Burgess & Dickinson, 1993). Building materials and poles have been shown to be the third ranking perceived value of forest products for men, young men and women surrounding Kazimzumbwi FR (Lagerstedt 1995 and Mwamfupe 1997). Concerns exist regarding the effects of commercial scale exploitation of poles. The effects of extracting selectively chosen species such as *Scorodophloeus fischeri* potentially damage the forest by removing young canopy trees, altering its natural composition (Clarke & Dickinson, 1995).

Firewood collection is the most important perceived value of forest products for women surrounding Kazimzumbwi FR, and has been recorded as commonplace. Collection of traditional medicines, honey and gum has also been noted (Clarke & Dickinson, 1995 and Burgess & Dickinson, 1993).

A number of trial plots were established within the natural forest areas of Kazimzumbwi FR mainly for exotic timber species such as teak (*Tectona grandis*), blackwood cassia (*Senna siamea*), *Eucalyptus* sp., rubber (*Hevea brasiliensis*) and the indigenous timber species *Mninga* (*Pterocarpus angolensis*). Results from these trials indicate that Kazimzumbwi FR is a marginal to suitable site for pine plantations (Procter, 1996 in Somi & Nshubemuki, 1980 in Burgess & Dickinson, 1993).

Past threats to large mammals in Kazimzumbwi FR have been acute (Burgess & Dickinson, 1993). Hunting for local and probably commercial operations has occurred. Most commonly trapped species were duiker and bush pig. Black and white colobus monkeys and hippopotamus

have been hunted out of the forest presumably using fire arms (Burgess & Dickinson, 1993). The hunting of animals for food has been shown to be the top ranking perceived value of forest products for men surrounding Kazimzumbwi FR (Lagerstedt 1995 and Mwamfupe 1997).

The close proximity of agricultural land to forest reserve borders and poor border maintenance encourages the dispersal of fire into the reserve. Degradation of forest to more fire susceptible habitats such as woodland or grassland also encourage the chances of fire damage (Sheil 1992).

According to local tradition, cultivation was permitted in the reserve following its gazettelement during the 1930s. In 1995 Clarke & Dickinson reported that the forest was under heavy pressure from agricultural encroachment in the reserve, especially from the east and southwest. Violent confrontation took place between forestry officials and some local people over this issue in 1994, 1995 and in 1998. In 1998 several hundred families were evicted from within the forest reserve. While the forest is now potentially retrieved, the relationship between the community and the Government is still hostile, particularly in the south and south-eastern parts of the reserve. Concerns over continued illegal encroachment for cultivation in Kazimzumbwi FR by people from local villages meant that the forest reserve was earmarked for protection by Tanzanian Forest Action Plan (TFAP) (Sheil, 1992). Other national and international organisations have also recently taken a large role in helping alleviate the pressures on Kazimzumbwi FR.

Since 1991, The Wildlife Conservation Society of Tanzania (WCST) has been working with local villages and Government to try and alleviate some of the problems that exist. WCST has acted on several roles (Rodgers and Burgess 2000):

channelling donor funds or conservation and education to District level; implementing conservation by convening planning meetings with villagers, training field staff, demarcating boundaries, planting village nurseries, etc.

acting as an information organisation, by issuing press releases and news sheets;

becoming an advocacy organisation, openly pushing Government to seek a solution as normal policing and extension methodologies failed; and

bringing together Central and District administrations with villagers and the press.

In 1999/2000 the Misitu Yetu Project was established to support local communities to manage and benefit from the biodiverse forests of Eastern Tanzania. This project is a collaboration between CARE International, WCST and the Tanzanian Forest Conservation Group (TFCG). Kazimzumbwi FR was chosen as one of four reserve areas targeted by the project. The Misitu Yetu Project allows communities the potential to secure tenure and user rights, increases long term livelihood security for households and increases the effectiveness of biodiversity conservation, as well as promoting the search for alternatives to forest exploitation.

A quantitative assessment of resource extraction and thorough study of disturbance patterns throughout Kazimzumbwi FR will help inform the Misitu Yetu Project of current pressures on the forest and guide managerial activities.

## 5.2 AIMS

- Quantify the intensity of pole and timber extraction per hectare along transect lines to give an indication of the rates/sustainability and sites of extraction.
- Compare quantified anthropogenic extraction with natural death along transect lines.
- Document all disturbance observations and intensities in order to form priorities for conservation management.

## 5.3 METHODS

Disturbance transects were used to record the intensity of pole cutting and logging systematically throughout the forest reserve. Disturbance transects were positioned diagonally across an imaginary 1.2 km x 1.2 km grid, running north-east, south-west across the reserve (Figure 5). Each transect was sampled from the northern border to a southern extent at grid reference 9230 (S 6°58'00")<sup>3</sup> (Figure 5).

Every self-standing tree (not creepers or lianas) above 5cm diameter at breast height (dbh) was measured within an area 5m either side of each transect line. Each plant was recorded under one of four categories: live, old cut, new cut or naturally dead or fallen. Old cutting was identified by darkening and rotting of a cut stump, and was assumed to have been cut more than 6 month prior to surveying. New cutting was identified by fresh cream or green cut stumps and assumed to have been cut less than six months prior to sampling. Within these categories a distinction was made between poles and timbers. Poles were classified as having a dbh between 5 and 15cm and a minimum 3m relatively straight trunk. Timber was classified as having a dbh greater than 15cm with a minimum 3m relatively straight trunk. These divisions are based on differences in use. Timber and pole cutting data are presented as an average per hectare.

All other forms of anthropogenic disturbance within an area 5m either side of each transect were also recorded for every 50m section. Other forms of disturbance were defined as follows:

1. Fire damage – an area affected by fire, evidence included burnt trees and ground vegetation.
2. Charcoal – an area where charcoal was burnt in the forest, evidence included small patches of burnt ground with charcoal remains.
3. Pitsaw – an area obviously cleared for pitsaw activities, with pitsaw platform, or remains of such.
4. Timber/planks/poles – cut timber, planks or cut poles laying on the ground ready for transportation.
5. Trapping – animal traps of all varieties whether set or sprung.
6. Cultivation – evidence of crop cultivation (past or present).
7. Grazing – direct evidence or remains of cattle or goat grazing.
8. Footpath – including all human used footpaths.
9. Clearing - well-established clearings within the forest as a consequence of human disturbance (usually short grassland, potentially previous settlement).

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<sup>3</sup> Forest Officers advised this to be the southern limit of fieldwork as a consequence of recent unrest in local communities in the south of the reserve.

## 5.4 RESULTS

A total area of 22 hectares was surveyed for signs of human disturbance along the five transects (labelled A-E, Figure 5). Due to the varied vegetation, access and topography of the reserve, the extent and type of disturbance differed between areas. Access in the reserve is by a network of footpaths (there is a well established footpath running east-west through the centre of the reserve between the villages of Buyuni and Vigama/Kazimzumbwi), a railway track in the northern section and by roads leading up to the reserve borders. The surrounding area is densely populated and due to its relatively flat topography, human access to the reserve is not difficult.

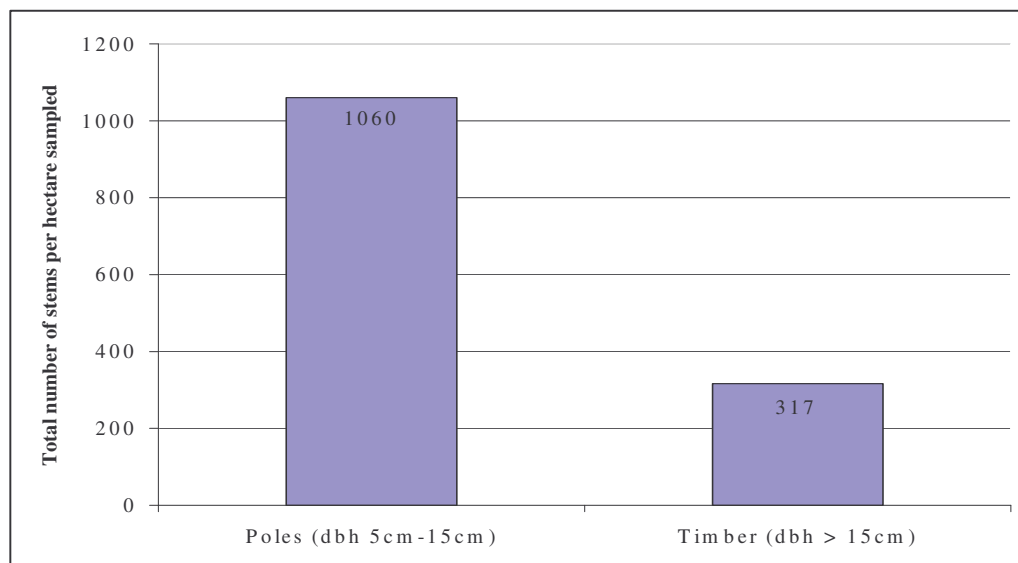
A total of 22,235 stems were sampled throughout the reserve, represented by 1060 poles per hectare and 317 timber per hectare, 87 % and 23 % respectively (Figure 6).

### 5.4.1 POLE AND TIMBER EXTRACTION

Pole and timber extraction was found along all five transects. The highest concentrations of recent cuttings were found near to footpaths. Cutters were heard and seen throughout these areas during the fieldwork.

### 5.4.2 POLES

Rates of pole extraction are summarised in Tables 6 and 7, Figures 7 and 8. A mean total of 584 (77%) poles sampled per hectare were alive, 83 (12%) naturally fallen, 140 (11%) old cut and 5 (0.4%) new cut. The number of cut poles was on average greater than the number of naturally fallen poles. The number of new cut poles was minimal. Old cutting was highly variable between transect lines.



**Figure 6** Total number of poles and timber sampled per hectare during Kazimzumbwi FR disturbance assessment.

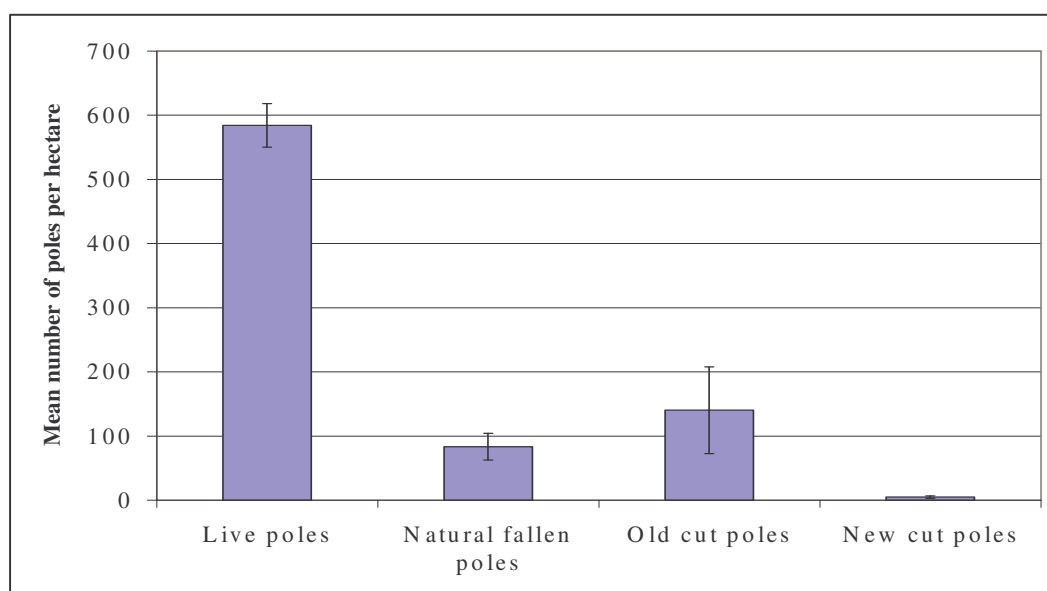
Transect lines D and E showed greatest evidence of pole cutting with 223 and 383 cut poles per hectare (21.5 % and 41.2 % of all poles sampled along each respective transect line). These figures were significantly greater (sixteen times greater along transect E) than the average number of naturally fallen poles per hectare. Transect E supported the largest density of new and old cut poles per hectare.

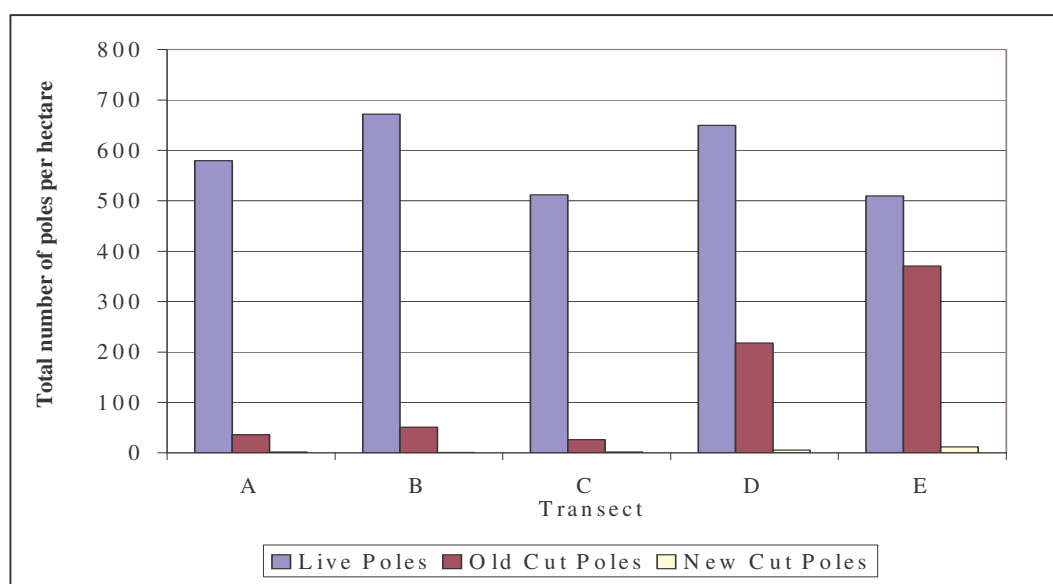
**Table 6** Disturbance transect results for total pole counts (mean percentages in brackets).

Transect Line	Transect Length (m) (no. of 50m sections)	Total no. poles sampled	Total Number Live poles (LP)	Total Number Naturally fallen poles (NFP)	Total Number Old Cut Poles (OCP)	Total Number New cut poles (NCP)
A	4600 (92)	3295	2665 (80)	459 (14)	164 (5)	7 (0.2)
B	6650 (133)	5419	4469 (82)	589 (11)	339 (6)	22 (0.4)
C	5850 (117)	3491	2993 (86)	335 (10)	152 (4)	11 (0.3)
D	4150 (83)	4231	2695 (64)	610 (14)	904 (21)	22 (0.5)
E	750 (15)	686	382 (56)	17 (2)	278 (40)	9 (1.2)
<b>TOTAL</b>	<b>22,000 (440)</b>	<b>17,122</b>	<b>13,204</b>	<b>2,010</b>	<b>1,837</b>	<b>71</b>

**Table 7** Disturbance transect results for total pole counts per hectare (percentages of all poles sampled per hectare in brackets).

Transect Line	Transect Length (m) (no. of 50m sections)	Transect Length (m)	Number of poles sampled per ha	Number of LP per ha	Number of NFP per ha	Number of OCP per ha	Number of NCP per ha
A	4600 (92)	4600	716 (100)	579 (81)	100 (14)	36 (5)	2 (0.3)
B	6650 (133)	6650	815 (100)	672 (83)	89 (11)	51 (6)	3 (0.4)
C	5850 (117)	5850	597 (100)	512 (86)	57 (10)	26 (4)	2 (0.3)
D	4150 (83)	4150	1020 (100)	649 (64)	147 (14)	218 (21)	5 (0.5)
E	750 (15)	750	915 (100)	509 (56)	23 (3)	371 (41)	12 (1.3)
<b>MEAN (Std. Dev.)</b>				<b>584.2 (67.5)</b>	<b>83.2 (41.7)</b>	<b>140.4 (135.0)</b>	<b>4.8 (3.8)</b>

**Figure 7** Mean number of live, naturally fallen, old cut and new cut poles per hectare throughout Kazimzumbwi FR with standard error bars.



**Figure 8** Total number of live, old cut and new cut poles per hectare for each transect line.

#### 5.4.3 TIMBER

Rates of timber extraction are summarised in Tables 8 and 9 and Figures 9 and 10. An average total of 192 (83% of all) timber sampled per hectare were live, 27 (11%) naturally fallen, 14 (6%) old cut and 0.5 (0.2%) new cut. As for poles, the number of naturally fallen timber was on average greater than cut timber. The number of new cut timber was minimal.

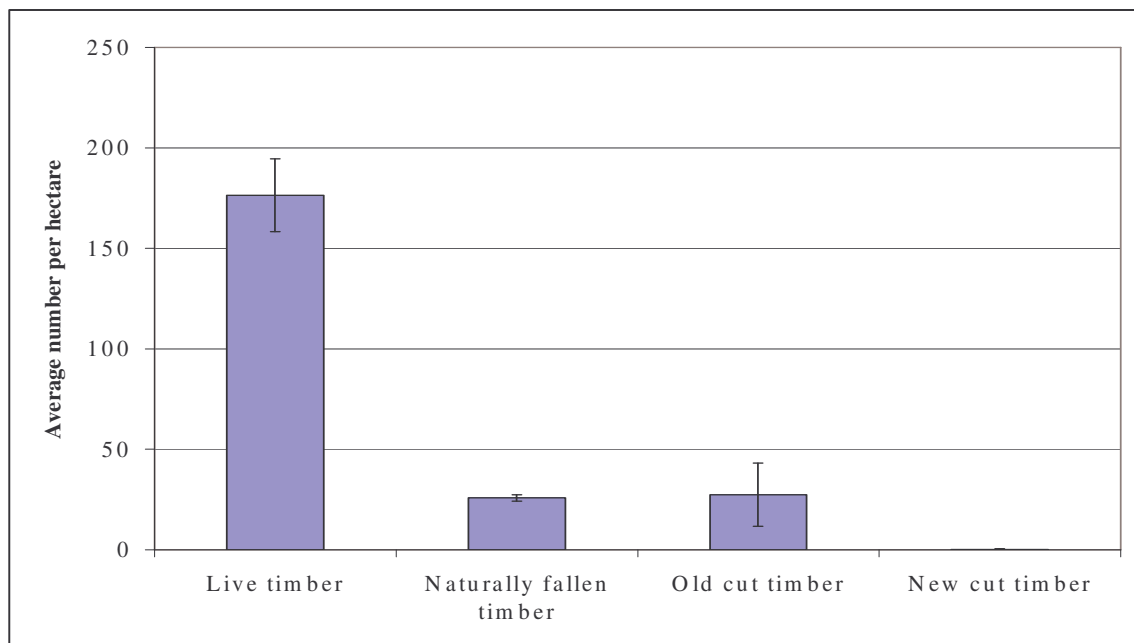
As for poles, transect lines D and E showed greatest evidence from timber cutting with 24 and 89 cut timber per hectare (11.2% and 39% of all timber sampled along respective transect lines). Transect C supported the greatest density of new cut timber, whilst transect D supported the greatest density of old cut timber. The mean density of cut timber per hectare was greater than that of naturally fallen timber along transect D.

**Table 8** Disturbance transect results for timber counts (mean percentage in brackets).

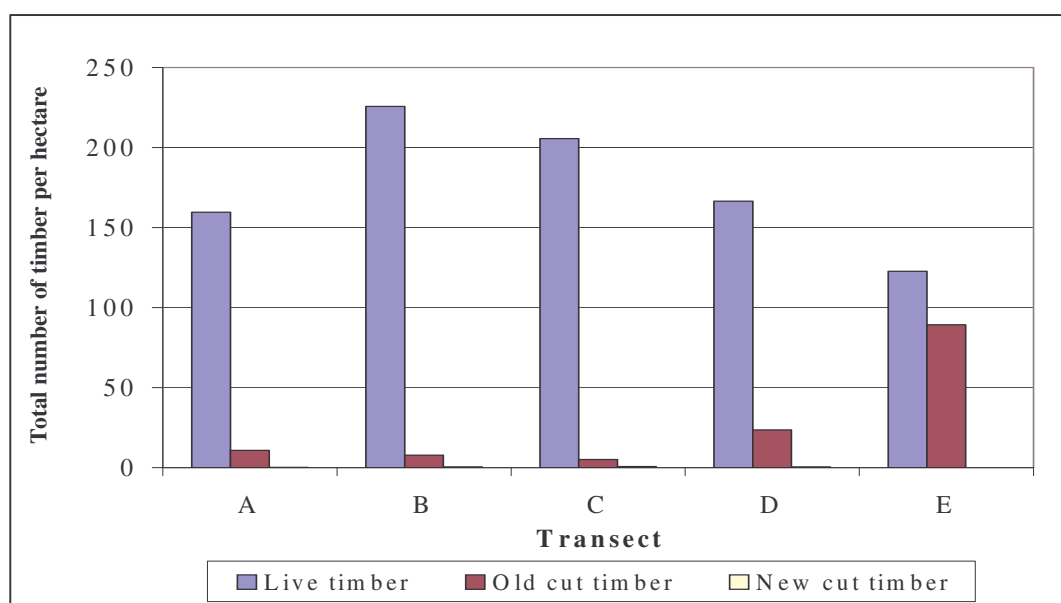
Transect Line	Transect Length (m) (no. of 50m sections)	Transect Length (m)	Total no. timber sampled	Live timber (LT)	Naturally dead timber (NDT)	Old Cut Timber (OCT)	New cut timber (NCT)
A	4600 (92)	4600	903	734 (81)	118 (13)	50 (5)	1 (0.1)
B	6650 (133)	6650	1728	1501 (87)	172 (10)	52 (3)	3 (0.2)
C	5850 (117)	5850	1394	1203 (86)	157 (11)	30 (2)	4 (0.3)
D	4150 (83)	4150	914	691 (76)	123 (13)	98 (11)	2 (0.2)
E	750 (15)	750	174	92 (53)	15 (9)	67 (39)	0 (0)
<b>TOTAL</b>	<b>22,000 (440)</b>	<b>22000</b>	<b>5113</b>	<b>4221</b>	<b>585</b>	<b>297</b>	<b>10</b>

**Table 9** Disturbance transect results for average timber counts per hectare (percentages of all timber sampled per hectare in brackets).

Transect Line	Transect Length (m) (no. of 50m sections)	Number of timber sampled per ha	Number of LT per ha	Number of NFT per ha	Number of OCT per ha	Number of NCT per ha
A	4600 (92)	196 (100)	160 (82)	26 (13)	11 (6)	0.22 (0.1)
B	6650 (133)	260 (100)	226 (87)	26 (10)	8 (3)	0 (0)
C	5850 (117)	238 (100)	206 (87)	27 (11)	5 (2)	1 (0.4)
D	4150 (83)	220 (100)	167 (76)	30 (14)	24 (11)	0 (0)
E	750 (15)	232 (100)	123 (53)	20 (9)	89 (38)	0 (0)
<b>MEAN</b> (Std. Dev.)			<b>176.4</b> <b>(40.5)</b>	<b>25.8</b> <b>(3.6)</b>	<b>27.4</b> <b>(35.2)</b>	<b>0.2</b> <b>(0.4)</b>



**Figure 9** Mean total number of live, naturally fallen, old cut and new cut timber per hectare throughout Kazimzumbwi FR with standard error bars.



**Figure 10** Total number of live, old cut and new cut timber per hectare for each transect line.

#### 5.4.4 OTHER FORMS OF DISTURBANCE

The most common form of disturbance other than pole and timber extraction throughout Kazimzumbwi FR was the presence of footpaths; present in 18% of all 50m sample sections (Table 10). Other commonly seen forms of disturbance included evidence of charcoal burning (ranked 2), piles of timber, planks or poles and trapping (jointly ranked 3). No evidence of cattle grazing or fresh settlement was seen during the survey.

**Table 10** Incidences of various types of disturbance shown as a tally (of a total of 440 50m transect sections) a percentage, and a rank.

	Footpath	Charcoal	Timber/ planks /poles	Trapping	Fire	Clearing	Cultivation	Pitsaw	Grazing
Tally	80	43	30	30	19	12	5	1	0
Percentage (%)	18.3	9.9	6.9	6.9	4.4	2.8	1.1	0.2	0
<b>Rank</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>

#### 5.4.5 DISTURBANCE HOTSPOTS

Figures 10 to 16 summarise the specific locations of disturbance within the forest reserve. 'Hotspots of disturbance' have been identified and are classified as areas within the forest reserve with more than a 30% incidence of a single disturbance type per transect section (a transect section is made up of seventeen 50m sections running between each vegetation plot). Hotspots are summarised in Table 11.

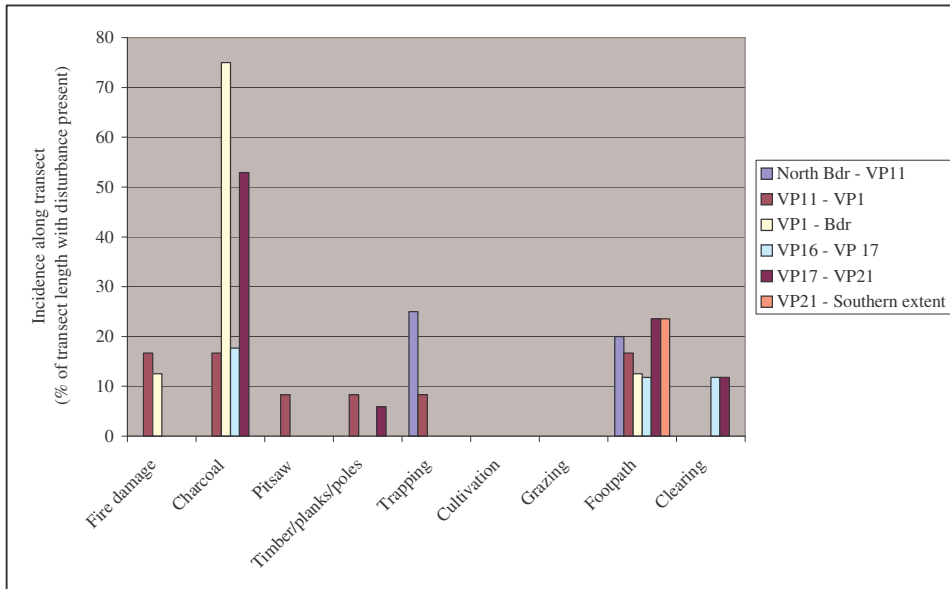
At the time of study, northern border areas of the forest reserve were recovering from past fire disturbance and suffering from charcoal exploitation, timber/plank/pole extraction and duiker

trapping. Clearings were found mainly in the southern part of the survey area (Figures 11, 12, 13, 14 and 15).

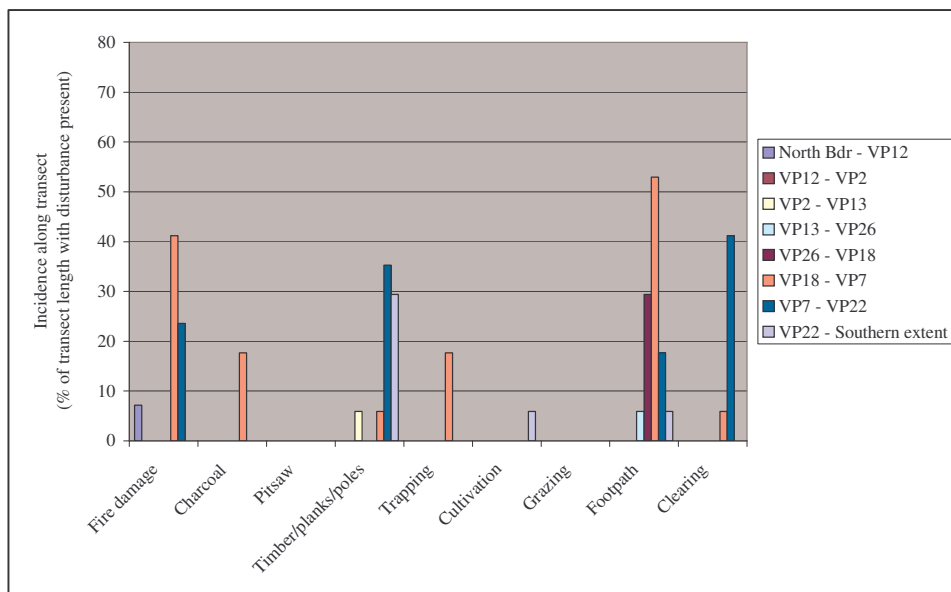
Transect D is under the most cumulative pressure (Table 11 and Figure 14). The hottest hotspots were between Vegetation Plot (VP) 3 and VP14 where significant evidence of duiker trapping was observed, between VP1 and the border near to the railway where charcoal burning was particularly evident, and northern border of transect E in the east where many footpaths were observed (refer to Figure 5 for transect section locations).

**Table 11** Summary of disturbance hotspots within Kazimzumbwi Forest Reserve (refer to Figure 6 for transect section locations). Percentages greater than 50% are given in bold.

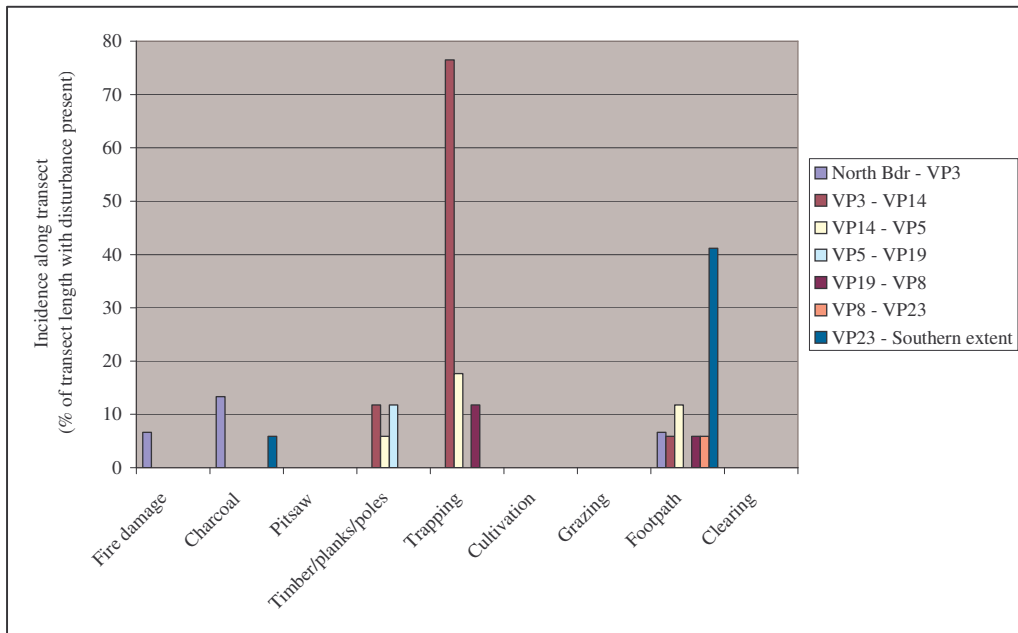
Transect	Transect Section	Disturbance type	Incidence as a percentage of transect section (%)
A	VP1 – Bdr	Charcoal	<b>75</b>
	VP17 – VP 21	Charcoal	<b>53</b>
B	VP18 – VP 7	Footpath	<b>53</b>
	VP 18 – VP 7	Fire	41
	VP 7 – VP 22	Clearing	41
	VP7 – VP22	Timber/planks/poles	35
C	VP 3 – VP 14	Trapping	<b>76</b>
	VP 23 – Southern extent	Footpath	41
D	VP 6 – VP 20	Footpath	41
	VP15 – VP 6	Trapping	35
	VP 6 – VP 20	Timber/planks/poles	35
	VP 20 – VP 9	Charcoal	35
	North Bdr – VP 15	Timber/planks/poles	33
	North Bdr – VP 15	Charcoal	33
E	North Bdr	Footpath	<b>73</b>



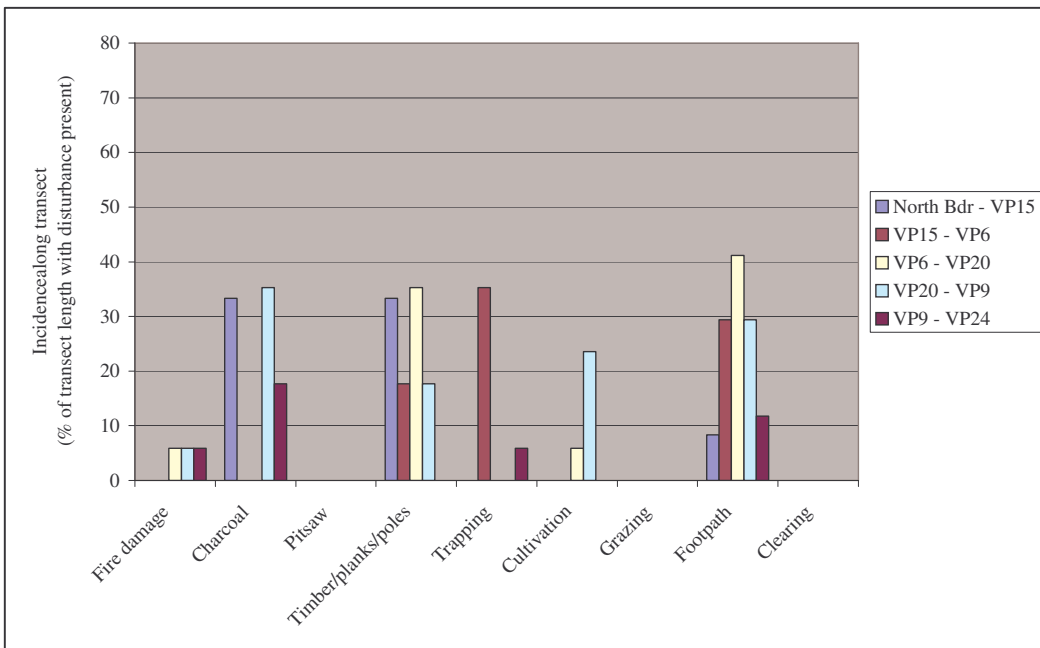
**Figure 11** Specific locations along Transect A of forms of disturbance other than pole and timber cutting (where VP stands for vegetation plot and Bdr, Forest Reserve Border).



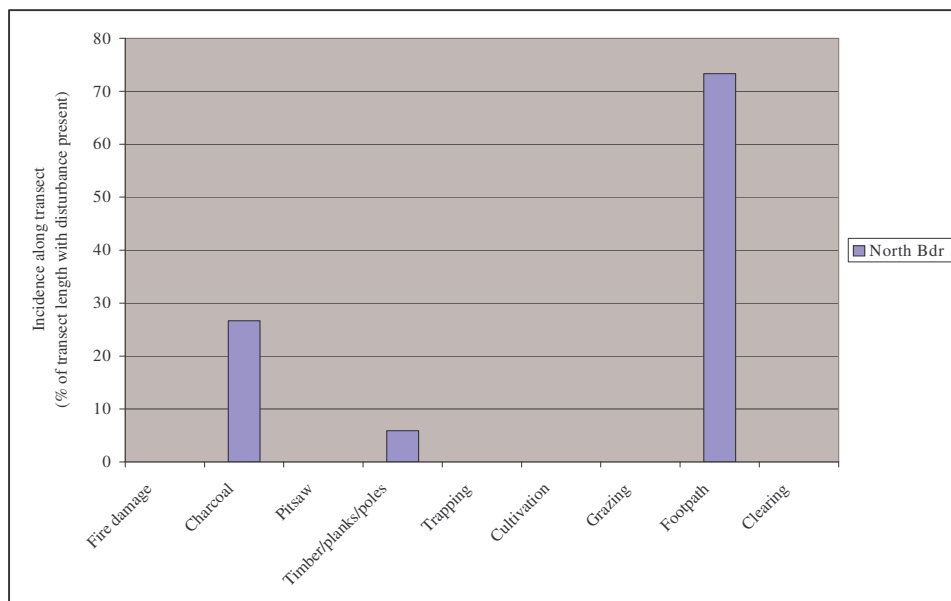
**Figure 12** Specific locations along Transect B of forms of disturbance other than pole and timber cutting.



**Figure 13** Specific locations along Transect C of forms of disturbance other than pole and timber cutting.



**Figure 14** Specific locations along Transect D of forms of disturbance other than pole and timber cutting.



**Figure 15** Specific locations along Transect E of forms of disturbance other than pole and timber cutting.

#### 5.4.6 CHARCOAL PRODUCTION

Areas near to the reserve borders (particularly in the north-west and north-east) would appear to have suffered most heavily from charcoal production, although no activities were taking place during the survey period (probably a seasonal pattern).

#### 5.4.7 ANIMAL TRAPPING

A significant number of traps were seen in the northern part of the reserve, north of the railway. Most traps were snares for small antelope such as suni (*Neotragus moschatus*) and duiker (*Cephalophus* sp.). Traps were deliberately placed in low canopy habitats with a high density of vines. Animal trapping between VP3 and VP14 was intense.

#### 5.4.8 PITSAWING

Although little pitsaw activity was seen along transect lines, fresh pitsaw platforms were seen in Kazimzumbwi FR during other survey work. Pitsawyers were heard on a daily basis in southern parts of the survey area. The main access route for pitsawyers seemed to be the Buyuni to Vigama/Kazimzumbwi village footpath that passes through the middle of the forest reserve. Large areas of forest between transect E and D and near to Trapsite 7 (see Figure 16) have been destroyed by recent harvesting activities.

#### 5.4.9 FIRE

No recent fires were seen, probably because the study was conducted soon after the long rainy season. However, past fire damaged areas were seen on northern borders of the reserve. Fire has altered the structure of the forest significantly in these areas and secondary grassland and woodland habitats now exist.

#### 5.4.10 PAST CULTIVATION AND SETTLEMENT

Past cultivation and evidence of settlement was common in the south-east and western parts of the study area. No current activities were witnessed.

### 5.5 DISCUSSION

Kazimzumbwi FR is still under significant pressure from local communities, although extraction levels are thought to have decreased in recent time (*pers comm* N. Kinyau, WCST). Relations between Government and communities are still poor, although improving slowly, thanks to work carried out by WCST. Threats from population influxes in the east, as a consequence of resettlement schemes, significantly increase pressures on the forest reserve and complicate the work of WCST.

#### 5.5.1 POLE AND TIMBER EXTRACTION

Pole and timber extraction in Kazimzumbwi FR, when compared to other forest areas previously studied by Frontier-Tanzania (1993-1997), show similar patterns. Compared to other Coastal Forests, Kazimzumbwi FR has a low mean percentage of live poles, although similar proportional densities to Manga Forest Reserve in the East Usambara mountains (Table 12). The proportions of live timber in Kazimzumbwi FR were similar to that of Genda Genda in northern Tanzania, whilst cut pole and timber figures were average. The proportion of stems falling naturally was similar to that in Manga FR, although greater than all other Coastal Forest sites reported here.

**Table 12** Mean percentages of natural and man made disturbance of four Coastal Forest sites and Manga Forest Reserve (East Usambara mountains). Refer also to Burgess et al. 2000 pp. 282).

	Live poles (%)	Live timber (%)	Cut poles (%)	Cut timber (%)	Total natural falls (%)
Kazimzumbwi Forest Reserve (2001)	59	19	9	1.4	12
Genda Genda (northern Tanzania) (1993) *	64.5	17.5	14.6	0.3	4.3
Litipo (southern Tanzania) (1994) *	82.3	7	7	1.6	2.3
Kimboza (lowland Ulugurus) (1994) *	78	7.2	12	0.3	2
Manga Forest Reserve (lowland forest East Usambara) (1997)	58	26	2	1	14

\* NB. In these asterisked forests, poles were classified as <10cm dbh, timber  $\geq$  10cm dbh, in others poles were classified as 5-15cm dbh and timber  $\geq$  15cm dbh

Although Kazimzumbwi FR shows similar proportional stem densities to that of Manga FR, a comparison of the highest extraction rates per hectare for timber and poles show Kazimzumbwi FR to be under much greater pressure (Table 13). The maximum extraction rate of poles per sample section in Kazimzumbwi FR was more than four times greater than that of Manga FR.

**Table 13** Greatest mean extraction rates of poles and timber per hectare in Kazimzumbwi and Manga Forest Reserves.

Forest Reserve (study date)	Greatest mean extraction rate of poles along transect section (between vegetation plots) per hectare	Greatest mean extraction rate of timber along transect section (between vegetation plots) per hectare
Kazimzumbwi FR (2001)	383	89
Manga FR (1997)	80	60

### 5.5.2 EFFECTS OF ACCESS ON DISTURBANCE

It is likely that the main factor affecting disturbance in Kazimzumbwi FR is access. A complicated network of footpaths exists within the reserve. The main routeways include border paths, the railway that accesses northern parts of the reserve, and the large footpath that transects the central parts of the reserve running from Buyuni village in the east to Vigama and Kazimzumbwi villages in the west.

Most timber extraction and pitsawing activities were seen around the Buyuni to Vigama/Kazimzumbwi footpath, particularly in the east (Buyuni side). Kazimzumbwi FR forest guards are based in Kisarawe offices, which are a particularly long way from this eastern part (Buyuni side) of the forest reserve. Current timber extraction and pitsaw activities around this footpath are severely degrading forest structure. This extraction is unsustainable particularly as few large trees remain.

Charcoal is still being extracted from Kazimzumbwi FR particularly near to borders where extraction is easy. With increasing population pressures in the area, concern lies for the future of the small patches of remaining forest.

Trapping of small antelope north of the railway is unsustainable at present intensities, action is required before populations of these mammals are decimated. It was previously thought that Black and White Colobus monkeys had been hunted out of Kazimzumbwi FR. Although none were seen during the survey, they were heard. It is likely that small fragmented and possibly isolated populations still exist which are still seriously under threat.

New settlement was not at present seen as a threat in any of the areas surveyed.

### 5.5.2 EFFECTS OF HABITAT ON DISTURBANCE

Kazimzumbwi FR comprises a patchwork of different types of secondary vegetation, which were formed as a consequence of past disturbance. The concentrations of present disturbance types are highly related to habitat.

Ridge tops in areas of closed dry forest have suffered from timber extraction and both old and recent pitsaws were found. Closed dry forest on steeper slopes appeared to be less disturbed by human activity due to its more inaccessible nature. This is also true of the Riverine and Swamp

forest areas within the reserve. Scrub forest exists on plateau areas and indicates past clearance of the area (most probably for cultivation and settlement). These areas are currently under pressure from animal traps set mostly for small antelope. *Brachystegia* forest and Grassland areas also indicate past clearance (again for cultivation and settlement) and both show evidence of past charcoal production and are currently affected by the presence of human footpaths. *Brachystegia* forest also suffers from timber extraction, with recent pitsaws being found. Grassland areas show signs of fire damage.

### 5.5.3 PRIORITIES FOR MANAGEMENT

Heavy disturbance has resulted in the introduction of secondary vegetation into remaining forest. This has not only diminished the biological value of the forest, but has introduced the risk of fires and further damage. Protection from fire and further exploitation may, however, allow the re-growth of forest e.g. woodland giving way to young forest regrowth. Degraded forest and subsequent thickets often preserve components of previous forest communities (Sheil, 1992). Such habitats were found in Kazimzumbwi FR, which therefore needs to be protected.

If community use of the forest is presently impossible to effectively control with the resources available, 'acceptable levels' of extraction or forest decline have to be set and local communities encouraged to manage the forest for themselves.

Action is required to decrease intensities of extraction in disturbance hotspots to prevent complete depletion of resources. Two forest guards were trained in biodiversity survey techniques during the present survey. More training is required and a cheap yet effective monitoring system designed to monitor changes in resource use in the field.

Continued efforts to work with local communities to manage their own forest resources are required and more intensive efforts needed to develop resource alternatives outside the forest.

Additional surveys are also required in order to assess biodiversity and conservation issues in the south and south-west of Kazimzumbwi FR. Agricultural encroachment is particularly evident in this area of the reserve (Clarke & Dickinson 1995) and therefore possibly also other forms of human disturbance are too.

## 6. FAUNAL DIVERSITY OF KAZIMZUMBWI FOREST RESERVE

*By: Staddon, S., Hall, S.M. and Murphy, A.*

### 6.1 INTRODUCTION

Coastal Forests, along with other forested areas of Africa, harbour an extremely rich fauna. Affinities between Coastal Forest and Guineo-Congolian forests tend to be limited, with Coastal Forests presenting a distinct fauna, more closely related to that of Eastern Arc forests (Burgess and Clarke 2000, and references therein). As a result of their small size and the fact that they are surrounded by open habitats, Coastal Forests tend to have a low number of forest dependent species. There are exceptions however; the great majority of molluscs are restricted to remnant forest patches of the Coastal Forests and Eastern Arc (Lange & Meena 2000). Endemism within Coastal Forests is extremely high, especially considering the small area involved. The number of endemic reptile species per km<sup>2</sup> in Coastal Forests is for example  $8.0 \times 10^{-3}$ , whilst in Eastern Arc forests is  $5.5 \times 10^{-3}$  and in Guineo-Congolian forests is  $0.9 \times 10^{-4}$  (Broadley & Howell 2000). Endemism within Coastal Forest millipede and mollusc fauna may for example be as high as 50% and 79% respectively (Hoffman 2000, Verdcourt 2000). Coastal Forests are considered the most important site in the world for both endemic and near-endemic elephant shrews (Nicoll & Rathbun 1990 in Burgess *et al.* 2000). Many endemic species are considered to be relicts of formerly more widespread species, currently restricted to small forest patches of the Coastal Forest mosaic.

With the exception of birds, few animal groups in Coastal Forests have been well documented (Mlingwa *et al.* 2000). Past research on Tanzanian mammals has concentrated on larger mammals of the open plains, whilst little is known of the bats, shrews, galagos, and nocturnal animals of Coastal Forests (Burgess *et al.* 2000). Records of both reptiles and amphibians tend to be greater for Eastern Arc forests than Coastal Forests and virtually nothing was known about the millipedes of Coastal Forests until Frontier-Tanzania started work in these forest in 1989 (Hoffman 2000). Taxonomic uncertainties and constant revisions hamper a clear knowledge of nearly all groups, with many Coastal Forest species, including five shrews and 190 millipedes, still undescribed.

### 6.2 AIMS

The aim of this study was to survey key faunal groups within Kazimzumbwi FR in order that they may be assessed in terms of species richness, diversity, forest dependence, endemic status and conservation concern. Target groups comprised mammals, reptiles, amphibians, butterflies, molluscs and millipedes. These groups were chosen for a combination of their relative ease of capture, ease of identification and the information they offer on ecological preferences and endemism.

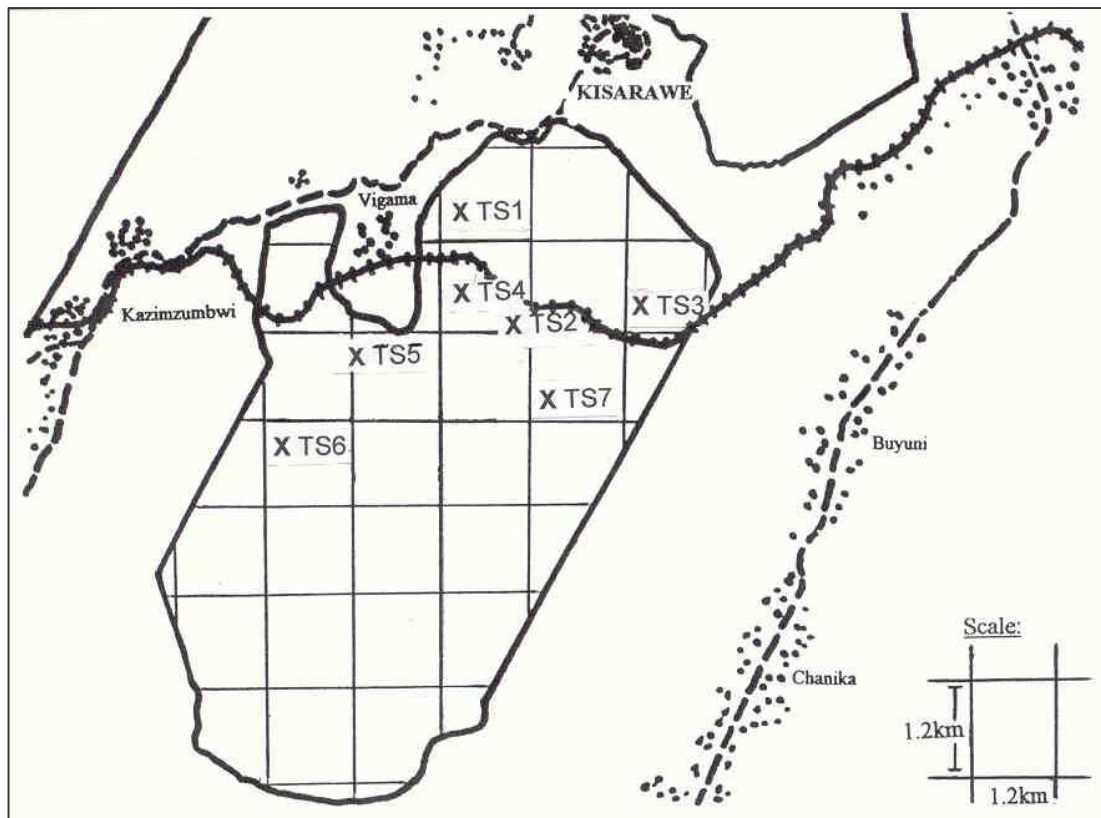


Figure 16. Location of zoological trappingsites (TS) in Kazimzumbwi FR.

## 6.3 METHODS

The target groups of fauna within Kazimzumbwi FR were surveyed using a combination of standardised, repeatable methods at 'zoological trappingsites', surveys of dung and other animal signs along specific transects and opportunistic collection and observation on a casual basis. For detailed research aims, objectives and methods see *Methodology Report* (SEE 1998).

### 6.3.1 ZOOLOGICAL TRAP SITES.

Seven trappingsites were established in habitats representative of those found within the reserve. All but one trappingsite were of 8 night duration. At each trappingsite the following methods were employed:

#### Bucket pitfall traps

Small mammals and ground-dwelling amphibians and reptiles were sampled using three linear transects, each consisting of buckets and a 'drift fence'. Eleven 20 litre plastic buckets were placed 5m apart and sunk flush to the ground to form each line. A piece of plastic sheeting approximately 0.5m high was erected perpendicular to the bucket line to act as the drift fence, channelling animals moving into the area from either side towards the buckets. Each line was placed no more than 50m apart but was located in order to encompass as great a diversity of micro-habitats as possible. Detailed habitat notes were taken for each pitfall trap. Traps were checked early each morning for the duration of the trappingsite and data recorded on standardised data sheets regarding the identification of each animal captured.

**Sherman traps**

Small rodents and insectivores were sampled using 100 Sherman traps (standard size) baited with varying combinations of fried coconut and peanut butter and small fish (*dagaa*). Traps were placed at least 2m apart forming wide loops around the bucket pitfall trap lines; 33 around two of the lines and 34 around the other. Traps were baited each evening for the duration of the trapsite and checked early the next morning. Traps were closed during the day. Data were recorded on standardised data sheets regarding the identification, sex, breeding status, weight and biometrics of each animal captured. In order to identify 'recaptures', released animals were given an individual mark code made by trimming small patches of fur in a given pattern. Detailed habitat notes were taken for each trap.

**Mist-netting**

Bats were sampled using varying combinations and configurations of mistnets (1 x 3m, 2 x 7m, 1 x 9m). Nets were placed across predicted 'flight corridors' such as rivers and paths, with the top of the net at a maximum height of 3m. Nets were opened at dusk and checked every 15 minutes for at least 3 hours each night that they were in use. Data were recorded on standardised data sheets regarding the identification, sex, breeding status, weight and biometrics of each bat captured. Detailed habitat notes were taken for each mist-netting location and the number of net-metre hours calculated (this varied between trapsites).

**Butterfly sweep-netting**

Low-flying butterflies were sampled using hand-held sweep-nets. Two man-hours were spent netting along the bucket pitfall lines each day for the duration of the trapsite.

**Butterfly canopy traps**

Butterflies were sampled using six canopy traps placed at varying heights within the canopy; two associated with each of the bucket pitfall trap lines. Traps were baited with fermenting banana and checked late afternoon each day for the duration of the trapsite. Data were recorded on the identification of all species collected and detailed habitat notes taken for each trap, including its height within the canopy.

**Mollusc plots**

Molluscs were sampled in three 1m x 1m quadrats per trapsite; one established near each of the bucket pitfall trap lines and located in order to encompass a range of microhabitats. Two man-hours were spent searching the leaf litter and first 3cm of soil within each quadrat. All molluscs encountered were collected.

**Millipede plots**

Millipedes were sampled in three 3m x 3m quadrats per trapsite; again, one established near each of the bucket pitfall trap lines and located in order to encompass a range of microhabitats. Four man-hours were spent searching the leaf litter and first 3cm of soil within each quadrat. All millipedes encountered were collected.

**6.3.2 DUNG AND SIGN SURVEYS**

More cryptic animals were surveyed along five transects of varying length (these transects were also used to investigate forest use and human impact, see Figure 5). The transects ran north-east to south-west through the reserve. Either side of the central transect line a 2m wide strip was searched for any animal dung, tracks, paths, burrows, diggings, feathers or other signs. All signs of animals were recorded and habitat notes were taken for each 50m stretch of transect.

### 6.3.3 OPPORTUNISTIC COLLECTION AND OBSERVATIONS

All taxa were collected and observed on a casual basis throughout the survey period. Opportunistic collections of amphibians and reptiles and observations and vocalisations of larger mammals were expected to be particularly useful in revealing the presence of species not encountered in the standardised trapsite techniques and dung and sign surveys.

### 6.3.4 IDENTIFICATION

In order to verify the identification of species recorded a number of measures were taken. Wherever possible, two specimens (one male, one female) of each species recorded were taken and sent to a variety of experts for taxonomic verification (Appendix 2.). Specimens were also taken of anything that could not be confidently identified in the field or cross-referenced to a specimen already taken. Detailed habitat notes of capture locations accompanied all specimens in order to aid identification. Where indirect evidence was being used (for instance in the dung and sign survey) identifications were based on discussion with trained gameguards/forest guards, a reference dung collection and by using Walker (1988).

## 6.4 RESULTS

Fieldwork was carried out over a 12 week period between 26 May 2000 and 5 September 2000. A total of 52 nights of trapping were accrued from all seven trapsites (Table 14), during which time 4796 Sherman trap-nights, 1749 bucket pitfall trap-nights and 2286 net metre-hours were completed. The trapsites were spread across the reserve (Figure 16) and encompassed a variety of habitats. Sites varied little in altitude but steep slopes tended to be associated with Mixed dry Coastal Forest whilst gentle slopes were associated with woodland and grasslands. Only some trapsites were associated with water sources.

**Table 14** Summary descriptions of trapsites in Kazimzumbwi FR.

Trap site	Duration	Location	Altitude (m asl)	Vegetation type	Topography	Water association (& distance)
1	4 nights	S 06° 55' 56.3" E 039° 03' 12.4"	200	Mixed dry Coastal Forest	Gentle mid-slope	None
2	8 nights	S 06° 56' 40.4" E 039° 03' 43.2"	140 - 180	Mixed dry Coastal Forest & Riverine forest (near railway)	Steep lower- & mid-slope & gentle upper-slope	Stream (5-50m)
3	8 nights	S 06° 58' 33.1" E 038° 04' 21.7"	240	Mixed dry Coastal Forest (near railway)	Gentle mid-slope	None
4	8 nights	S 06° 56' 53.5" E 038° 52' 39.9"	200 - 230	Mixed dry Coastal Forest & Swamp forest	Steep lower- & mid-slope & hilltop	River (0-50m)
5	8 nights	S 06°56'47.6" E 039°02'30.0"	180	Wooded Grassland	Gentle lower-slope	Swamp (0-50m)
6	8 nights	S 06°57'36. 8" E 039°02'05.7"	170	<i>Brachystegia</i> Forest	Gentle lower-slope	Dry river (0-50m)
7	8 nights	S 06°57'19.5" E 039°03'43.2"	220	Mixed dry Coastal Forest (highly disturbed by pitsawing)	Gentle upper- slope	None

### 6.4.1 MAMMALS

The mammal species recorded in Kazimzumbwi FR represent 18 families, 28 genera and 32 species (Table 15 and 16). Identifications of small mammals and bats recorded from trapping activities remain tentative whilst awaiting taxonomic verifications (see Appendix 2). Identifications of species recorded from observational or indirect data sources are considered certain.

**Table 15** Summary of mammal diversity recorded in Kazimzumbwi FR.

Order	Number of		
	Families	Genera	species
Primates	3	4	5
Bats	3	3	3
Insectivores	1	1	1
Elephant shrews	1	2	2
Hares	1	1	1
Rodents	4	10	12
Carnivores	2	3	3
Scaly ant-eater	1	1	1
Ungulates (even-toed)	2	3	5
Totals	18	28	32

**Table 16** Mammal species recorded in Kazimzumbwi FR. (Ecological type, endemic status, conservation status and 'new records' are compiled from the National Biodiversity Database (UDSM 1997), Kingdon (1989) and Burgess and Clarke (2000) and lists given in Appendix 4 and IUCN (1996). These are not given for species identified to genera only).

Species	Common name (local name)	Ecol. type	End. status	IUCN status (CITES)	Evidence			
					Trap	Direct obs.	Dung	Track Other
<b>Primates - Primates</b>								
COLOBIDAE								
<i>Colobus</i> sp.	Colobus	-	-					heard
CERCOPITHECIDAE								
<i>Papio cynocephalus</i> *	Yellow baboon (Nyani)	f	W	(II)	x		x	path
<i>Cercopithecus mitis</i>	Blue monkey (Kima)	f	W	(II)	x	x		
GALAGONIDAE								
<i>Galagoides zanzibaricus</i>	Zanzibar galago	F	N(b)	LR nt (II)	x			heard
<b>Bats – Chiroptera</b>								
NYCTERIDAE								
<i>Nycteris</i> sp.	Slit-faced bat	-	-		x			
HIPPOSIDERIDAE								
<i>Hipposideros ruber</i>	Leaf-nosed bat	f	W		x			
RHINOLOPHIDAE								
<i>Rhinolophus simulator</i> **	Horseshoe bat	F	W		x			
<b>Insectivores – Insectivora</b>								
SORICIDAE								
<i>Crociodura</i> sp.	White-toothed shrew	-	-		x			

Table 16 Continued.

Elephant shrews - Macroscelidea							
MACROSCELIDAE							
<i>Rhynchocyon petersi</i>	Zanj elephant shrew (Ndovu/Ndole)	F	N(b)	EN		x	path
<i>Petrodromus tetradactylus</i>	Four-toed elephant shrew (Sengi)	f	W			x	
<b>Hares – Lagomorpha</b>							
LEPORIDAE							
<i>Lepus saxatalis</i> **	Scrub hare	O	W			x	
<b>Rodents – Rodentia</b>							
THRYONOMYDAE							
<i>Thryonomys</i> cf. <i>swinderianus</i>	Marsh cane-rat	f	W			x	x
CRICETOMYDAE							
<i>Cricetomys</i> cf. <i>gambianus</i> *	Greater pouched rat (Panya buku)	f	W				burrow
<i>Beamys hindei</i> *	Lesser pouched rat	F	N(c)	VU		x	
DENDROMURINAE							
<i>Dendromys</i> sp.	Climbing mouse	-	-			x	
MURIDAE							
<i>Acomys</i> sp.	Spiny mouse	-	-			x	
<i>Grammomys</i> sp. A	Narrow-footed woodland mouse	-	-			x	
<i>Grammomys</i> sp. B	Narrow-footed woodland mouse	-	-			x	
<i>Lemniscomys</i> sp.	Zebra mouse	-	-			x	
<i>Mastomys natalensis</i> *	Multimammate rat	f	W			x	
<i>Mastomys</i> sp.	Multimammate rat	-	-			x	
<i>Mus</i> sp.	Common mouse	-	-			x	
<i>Rattus rattus</i>	Black rat	O	W			x	
<b>Carnivores – Carnivora</b>							
HERPESTIDAE							
<i>Mungos</i> sp.	Mongoose (Mwchiro)	-	-			x	x
VIVERRIDAE							
<i>Genetta genetta</i>	Common genet	O	W			x	
<i>Nandinia binotata</i>	African palm civet	f	W			x	
<b>Scaly ant-eaters - Pholidota</b>							
ORYCTEROPODIDAE							
<i>Orycteropus afer</i> *	Aardvark (Muhanga)	f	W				burrow
<b>Even-toed ungulates - Artiodactyla</b>							
SUIDAE							
<i>Potamochoerus larvatus</i>	Bush pig (Nguruwe)	f	W			x	x
BOVIDAE							
<i>Cephalophus adersi</i> *	Aders' duiker (Mbala)	F	N(a)	EN		x	x
(IDENTIFICATION UNSURE)							
<i>Cephalophus monticola</i> *	Blue duiker (Ndimba)	F	W	(II)		x	x
<i>Cephalophus natalensis</i>	Natal duiker (Digi-digi)	F	W	LR cd		x	x
<i>Neotragus moschatus</i> *	Suni (Nokera)	f	W			x	x
path							

**KEY TO ABBREVIATIONS IN ZOOLOGICAL TABLES****NEW RECORDS**

\* Species not previously recorded in Kazimzumbwi FR

\*\* Species not previously recorded in Coastal Forests

**ECOLOGICAL (ECOL.) TYPE**

F - Forest dependent species (primary forest only, not including forest edge or secondary forest)

f - Forest dwelling but not forest dependent species

O - Non-forest species

**ENDEMIC (END.) STATUS**

E - Endemic species (occurring only in the Pugu Hills)

N - Near endemic species (a - range limited to Coastal Forests, b - range limited to Coastal Forests and the Eastern Arc Mountains, c - range limited to Coastal Forests, the Eastern Arc Mountains and a few other East African forests)

W - Widespread distribution species

**IUCN STATUS (1996)**

EN - Endangered, VU - Vulnerable, LR - Lower Risk (cd - Conservation Dependent, nt - Near Threatened)

(CITES classification is given as the Appendix in which the species appears)

Nine species listed in Table 16 have not previously been recorded in Kazimzumbwi FR; mainly antelope (including the near-endemic *Cephalophus adersi*) and Cricetomyidae (including the near-endemic *Beamys hindei*). Two of these species also represent new records for Coastal Forests (in general). One species; *Lepus saxatalis*, is a non-forest species however and it may be for this reason that it has not been listed in previous Coastal Forest mammal fauna.

Of the 32 mammal species recorded in Kazimzumbwi FR, 7 (22%) are forest dependent, 11 (34%) forest dwelling and 3 (9%) non-forest species (Table 17). The greatest forest dependency is within the ungulates, notably *Cephalophus* species. There are no mammal species endemic to the Pugu Hills, although 4 species recorded (13%) are near-endemics. One has a range restricted to Coastal Forests alone, two have ranges restricted to Coastal Forests and Eastern Arc Mountains and one has a range of Coastal Forests, Eastern Arc Mountains and a few other East African forests (Table 17 and 18). The majority of species recorded (17 or 53%) have wide distributions. Three species were recorded which are listed as Threatened (Endangered or Vulnerable) by the IUCN and two that are listed as at Lower Risk. Four species were recorded which appear in CITES Appendix II.

**Table 17** Summary of ecological type and endemic status of mammal species recorded in Kazimzumbwi FR. (For abbreviations see key following Table 16).

Taxon	Ecological type				Endemic status			
	F	f	O	Unknown	E	N	W	Unknown
Primates	1	2	0	1	0	1	2	1
Bats	1	1	0	1	0	0	2	1
Insectivores	0	0	0	1	0	0	0	1
Elephant shrews	1	1	0	0	0	1	1	0
Hares	0	0	1	0	0	0	1	0
Rodents	1	3	1	7	0	1	4	7
Carnivores	0	1	1	1	0	0	2	1
Scaly ant-eater	0	1	2	0	0	0	1	0
Ungulates	3	2	0	0	0	1	4	0
Totals	7	11	3	11	0	4	17	11

**Table 18** Ranges of near-endemic mammal species recorded in Kazimzumbwi FR . (Taken from National Biodiversity Database (UDSM 1997)).

<b>Species</b>	<b>Range</b>
GALAGONIDAE	
<i>Galagoides zanzibaricus</i>	Coastal Forests in southern Kenya, northern Tanzania and Zanzibar (Kingdon 1997)
MACROSCOLIDIDAE	
<i>Rhynchocyon petersi</i>	NE and E Tanzania, also Zanzibar and Mafia, SE Kenya
CRICETOMYDAE	
<i>Beamys hindei</i>	Coastal forests in NE and E Tanzania, also SE Kenya
BOVIDAE	
<i>Cephalophus adersi</i>	Zanzibar, also Sokoke Forest in Kenya

#### 6.4.1.1 Bats and small mammals

Different groups of mammals were sampled using different techniques and as bats and small mammals were surveyed systematically within trapsites (for which detailed habitat records were made, see Table 14 for a summary), additional information can be gained concerning their distribution and ecology.

Records of 6 bats, 9 shrews and 60 rodents were collected through the use of mistnets, Sherman traps and bucket pitfall traps (Table 19).

**Table 19** Small mammal species captured at trapsites in Kazimzumbwi FR.

Species	Common name	Number recorded at each trapsite							Total	
		1	2	3	4	5	6	7		
<b>BATS</b>										
<b>NYCTERIDAE</b>										
<i>Nycteris sp.</i>	Slit-faced bat				4					4
<b>HIPPOSIDERIDAE</b>										
<i>Hipposideros ruber</i>	Leaf-nosed bat				1					1
<b>RHINOLOPHIDAE</b>										
<i>Rhinolophus simulator</i>	Horseshoe bat					1				1
	Totals	0	0	0	5	1	0	0		6
<b>SHREWS</b>										
<b>SORICIDAE</b>										
<i>Crocidura sp.</i>	White-toothed shrew					2	2	5		9
	Totals	0	0	0	0	2	2	5		9
<b>RODENTS</b>										
<b>CRICETOMINAE</b>										
<i>Beamys hindei</i>	Lesser pouched rat	3			2					5
<b>DENDROMURINAE</b>										
<i>Dendromys sp.</i>	Climbing mouse					2	1	1		4
<b>MURIDAE</b>										
<i>Acomys sp.</i>	Spiny mouse							19		19
<i>Grammomys sp. A</i>	Narrow-footed woodland mouse		1					1		2
<i>Grammomys sp. B</i>	Narrow-footed woodland mouse				9					9
<i>Lemniscomys sp.</i>	Zebra mouse					1				1
<i>Mastomys natalensis</i>	Multimammate rat				1					1
<i>Mastomys sp.</i>	Multimammate rat					14		2		16
<i>Mus sp.</i>	Common mouse					2				2
<i>Rattus rattus</i>	Black rat		1							1
	Totals	3	2	0	12	19	21	3		60

The majority of bats were captured at trapsite 4, where mistnets were set up over the River Mzumbwi. Four of the six records were of only one species; *Nycteris sp.*, although mistnetting was carried out over a number of consecutive nights and the number of recaptures is unknown but may bias the results.

Shrews were recorded in half of the trapsites, within Wooded Grassland, *Brachystegia* Forest and Mixed dry Coastal Forest. Over half of the individuals recorded were captured at only one trapsite; trapsite 7.

A high number, at least 12 species, of rodent were recorded; a number which may increase further on receipt of the formal identification of specimens taken. Rodents were recorded in almost all of the habitats surveyed. *Acomys sp.* was the most abundant rodent, although all records were in one trapsite only. This trapsite was in *Brachystegia* Forest; a very dry and fairly open habitat. *Mastomys sp.* was also found to be abundant, occurring mainly in Wooded Grassland habitats, where one record of *Lemniscomys sp.* was also made. *Grammomys* were recorded only in forest habitats, as was the near-endemic and forest dependent *Beamys hindei*. One record of *Rattus rattus* was collected, from trapsite 2.

#### 6.4.1.2 Larger mammals

Mammal species other than those bats and small mammals discussed above were detected from opportunistic observations or by using dung and sign surveys. Records are thus from locations and habitats throughout the reserve.

*Colobus* sp. was heard calling on only one occasion and only from within forested areas, whilst *Papio cynocephalus* and *Cercopithecus mitis* were abundant and most evident at the forest edge. Certain forest dependent species were indeed only recorded from forested areas; *Galagoides zanzibaricus*, *Rhynocyon petersi* and *Cephalophus* spp. Elephant shrew paths were widely observed in forested habitats and *Orycteropus afer* burrows were fairly widely distributed in at least partly forested areas. *Cricetomys* cf. *gambianus* burrows were observed on only a few occasions, although are obviously less easy to spot than an aardvark burrow. *Cephalophus natalensis* and *Neotragus moschatus* were the most frequently recorded antelope. *Potamochoerus larvatus* was recorded from all habitats and from the large number of records collected was considered abundant. Evidence of *Mungos* sp. was found throughout the reserve, whilst *Genetta genetta* and *Nandinia binotata* were recorded from only a few observations around the forest edge.

#### 6.4.2 REPTILES

Records of 46 reptiles were made in Kazimzumbwi FR, representing 8 families, 19 genera and 28 species (Table 20). Taxonomic verifications have yet to be received for all specimens and therefore some identifications should be considered tentative.

**Table 20** Reptile species recorded in Kazimzumbwi FR. The identification of species given in bold have been confirmed. (Ecological type, endemic status, conservation status and 'new records' are compiled from National Biodiversity Database (1997), Broadley and Howell (unpubl.), IUCN (1996) and Burgess and Clarke (2000); this is not possible for species identified to genera only).

Species	Common name	Ecol. type	End. status	IUCN status (CITES)	Number recorded at each trapsite							
					1	2	3	4	5	6	7	- Total
VARANIDAE												
<i>Varanus</i> sp.	Monitor lizard	-	-								1	1
VIPERIDAE												
<i>Bitis arietans</i> **	Puff adder	O	W								1	1
<i>Bitis gabonica</i>	Gaboon viper	F	W								1	1
COLUBRIDAE												
<i>Apparalactus capensis</i> **	Cape centipede eater	?	W								1	1
<i>Crotaphopeltis hotamboei</i> **	Herald snake	O	W						1			1
<b><i>Lamphrosia capensis</i>**</b>	<b>Common house snake</b>	f	W								1	1
<i>Lamphrosia fuliginosus</i> **	Brown house snake	O	W								1	1
<i>Lycophidion capense loveridgei</i> *	Loveridge's Wolf snake	F	W								1	1
<i>Lychophidion meleagre</i> **	<b>Speckled Wolf snake</b>	F	W				1					1
<i>Natriciteres olivacea</i> *	<b>Olive Marsh-Snake</b>	f	W								1	1

**Table 20 Continued.**

<i>Philothamnus haplogaster</i>	<b>Southeastern Green snake</b>	f	W					1	1
<i>Philothamnus heterolepidotus</i> **	Slender Green snake	?	W			1			1
<i>Philothamnus</i> sp.	Green snake	-	-					1	1
<i>Prosymna abigua stuhlmanni</i>	East African Shovel-Snout	f	W					1	1
<i>Psammnophis subtaeniatus orientalis</i> **	Stripe-bellied sand snake	?	W					2	2
<i>Thelotornis capensis</i>	Mozambique vine snake	f	W			1		1	2
<b>CHAMAELEONIDAE</b>									
<i>Chamaeleo dilepis</i>	Flap-necked chameleon	f	W	(II)				1	1
<i>Chamaeleo melleri</i>	Giant one-horned chameleon	f	W			1		2	3
<i>Rhampholeon brevicaudatus</i>	<b>Bearded pygmy chameleon</b>	F	N(b)	VU				1	2 3
<b>SCINCIDAE</b>									
<i>Mabuya maculilabris</i>	<b>Speckled-lipped skink</b>	f	W					3	2 5
<i>Sepsina tetradactyla</i> *	<b>Four-toed burrowing skink</b>	?	N(a)					1	1
<b>AGAMIDAE</b>									
<i>Agama montana</i> **	<b>Montane agama</b>	F	N	VU				1	1
<i>Agama</i> sp.	Agama	-	-						1
<b>LACERTIDAE</b>									
<i>Nucras boulengeri</i> **	<b>Boulenger's Scrub-lizard</b>	?	W					7	7
Unidentified sp.		-	-					1	1 2
<b>GEKKONIDAE</b>									
<i>Hemidactylus maboui</i>	<b>Moreau's Tropical house gecko</b>	f	W					2	1 3
<i>Lygodactylus groteti</i> *	<b>Grote's dwarf gecko</b>	?	N(c)						1 1
Unidentified sp.		-	-						1 1
<b>Totals</b>									
<b>0 3 4 5 7 2 4 21 46</b>									

**KEY TO ABBREVIATIONS IN ZOOLOGICAL TABLES****NEW RECORDS**

\* Species not previously recorded in Kazimzumbwi FR

\*\* Species not previously recorded in Coastal Forests

**ECOLOGICAL (ECOL.) TYPE**

F - Forest dependent species (primary forest only, not including forest edge or secondary forest)

f - Forest dwelling but not forest dependent species

O - Non-forest species

**ENDEMIC (END.) STATUS**

E - Endemic species (occurring only in the Pugu Hills)

N - Near endemic species (a - range limited to Coastal Forests, b - range limited to Coastal Forests and the Eastern Arc Mountains, c - range limited to Coastal Forests, the Eastern Arc Mountains and a few other East African forests)

W - Widespread distribution species

**IUCN STATUS (1996)**

EN - Endangered

VU - Vulnerable

LR - Lower Risk (cd - Conservation Dependent, nt - Near Threatened)

(CITES classification is given as the Appendix in which the species appears)

Fourteen species listed have not previously been recorded in Kazimzumbwi FR, including the near-endemic *Sepsina tetradactyla* and *Natriciteres olivaceae*. The latter species has apparently not been found on the coast for 15 years (K.Howell, *pers. comm.*). Ten of these species have not previously been recorded in Coastal Forest, although half of these are non-forest species and it may be for this reason that they have not previously been listed in other Coastal Forest inventories. The record of *Agama montana*, previously recorded only from Eastern Arc Mountains, represents a range extension for the species.

Although more reptiles were captured in trap site 5 than any other these records represent just one species. No reptiles were recorded from trap site 1 but this trap site ran for only half the time of the others (see Table 14). No clear patterns emerge with regard to the diversity or species richness recorded from the different trap sites, and thus different habitats.

Five reptile species (19%) were forest dependent whilst 9 (33%) were forest dwelling. Three species (11%) are non-forest and these were indeed found outside of densely forested areas.

There are no reptiles endemic to the Pugu Hills although four near-endemic species were recorded; one endemic to Coastal Forests alone, one endemic to Coastal Forests and Eastern Arc Mountains and one endemic to Coastal Forest, Eastern Arc Mountains and a few other East African forests (see Table 21). The majority of species (70%) are known to have widespread distributions.

Two species are considered Vulnerable by the IUCN and one species appears on Appendix II of CITES listings.

**Table 21** Ranges of near endemic reptile species recorded in Kazimzumbwi FR. (Taken from National Biodiversity Database (UDSM 1997)).

Species	Range
<b>CHAMAELEONIDAE</b>	
<i>Rhampholeon brevicaudatus</i>	Forests of coastal Tanzania and part of Eastern Arc mountains (Usambara Mountains and Uluguru mountains)
<b>SCINCIDAE</b>	
<i>Sepsina tetradactyla</i>	S.E. Tanzania, Malawi and Zambia
<b>AGAMIDAE</b>	
<i>Agama montana</i>	Usambara, Uluguru and Nguru Mountains
<b>GEKKONIDAE</b>	
<i>Lygodactylus groteti</i>	S.E. Tanzania, Mafia Island and N. Mozambique

### 6.4.3 Amphibians

Records of 801 amphibians were made in Kazimzumbwi FR, representing 8 families, 13 genera and 23 species (Table 22). Taxonomic verifications have been received and thus all identifications are confirmed.

**Table 22** Amphibian species recorded in Kazimzumbwi FR. (Ecological type, endemic status, conservation status and 'new records' are compiled from the National Biodiversity Database (1997), Schiötz (1999), IUCN (1996) and Burgess and Clarke (2000); this is not given for species identified to genus only).

Species	Ecol. type	End. status	IUCN status (CITES)	Number recorded at each trapsite								
				1	2	3	4	5	6	7	-	Total
<b>ARTHROLEPTIDAE</b>												
<i>Arthroleptis stenodactylus</i>	F	W		15	103	13	71	44	15	37	1	<b>298</b>
<i>Arthroleptis xenodactyloides</i> *	F	N(c)		2	14	11	308	10	1	15	4	<b>365</b>
<i>Arthroleptis</i> sp. indet.	-	-			2						1	<b>3</b>
<b>BUFONIDAE</b>												
<i>Bufo gutturalis</i>	O	W						1			1	<b>2</b>
<i>Bufo lindneri</i> *	f	N(c)						11		2		<b>13</b>
<i>Mertensophryne micranotis</i>	F	N(b)						1	1	1	3	<b>6</b>
<b>HYPEROLIDAE</b>												
<i>Leptopelis argenteus</i> *	O	N(c)						1				<b>1</b>
<i>Leptopelis barbouri</i> **	F	N									1	<b>1</b>
<i>Leptopelis flavomaculatus</i>	F	N(c)			1		1	1			1	<b>4</b>
<i>Kassina senegalensis argyreivittus</i> *	O	W						2	1			<b>3</b>
<i>Afrixalus brachynemis</i>	O	W									1	<b>1</b>
<b>MICROHYLIDAE</b>												
<i>Breviceps mossambicus</i>	O	W									1	<b>1</b>
<b>PIPIDAE</b>												
<i>Xenopus muelleri</i> *	f	W									3	<b>3</b>
<b>RANIDAE</b>												
<i>Hemisus marmoratus</i> *	f	W					1	19			1	<b>21</b>
<i>Ptychadena anchietae</i> *	O	W									3	<b>3</b>
<i>Ptychadena mossambica</i>	f	W						1				<b>1</b>
<i>Ptychadena</i> sp. indet.	-	-						1			2	<b>3</b>
<i>Phrynobatrachus acridoides</i>	f	W									1	<b>1</b>
<i>Phrynobatrachus mababiensis</i>	O	W						2	36			<b>38</b>
Unidentified sp.	-	-					30				1	<b>31</b>
<b>RHACOPHORIDAE</b>												
<i>Chiromantis xerampelina</i>	O	W									1	<b>1</b>
<b>CAECILIDAE</b>												
<i>Boulengerula cf. changamwensis</i> *	F	N(c)			1							<b>1</b>
<b>Totals</b>				<b>17</b>	<b>121</b>	<b>24</b>	<b>411</b>	<b>93</b>	<b>54</b>	<b>55</b>	<b>26</b>	<b>801</b>

#### KEY TO ABBREVIATIONS IN ZOOLOGICAL TABLES

##### NEW RECORDS

\* Species not previously recorded in Kazimzumbwi FR

\*\* Species not previously recorded in Coastal Forests

##### ECOLOGICAL (ECOL.) TYPE

F - Forest dependent species (primary forest only, not including forest edge or secondary forest)

f - Forest dwelling but not forest dependent species

O - Non-forest species

##### ENDEMIC (END.) STATUS

E - Endemic species (occurring only in the Pugu Hills)

N - Near endemic species (a - range limited to Coastal Forests, b - range limited to Coastal Forests and the Eastern Arc Mountains, c - range limited to Coastal Forests, the Eastern Arc Mountains and a few other East African forests)

W - Widespread distribution species

**IUCN STATUS**

EN - Endangered

VU - Vulnerable

LR – Lower Risk (cd – Conservation Dependent, nt – Near Threatened)

(CITES classification is given as the Appendix in which the species appears)

Eight species listed have not previously been recorded in Kazimzumbwi FR, including *Leptopelis barbouri* that has not previously been recorded in Coastal Forests (the identification of this species is however the only one not yet confirmed (KMH 23614) and thus this record remains tentative).

The majority of amphibian records were of *Arthroleptis* species, which were recorded throughout the reserve. Few amphibian records were collected at trapsites 1 and 3, which unsurprisingly were not associated with water sources. The caecilian was, as expected, collected near to a water source; the River Mzumbwi.

Six species recorded (26%) were forest dependent, 5 (22%) were forest dwellers and 8 (35%) were non-forest species. The greatest forest dependence was among the Arthroleptidae and some Hyperolidae, with other Hyperolidae and many Ranidae non-forest species.

There are no endemic species to the Pugu Hills although 7 near-endemic species (30%) were recorded (see Table 23). One species was endemic to Coastal Forests and Eastern Arc Mountains and five species were endemic to Coastal Forest, Eastern Arc Mountains and a few other East African forests Twelve species (43%) had widespread distributions.

None of the species recorded were listed as Threatened by IUCN or appear on CITES listings.

**Table 23** Ranges of near-endemic amphibian species recorded in Kazimzumbwi FR. (Taken from National Biodiversity Database (UDSM 1997)).

Species	Range
<b>ARTHROLEPTIDAE</b>	
<i>Arthroleptis xenodactyloides</i>	Forests in Tanzania, Malawi, Mozambique, E. Zambia and E. Zimbabwe
<b>BUFONIDAE</b>	
<i>Bufo lindneri</i>	Dar es Salaam and vicinity, S. Malawi and N. Mozambique
<i>Mertensophryne micranotis</i>	Coastal Forests of Kenya and Tanzania and the East Usambaras
<b>HYPEROLIDAE</b>	
<i>Leptopelis argenteus</i>	E. and S.E. Tanzanian coastal lowlands, possibly N. Mozambique
<i>Leptopelis barbouri</i>	Usambara and Udzungwa Mountains
<i>Leptopelis flavomaculatus</i>	Coastal zone from Kenya to Mozambique, possibly Malawi and E. Zimbabwe
<b>CAECILIDAE</b>	
<i>Boulengerula changamwensis</i>	Coastal Forests of Kenya and Tanzania

#### 6.4.4 BUTTERFLIES

Records of 1115 butterflies were collected in Kazimzumbwi FR, representing 5 families, 53 genera, 140 species and 148 subspecies (Table 24 and 25). All identifications are considered tentative whilst awaiting taxonomic verifications.

**Table 24** Summary of butterfly species recorded in Kazimzumbwi FR.

Family	No. of genera	No. of species	No. of subspecies
Hesperiidae	4	5	5
Lycaenidae	11	20	21
Nymphalidae	27	77	79
Papilionidae	2	5	7
Pieridae	9	33	36
Totals	53	140	148

**Table 25** Butterfly species recorded in Kazimzumbwi FR. (Ecological type, endemic status and 'new records' are compiled from Kielland (1990), Larsen (1996) and Burgess and Clarke (2000); this is not given for species identified to genus only).

Species	Ecol. type	End. status	Species	Ecol. type	End. status
<b>HESPERIIDAE</b>					
<i>Coeliades sejuncta</i> **	F	W	<i>Tagiades flesus</i> *	F	W
<i>Monza cretacea</i> ***	?	W	Unknown sp.	-	-
<i>Spialia despauperata despauperata</i> **	f	W			
<b>LYCAENIDAE</b>					
<i>Anthene</i> sp.	-	-	<i>Ornipholidotos peucetia peucedata</i> *	f	W
<i>Appias epaphia</i>	f	W	<i>Pentila pauli</i> **	f	W
<i>Deudarix dinochares</i>	f	W	<i>Pentila rondo</i> *	F	N
<i>Euchrysops malathana</i> ***	f	W	<i>Pentila rogersi</i> *	F	N
<i>Euchrysops osiris</i> ***	f	W	<i>Pentila tropicalis</i>	F	W
<i>Euchrysops subpallida</i> ***	O	W	<i>Pentila tropicalis mombasae</i>	F	W
<i>Hemiolaus coeculus</i>	f	W	<i>Pentila</i> sp.	-	-
<i>Hemiolaus coeculus littoralis</i> *	f	W	<i>Teriomima micra</i> *	F	N
<i>Lepidochrysops barkeri</i> ***	f	W	<i>Teriomima subpunctata</i> **	F	N
<i>Lepidochrysops</i> sp.	-	-	Unknown sp.	-	-
<i>Leptotes pirithous</i> ***	O	W			
<b>NYMPHALIDAE</b>					
<i>Acraea aganice montana</i>	F	W	<i>Euxanthe wakefieldi</i>	F	W
<i>Acraea cerasa</i> *	F	W	<i>Hamanumida daedalus</i>	f	W
<i>Acraea encedena</i> *	f	W	<i>Harma theobene</i>	f	W
<i>Acraea epaea epitellus</i>	F	N	<i>Harma theobene blassi</i> *	f	W
<i>Acraea eponina eponina</i> *	f	W	<i>Henotesia perspicua</i> *	f	W
<i>Acraea insignis insignis</i> *	f	W	<i>Hypolimnas anthedon walbergi</i> **	F	W
<i>Acraea orestia orestia</i> **	F	W	<i>Hypolimnas deceptor deceptor</i> *	f	W
<i>Acraea petraea</i> *	f	W	<i>Hypolimnas misippus</i> *	O	W

Table 25 Continued.

<i>Acraea rabbaiae mombasae</i> *	F	W	<i>Junonia natalica natalica</i> *	f	W
<i>Acraea zonata</i> *	F	N	<i>Junonia oenone oenone</i>	f	W
<i>Acraea</i> sp.	-	-	<i>Junonia orithya madagascariensis</i> *	f	W
<i>Amauris niavus niavus</i> **	f	W	<i>Junonia terea elgiva</i>	f	W
<i>Amauris ochlea ochlea</i> *	f	W	<i>Melanitis leda</i>	f	W
<i>Bicyclus campinus ocelligerus</i> *	F	W	<i>Mylothris kiwuensis rhodopoides</i>	F	W
<i>Bicyclus safitza safitza</i> *	O	W	<i>Neptidopsis fulgurata platyptera</i> *	F	N
<i>Bicyclus</i> sp.	-	-	<i>Neptis alta</i> **	f	W
<i>Byblia anvatarata acheloia</i>	f	W	<i>Neptis carcassoni</i> *	F	W
<i>Byblia ilithya</i> *	f	W	<i>Neptis goochi</i>	F	W
<i>Byblia</i> sp.	-	-	<i>Neptis melicerta</i> **	F	W
<i>Charaxes baumanni granti</i> *	f	W	<i>Neptis morosa</i>	f	W
<i>Charaxes brutus</i> trans. ad. <i>Angustus</i>	f	W	<i>Neptis saclava marpessa</i> *	f	W
<i>Charaxes candiope candiope</i>	F	W	<i>Neptis</i> sp.	-	-
<i>Charaxes castor castor</i>	f	W	<i>Pardopsis punctatissima</i> *	f	W
<i>Charaxes cithaeron nairobiensis</i> **	F	W	<i>Phalanta eurytis eurytis</i> *	F	W
<i>Charaxes etesipe gordonii</i> *	F	W	<i>Physcaeneura leda</i> *	f	N
<i>Charaxes hansali baringana</i> **	f	W	<i>Precis pelarga actia</i>	f	W
<i>Charaxes jahluca kenyensis</i> **	f	W	<i>Pseudacrea lucretia protracta</i>	F	W
<i>Charaxes lasti lasti</i> *	F	N	<i>Salamis anacardii anacardii</i> *	f	W
<i>Charaxes macclounii</i> **	O	W	<i>Salamis parhassus parhassus</i>	F	W
<i>Charaxes protoclea azota</i>	f	W	<i>Salamis</i> sp.	-	-
<i>Charaxes varanes volgensis</i>	f	W	<i>Sallya amulia rosa</i> **	f	W
<i>Charaxes violetta maritimus</i> *	F	N	<i>Sallya boisduvali</i>	f	W
<i>Charaxes zoolina zoolina</i>	f	W	<i>Sallya boisduvali omissa</i> *	f	W
<i>Charaxes</i> sp.	-	-	<i>Sallya garega garega</i> **	f	W
<i>Coenyropsis carcasonni</i> *	f	N	<i>Sallya natalensis</i> *	f	W
<i>Danaus chrysippus chrysippus</i> *	f	W	<i>Sallya umbrina</i> **	f	W
<i>Euphaedra neophron</i> *	f	W	<i>Ypthima asterope</i> **	O	W
<i>Euptera kinugnana</i>	F	N	<i>Ypthima recta</i> **	f	W
<i>Eurytela dryope</i>	f	W	Unknown sp.	-	-
<i>Eurytela dryope angulata</i>	f	W			
<b>PAPILIONIDAE</b>					
<i>Catopsila florella</i>	f	W	<i>Papilio dardanus tibullus</i>	F	W
<i>Papilio constantinus constantinus</i> *	F	W	<i>Papilio demadocus demadocus</i>	f	W
<i>Papilio dardanus dardanus</i> **	F	W	<i>Papilio ophidicephalus ophidicephalus</i> **	F	W
<i>Papilio dardanus polytrophus</i> **	F	W			
<b>PIERIDAE</b>					
<i>Appias epaphia orbona</i> **	f	W	<i>Dixeia</i> sp.	-	-
<i>Appias lasti lasti</i>	F	W	<i>Eronia cleodora</i> *	f	W
<i>Belenois aurota aurota</i> *	F	W	<i>Eronia leda</i> *	f	W
<i>Belenois creona severina</i>	f	W	<i>Eurema brigatta brigatta</i> **	f	W
<i>Belenois subeida sylvander</i> **	f	W	<i>Eurema desjardiusi oberthane</i> *	f	W
<i>Belenois thysa thysa</i>	f	W	<i>Eurema floricola orientalis</i>	F	W
<i>Belenois</i> sp.	-	-	<i>Eurema hecabe</i>	f	W
<i>Catopsila florella</i>	f	W	<i>Eurema hecabe solifera</i>	f	W
<i>Colotis antevippe zera</i> *	f	W	<i>Eurema regularis</i> **	f	W

Table 25 Continued.

<i>Colotis auxo</i> **	f	W	<i>Eurema senegalensis</i>	F	W
<i>Colotis दौरا jacksoni</i> **	O	W	<i>Eurema</i> sp.	-	-
<i>Colotis danae eupompe</i> **	f	W	<i>Leptosia alcesta inalcesta</i> *	f	W
<i>Colotis euipe</i> *	f	W	<i>Leptosia nupta nupta</i> **	F	W
<i>Colotis euipe complexivus</i> *	f	W	<i>Nepheronia argia argia</i>	F	W
<i>Colotis euipe omphale</i> *	f	W	<i>Nepheronia buqueti buqueti</i> *	f	W
<i>Colotis ione</i>	f	W	<i>Nepheronia thalassina</i>	f	W
<i>Colotis</i> sp.	-	-	<i>Nepheronia</i> sp.	-	-
<i>Dixeia doxo costata</i> *	f	W	Unknown sp.	-	-

## KEY TO ABBREVIATIONS IN ZOOLOGICAL TABLES

## NEW RECORDS

\* Species not previously recorded in Kazimzumbwi FR

\*\* Species not previously recorded in Coastal Forests

## ECOLOGICAL (ECOL.) TYPE

F - Forest dependent species (primary forest only, not including forest edge or secondary forest)

f - Forest dwelling but not forest dependent species

O - Non-forest species

## ENDEMIC (END.) STATUS

E - Endemic species (occurring only in the Pugu Hills)

N - Near endemic species (a - range limited to Coastal Forests, b - range limited to Coastal Forests and the Eastern Arc Mountains, c - range limited to Coastal Forests, the Eastern Arc Mountains and a few other East African forests)

W - Widespread distribution species

Over half (58%) of the butterfly species listed have not previously not been recorded in Kazimzumbwi FR and most notably all of the Hesperiiids represent new records. These records also represent 29 species and 6 genera that have not previously been recorded in Coastal Forests. All of these genera are from the Hesperidae and Lycaenidae families.

Many Nymphalidae were recorded whilst very few Hesperidae. Forty-two species recorded (30%) were forest dependent, including the majority of Papilionidae species. Relatively few forest dependent Pieridae species were recorded, most being forest dwelling. Eighty species recorded (54%) were forest dwellers and only 7 (5%) were non-forest species. No endemic butterfly species were recorded although 12 (8%) were near-endemics (see Table 26). If verified taxonomically, the record of *Pentils rondo* represents a range extension for the species that has only been found on the Rondo Plateau. The majority of butterfly species recorded (111 or 75%) have widespread distributions. No species recorded are listed by IUCN as Threatened or appear in CITES listings.

**Table 26** Ranges of near endemic butterfly species recorded in Kazimzumbwi FR. (Compiled from Kielland & Cordiero 2000).

Species	Range
LYCAENIDAE	
<i>Pentila rondo</i>	Known only from a FR on the Rondo Plateau, W. of Lindi, Tanzania
<i>Pentila rogersi</i>	Coastal Forests of Kenya and Tanzania
<i>Teriomima micra</i>	Coastal Forests of Kenya and Tanzania
<i>Teriomima subpunctata</i>	Coastal Forests of Kenya and Tanzania
NYMPHALIDAE	
<i>Acraea epaea epitellus</i>	Coastal Forests of Kenya and Tanzania
<i>Acraea zonata</i>	Coastal Forests of Kenya and Tanzania
<i>Charaxes lasti lasti</i>	Coastal Forests of Kenya and Tanzania
<i>Charaxes violetta maritimus</i>	Coastal Forests of Kenya and Tanzania
<i>Coenyropsis carcasonni</i>	E. Tanzania and S.E. Kenya
<i>Euptera kinugnana</i>	Coastal Forests of Kenya and Tanzania
<i>Neptidopsis fulgurata platyptera</i>	Coastal Forests of Kenya and Tanzania
<i>Physcaeneura leda</i>	Coastal Forests of Kenya and Tanzania

#### 6.4.5 MOLLUSCS

Whilst awaiting the formal identification of 50 mollusc, little can unfortunately be ascertained regarding the mollusc fauna of Kazimzumbwi FR.

#### 6.4.6 MILLIPEDES

Whilst awaiting the formal identification of 200 millipede, little can unfortunately be ascertained regarding the millipede fauna of Kazimzumbwi FR.

### 6.5 DISCUSSION

#### 6.5.1 MAMMALS

Thirty-two species of mammal were recorded in Kazimzumbwi FR. This compares favourably with other Coastal Forests, which have an average of  $24 \pm 12.3$  species each (Burgess *et al.* 2000). Taxonomic verifications are still awaited for shrew, rodent and bat specimens and these are expected to increase the number of species recorded even further. In general, the most diverse groups of mammals in Coastal Forests are bats (58 species), rodents (>27 species), carnivores (19 species), primates (14 species) and shrews (14 species) (Burgess *et al.* 2000). This general pattern was largely observed within Kazimzumbwi, although recorded bat diversity was low. This may reflect seasonal variations or serve to emphasise the difficulties of mistnetting in open habitats. The results will also be biased towards low-flying insectivorous species, for example those feeding close above the water at riverine sites. No megachiroptera were recorded. High numbers of rodents and ungulates were recorded, reflecting the great diversity that exists within these taxa and the high forest dependence of many ungulate species. *Rattus rattus* was recorded close to the railway track and its associated drainage system; this may have provided the species with an access route into the forest from villages and cultivated areas around the reserve. Primate and carnivore diversity was fairly high, although difficulties exist in gaining evidence of elusive

carnivores and therefore true species diversity may well be greater. People living around the reserve believe there to be *Panthera pardus* (Leopard) south of the railway track. Records of galagos may have been increased if vocalisations were used more widely. When taxonomic verifications are received and species identified the number of shrews is expected to reflect the high shrew diversity of Coastal Forests in general. Although shrews generally prefer moist habitats (Kingdon 1997), only some of the sites where shrews were recorded in Kazimzumbwi were associated with water. Previous studies report a positive relationship between shrew abundance and rain (Frontier Tanzania 2001). There was very little rain during the study period although no formal records were made in order to investigate such a relationship. Much remains to be known about Coastal Forest shrew fauna, with five unidentified species recorded from separate forests (including one from Kazimzumbwi FR), four of which are undescribed (Burgess et al. 2000). Results of shrews from this study should therefore prove interesting. No Hyracoidea (Hyrax) records were made although *Dendrohyrax* species are expected within the reserve and were possibly smelt on a number of occasions.

Nine of the 32 mammal species recorded (28%) have not previously been reported in Kazimzumbwi FR. Many are antelope (including the near-endemic *Cephalophus adersi*<sup>4</sup>) or Cricetomyidae (including the near-endemic *Beamys hindei*). This reflects the lack of attention given Kazimzumbwi FR, despite the large number of biological studies within neighbouring Pugu FR. The results of the current study are thus particularly important.

Within Kazimzumbwi FR 22% of species recorded are forest dependent, 34% are forest dwelling and 9% are non-forest species (the ecological requirements of 11 species or 34% are unknown). These figures compare well with those recorded in Coastal Forest mammals in general, where 20% of species are recorded as forest dependent, 42% as forest dwelling and 37% as non-forest species (Burgess et al. 2000). The greatest forest dependence would appear to be among the ungulates, notably *Cephalophus* species. The galago and elephant shrews recorded also show high forest dependence. No information on the ecological requirements of the majority of small mammals recorded is currently available (as few are yet identified to species). From their trapping locations however it would appear that *Grammomys* are confined to forested areas (along with *Beamys hindei*, which is known to be forest dependent). Four of the seven forest dependent species recorded in Kazimzumbwi FR are also near-endemics, highlighting the link between endemism and forest dependence. Large areas of the Kazimzumbwi FR comprise habitats other than forests and thus the high number of ecological generalists is to be expected. The dominance of ecological generalists in Coastal Forests in general is attributed to the small size of forest patches and the fact that they are surrounded by open habitats and are dry for large parts of the year (Burgess et al. 2000).

Four species recorded in Kazimzumbwi FR have restricted ranges. The antelope *Cephalophus adersi* is endemic to Coastal Forests alone, the galago *Galagoides zanzibaricus* and the elephant shrew *Rhynchocyon petersi* are endemic to Coastal Forests and Eastern Arc Mountains, and the rodent *Beamys hindei* is endemic to Coastal Forests, Eastern Arc Mountains and a few other East African forests. In Coastal Forests in general, endemism is especially high within shrews, bats, galagos, rodents, antelope and elephant shrews, thus the pattern in Kazimzumbwi FR fits well with this general trend. The endemic status cannot be given for those species identified to genera only and at the time of writing the taxonomic verification of small rodents, insectivores and bats is awaited. All of these groups show high levels of endemism and thus information regarding this should prove interesting. All of the restricted range species recorded in Kazimzumbwi FR are also forest dependent. The number of near-endemic species recorded is the same as that recorded

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<sup>4</sup> The identification of this species remains uncertain.

during previous surveys of the Pugu Hills (Burgess *et al.* 2000). The species are however different as both *Beamys hindei* and *Cephalophus adersi* (recorded during the current study) have not previously been recorded in the reserve.

Five species recorded within Kazimzumbwi FR are listed by IUCN as of conservation concern. Two are listed as Endangered, both of which are forest dependent and near-endemic; the Zanzibar elephant shrew *Rhynchocyon petersi* and Ader's duiker *Cephalophus adersi*. One is listed as Vulnerable, the forest dependent and near-endemic Lesser pouched rat *Beamys hindei*. Two are listed as at Lower Risk; the forest dependent and near-endemic Zanzibar galago *Galagoides zanzibaricus* and the forest dependent Natal duiker *Cephalophus natalensis*. Three of the primate species recorded appear on CITES Appendix II, along with the antelope *Cephalophus monticola*.

The present study employed a number of survey techniques in order to sample various groups of mammals. With regard to mist-netting for bats, the river Mzumbwi provided a natural flight corridor, an excellent feeding site for insectivorous bats and an ideal location for mistnetting. Mist-netting in more open habitats, such as wooded grassland, proved far less successful. Sherman traps were most successful in trapping rodents whilst bucket pitfall traps were more successful with regard to shrews. It may be that shrews were not attracted to the coconut and peanut butter bait used in Sherman traps, although small fish (*dagaa*) were used at one trap site but with no noticeable increased success rates in catching shrews. It is considered advisable to use the combination of both trapping methods in order to fully sample small mammal fauna. It was thought possible that larger rodent species may be able to escape bucket pitfall traps, whilst Sherman traps may be biased towards catching nocturnal species however.

### 6.5.2 REPTILES

Twenty-eight species of reptile were recorded within Kazimzumbwi FR, half of which have not previously been recorded within the reserve. This reflects the lack of attention given to Coastal Forests in past reptile research and the resulting small number of forests with full species lists (Broadley & Howell 2000). Of the fourteen species not previously recorded within the reserve, *Sepsina tetradactyla* is near-endemic to Coastal Forests and *Natriciteres olivacea* has not been recorded on the coast for 15 years (K.Howell, *pers. comm.*). The record of *Agama montana* represents a range extension for this species which has previously only been recorded in the Usambara, Uluguru and Nguru Mountains (National Biodiversity Database, UDSM 1997). Two of the three chameleon genera occurring in Coastal Forests were represented in Kazimzumbwi FR, with three species recorded. Two species of venomous snake were recorded in Kazimzumbwi, although when compared to West and Central African forests, Coastal Forests (in general) are poor in such species (Broadley & Howell 2000). If taxonomic verifications are received confirming field identifications, many of the colubrid species recorded in Kazimzumbwi FR will represent new records for the reserve and some for Coastal Forests. Unfortunately, as in previous studies, fossorial reptiles were under-represented in this study.

Of the 28 reptile species recorded in Kazimzumbwi FR, only five (19%) are forest dependent, although the ecological requirements of ten species (37%) are not known and therefore bias these results. This figure is (without additional information) low when compared to that within Coastal Forests in general, where 50% are forest dependent (Broadley & Howell 2000). Reptiles were recorded at all trap sites and opportunistically throughout the reserve, in both forested and non-forested habitats. Large areas of the Kazimzumbwi FR comprise habitats other than forests and thus, as with the mammal records, the high number of ecological generalists is to be expected. Two of the five forest dependent species also have restricted ranges.

Four species recorded in Kazimzumbwi FR (14%) have restricted ranges. The skink *Sepsina tetradactyla* is endemic to Coastal Forests alone, the dwarf chameleon *Rhampholeon brevicaudatus* is endemic to Coastal Forests and Eastern Arc Mountains and the gecko *Lygodactylus grotei* is endemic to Coastal Forests, Eastern Arc Mountains and a few other East African forests. The remaining species, *Agama montana*, is recorded as endemic to selected Eastern Arc forests. The record in Kazimzumbwi FR however alters the endemic status of this species. The ecological requirements of two of the four restricted range species could not be found, however the other two are forest dependent. Twenty-four species are known to be endemic to Coastal Forests, although it is believed that this figure could easily increase with greater sampling effort (Broadley & Howell 2000). The remaining taxonomic verifications of reptiles recorded in Kazimzumbwi FR are thus eagerly awaited, particularly as between 1989 and 1994 Frontier-Tanzania Coastal Forest Research Programme found six new species within a number of Coastal Forests.

Two reptile species recorded in Kazimzumbwi FR are listed as Vulnerable by the IUCN. Both *Rhampholeon brevicaudatus* and *Agama montana* are forest dependent and have restricted ranges. The chameleon *Chamaeleo dilepis* is listed on CITES Appendix II.

Almost half (46%) of the reptile species recorded in Kazimzumbwi FR were as a result of opportunistic collections or observations made outside of the trapsites. This highlights the importance of this activity and the limitations of relying solely on the trapsite techniques to specifically capture reptiles. Larger reptiles will easily escape bucket pitfall traps and arboreal species will not be targeted by this sampling technique at all.

### 6.5.3 AMPHIBIANS

Twenty-three species of amphibia were recorded in Kazimzumbwi FR, including eight (35%) that have not previously been recorded in the reserve. If the identification of *Leptopelis barbouri* is confirmed it will represent the first record of the species in Coastal Forests. Three of the species not previously recorded in the reserve are forest dependent and five are near-endemics. The species recorded in Kazimzumbwi FR represent a typical lowland assemblage (Poynton, *pers. comm.*). *Arthroleptis* species were the commonest species in Kazimzumbwi FR, as they are in Coastal Forests in general (Poynton 2000). Coastal Forest and the Eastern Arc differ quite substantially in terms of amphibia, with no records of the speciose bufonid genus *Nectophrynoides* in Coastal Forests whilst Coastal Forests appear to be the distributional centre of the bufonid genera *Mertensophryne* and *Stephopaedes* (Poynton 2000). *Mertensophryne micranotis* was recorded in Kazimzumbwi FR although no *Stephopaedes*. With its highly specialised breeding strategy, *Mertensophryne micranotis* is very interesting from an evolutionary and biogeographical point of view and thus the record in Kazimzumbwi FR is important. The caecilian record is interesting as much data is required in order to adequately assess the forest dependence and distribution of these little studied amphibia (Poynton 2000). *Leptopelis* was represented by only a few individuals and no *Hyperolius* were recorded. This may well reflect the timing of the survey, which took place in the dry season. Very little rainfall occurred for the duration of the survey period. Interestingly, nearly all of the *Hemisus* and *Phrynobatrachus* records were from Wooded Grassland and *Brachystegia* Forest respectively. *Hemisus* is considered a forest dwelling species whilst *Phrynobatrachus mababiensis* is considered a non-forest species.

Six of the amphibian species recorded (26%) are forest dependent, although the ecological requirements of four species (17%) are unknown and thus possibly bias the results. The greatest forest dependence was found within the Arthroleptidae and Hyperolidae, although almost equal

numbers of Hyperolidae are non-forest species. Five of the six forest dependent species also have restricted ranges. Difficulties exist in defining forest dependence among amphibia as many species breed in open habitats (Poynton 2000) and figures with which to compare the extent of forest dependency in Kazimzumbwi FR amphibia were hard to find.

Seven species recorded in Kazimzumbwi FR (30%) have restricted ranges. One is confined to Coastal Forests and Eastern Arc Mountains; *Mertensophryne micranotis*, and five are confined to Coastal Forests, Eastern Arc Mountains and a few other East African forests; *Arthroleptis xenodactyloides*, *Bufo linderi*, *Leptopelis argenteus*, *Leptopelis flavomaculatus* and *Boulengerula* cf. *changamwensis*. The remaining species, *Leptopelis barbouri*, is endemic to the Usambara and Udzungwa Mountains, although if the identification of the species is confirmed the record alters its endemic status. Five of these restricted range species are also forest dependent.

No amphibian species recorded are listed by IUCN or CITES as of conservation concern.

With regards to sampling techniques, unlike the reptiles recorded in Kazimzumbwi FR, the majority of amphibians recorded were the result of standard trapsite methods. Opportunistic collection did however reveal the presence of genera such as *Chiromantis*, *Xenopus* and some species of *Ptychadena*.

#### 6.5.4 BUTTERFLIES

One hundred and forty species of butterfly were recorded in Kazimzumbwi FR, of which 58% have not previously been reported in the reserve, 20% have not previously been recorded in Coastal Forests and 5% are genera that have not previously been recorded in Coastal Forests. If formal identifications verify the species recorded, these represent a wealth of new data on Coastal Forest butterfly fauna. This is especially true as these records build on those of 241 species recorded throughout the Pugu Hills during extensive survey by regional experts (Kielland & Cordeiro 2000). Due to their small size and inconspicuousness, Hesperiiids and Lycaenids tend to be under-represented in butterfly records, and indeed, all of the Hesperiiids recorded in Kazimzumbwi FR are at least new species to the reserve, with some representing new genera to Coastal Forests. The Nymphalidae family is particularly well represented in Kazimzumbwi FR, reflecting their generally larger size and conspicuousness. Pieridae species of open habitats often migrate and exhibit much seasonal variation (Kielland 1990). It would therefore be interesting to re-survey at different times of year in order to investigate any such changes. Butterflies are a relatively well studied taxa and although Coastal Forests are known to harbour a diverse assemblage of butterflies, surveys of all forests are far from complete (Kielland & Cordeiro 2000). The results of the current study would support this statement.

Forty-two species (30%) recorded in Kazimzumbwi FR are forest dependent, including the majority of Papilionidae species. High numbers of Hesperiiidae are also forest dependent although relatively few Pieridae are forest dependent, most being forest dwelling. Seventy-five of more than 400 butterfly species and subspecies (c.19%) inhabiting Coastal Forests are known to be forest dependent (Kielland & Cordeiro 2000) and thus the level of forest dependency in Kazimzumbwi FR is high. One-quarter of forest dependent species also have restricted ranges.

Twelve species (8%) recorded in Kazimzumbwi FR are endemic to Coastal Forests including one, which if verified taxonomically, represents a range extension for the species *Pentila rondo*, previously only recorded on the Rondo Plateau, southern Tanzania. All but two of these species are also forest dependent. Neither of the two genera endemic to Coastal Forests were recorded although the near-endemic genera *Teriomima* was represented in Kazimzumbwi by two species.

The use of both canopy traps baited with fermenting fruit and hand-held sweepnets was found to sample greater species diversity than either method alone. Canopy traps sampled an obviously higher flying butterfly assemblage and captured many *Charaxes* and *Sallya* species. Sweepnets could be used to target smaller species flying low to the ground.

### 6.5.5 MOLLUSCS AND MILLIPEDES

Unfortunately until identifications are received for those specimens collected in Kazimzumbwi FR, little can be ascertained regarding the ecological preferences or endemic status of its mollusc and millipede fauna. These results are eagerly awaited however and should prove to be very interesting. Virtually nothing is known about Coastal Forest millipede fauna, although due to their hard, persistent shells, mollusc fauna (namely snails) is better known (Hoffman 2000). One hundred and twenty-five mollusc species are known to inhabit Coastal Forests and coastal bushland (Verdcourt 2000) whilst 224 named and 190 undescribed species of millipede are known to occur in Tanzania. Endemism is thought to be high in both; 79% in molluscs and >50% in millipedes. As many undescribed taxa exist within both groups however, the true number of endemic, and also forest dependent, species is likely to be higher.

## 6.6 CONCLUSIONS

The faunal diversity recorded in Kazimzumbwi FR is summarised in Table 27, accompanied by the forest dependency, endemic status and conservation concern of the taxon involved. The species richness, number of forest dependent species and those of restricted ranges are all expected to increase when taxonomic verifications are received. This is especially likely to be true within the molluscs, millipedes, shrews and rodents recorded.

**Table 27** Summary of faunal richness and the forest dependency, endemism and conservation status of species recorded in Kazimzumbwi FR. (For sources of information refer to relevant tables in the results section).

Taxon	Number of families	Number of genera	Number of species	Species not previously recorded	Forest dependent	Restricted range	IUCN conservation concern
Mammals	17	28	32	9 (28%)	7 (22%)	4 (13%)	5 (16%)
Reptiles	8	19	28	14 (50%)	5 (18%)	4 (14%)	2 (7%)
Amphibians	8	13	23	8 (24%)	6 (26%)	7 (30%)	0
Butterflies	5	53	140	81 (58%)	42 (30%)	12 (9%)	0
Totals	38	113	223	112 (50%)	60 (27%)	27 (12%)	7 (3%)

### 6.6.1 'NEW RECORDS'

A high proportion of species within all taxon have not previously been recorded in Kazimzumbwi FR. This is particularly notable in the butterflies and reptiles, at least half of the species of which represent 'new records' for the reserve. The figure given for butterflies would be even greater if subspecies were considered. Broadley and Howell (2000) note the lack of attention given Coastal Forests in past reptile research and Kielland and Cordiero (2000) report a far from complete coverage of butterfly studies despite Lepidoptera being a fairly well studied order. Records of Coastal Forest amphibia are also considered patchy and incomplete (Poynton 2000) and Kingdon (1997) stresses the need for more information on the ecology and distribution of certain mammal species in order to develop efficient conservation strategies. Detailed habitat notes accompanied all records of species recorded in Kazimzumbwi FR and as such, the data collected from this study represents a wealth of information with regard to all the taxon. Gathering information on

the presence of species in different forests also allows the distribution and ranges of individual species to be assessed. The distribution of *Beamys hindei* has for example recently been found to be greater than once thought, although it is very patchy but for reasons as yet unknown (Burgess et al. 2000). *Mertensophryne* also presents an interesting case of biogeography which is indicative of the distinctiveness of East African lowland amphibian fauna (Poynton 2000). Both of these species were recorded in Kazimzumbwi FR, *Beamys hindei* for the first time.

#### **6.6.2 SPECIES RICHNESS AND DIVERSITY**

For those taxa for which information is available, the species richness and diversity of Kazimzumbwi FR compares very favourably with that of other Coastal Forests. The recorded mammal diversity was for example shown to be above average for Coastal Forests (even without species identifications for shrews and rodents) and the number of restricted range mammals is comparable to that recorded throughout the Pugu Hills. This high diversity was to be expected, as the Pugu Hills have been ranked third amongst all Coastal Forests in terms of their mammal diversity (Burgess et al. 2000).

#### **6.6.3 FOREST DEPENDENCY**

Sixty species (27%) from all taxa recorded in Kazimzumbwi FR are directly dependent upon closed canopy, primary forest. Forest dependency is highest within the butterflies and amphibians. The mosaic of habitats present in Kazimzumbwi FR supports a great variety of species, including many ecological generalists, however it is the forest dependent species that are most at threat from habitat alteration. Forest dependent species rely on areas which are currently threatened by activities such as pole cutting, charcoal production and pitsawing (see Chapter 5) and it is these habitats that should thus receive top conservation priority.

#### **6.6.4 ENDEMISM**

Thirty species recorded in Kazimzumbwi FR (13 %) have ranges restricted to Coastal Forest and/or Eastern Arc Mountains and/or other East African forests. The highest degree of endemism is recorded within the amphibia. The endemic status of *Agama montana* has been altered by the record of this species within Kazimzumbwi FR, as it has previously only been recorded in certain Eastern Arc Mountains. The link between endemism and forest dependence has been demonstrated within all taxa recorded in Kazimzumbwi FR, as has the link between these factors and species of conservation concern.

#### **6.6.5 SPECIES OF CONSERVATION CONCERN**

Seven species recorded are of IUCN conservation concern, many of which are mammals. This reflects, in part, the relatively more complete investigation of this taxa when compared to others. Many Tanzanian reptiles have for example been deemed of conservation concern based on the criteria of IUCN by Professor K. Howell (UDSM), although none are officially recognised as such (see Frontier Tanzania 2001). Six of the seven species of conservation concern recorded in Kazimzumbwi FR are considered Threatened (Vulnerable or Endangered) by IUCN whilst the other two are considered of Lower Risk.

Overall, the fauna recorded in Kazimzumbwi FR demonstrates high species richness, moderate forest dependency and a high level of endemism. A number of species are also internationally recognised as being under threat. Species are distributed throughout the mosaic of habitats found within the reserve, although the restricted range species tend to be confined to areas of forest and thus this habitat is considered the highest priority for conservation. It is also this habitat that is most at threat from human activities that may alter both vegetation type and structure.

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## APPENDIX 1

### COASTAL FOREST VEGETATION TYPES *After Clarke (2000)*

- EASTERN AFRICAN COASTAL DRY FOREST

This is the predominant and most variable of the Coastal Forest vegetation types. Legume dominance is high and it is believed to have covered much of the eastern African coastal zone prior to human intervention. It comprises two sub-types:

1. *Legume-dominated dry forest*

This occurs on well-drained soils with <50-95% of individuals accounted for by 1 or 2 legume species. Characteristic species include *Scorodophloeus fischeri*, *Cynometra* sp., *Manilkara sulcata*, *M. sansibarensis* and *Brachylaena huillensis*. Shrubs are common, herbs are rare and lianes scarce. Canopy height varies between 6m and 25m, but is typically around 12-15m. This is a long-term vegetation climax community.

2. *Mixed dry forest*

There is much inter-forest variation in this vegetation type, with 152 species recorded as dominant in one or more forests and 94 listed as common or frequent. *Grewia* and *Combretum* are virtually absent. Lianes and shrubs are frequent, herbs infrequent and epiphytes rare. Canopy height varies between 10 and 30-40m. It may develop on coral rag and is considered a regeneration climax community in the absence of competition from slower dispersed legumes.

- EASTERN AFRICAN COASTAL SCRUB FOREST

This is often mislabelled as forest or thicket. Most is seral following disturbance or regeneration from clearing and/or burning. Other is sub-climax where disturbance has stopped or climax on coral rag. It comprises two sub-types:

1. *Mixed Scrub Forest*

Monospecific dominance is rare in this vegetation type, with 141 species dominant or common. Well-represented genera include *Albizia*, *Combretum*, *Diospyros*, *Grewia*, *Manilkara*, *Strychnos* and *Vitex*. Lianes are frequent to scarce whilst herbs are absent. Canopies may reach 5-6m.

2. *Maritime Scrub Forest*

This is scrub forest and thicket on coral rag along the coast. It is similar to Mixed Scrub Forest but with a canopy reaching 6-10m. It is depauperate in species compared to other forest types.

- EASTERN AFRICAN COASTAL BRACHYSTEGLIA FOREST

This is a fire-excluded, closed-canopy vegetation type, dominated by *Brachystegia spiciformis* or *B. microphylla*. Frequent co-dominants include *Hymenea verrucosa* and *Julbernardia magnistipulata*. Lianes are scarce to absent, shrubs frequent to scarce and grasses scarce to absent. It is found on well-drained, nutrient poor or heavily leached soils.

- EASTERN AFRICAN COASTAL/AFROMONTANE TRANSITIONAL FOREST

This occurs where rainfall is increased (typically >1500mm) or drainage impeded; physiognomically similar to lowland rainforest. Characteristic species are also common to Riverine Forest and include *Sterculia* sp. and *Milicia* sp. Multiple tree strata are present with 45m emergents reaching above a 30-40m canopy and a dense shrub layer. Lianes, epiphytes and herbs rare or scarce although the grass *Olyra latifolia* may be abundant.

- EASTERN AFRICAN COASTAL RIVERINE/SWAMP/GROUNDWATER FOREST

Some unique species differentiate between the otherwise difficult to separate Riverine and Groundwater Forest. 87 species dominate with 28 common or frequent species occurring in these vegetation types.

1. *Groundwater Forest*

This occurs on slopes of impeded drainage and in valley bottoms. Typically deciduous emergents occur above a 25-35m canopy. Moraceae are prominent and bird and bats commonly disperse these and others species. Shrubs and lianes are frequent.

2. *Riverine Forest*

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This is found along permanent or near-permanent watercourses or on floodplains (where species composition depends on the recurrence interval of floods). Large trees typically occur in a diverse canopy. Lianas may be abundant whilst herbs are rare.

3. *Swamp Forest*

Freshwater swamp conditions are rare in Coastal Forest and thus so is this vegetation type. Monocotyledon dominated, for example *Pandanus rabaiensis*, *Raphia farinifera*, *Elaeis guineensis* and *Typhonodorum lindleyanum*.

## APPENDIX 2 TAXONOMIC VERIFICATION

### BOTANY

Mr Albert Ntemi Sallu	East Usambara Catchment Area Management Programme (EUCAMP)	P.O.Box 85869, Tanga, Tanzania
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### ZOOLOGY

#### Vertebrates:

##### *Bats and small mammals.*

Prof. Kim Howell	Department of Zoology	University of Dar es Salaam, P.O. Box 35060, Dar es Salaam, Tanzania
Dr. Dieter Kock	Frankfurt Zoological Museum	Saugetiere III, Senckenberg, Senckenberganlage 25, 60325 Frankfurt am Main, Germany
Dr. W. Stanley	Field Museum of Natural History	Chicago, Illinois, USA

##### *Amphibians*

Prof. Kim Howell	Department of Zoology	University of Dar es Salaam, P.O. Box 35060, Dar es Salaam, Tanzania
Charles Msuya	Natural History Museum	Cromwell Road, London, UK
Dr. J. Poynton		
Dr. B. Clarke		

##### *Reptiles*

Prof. Kim Howell	Department of Zoology	University of Dar es Salaam, P.O. Box 35060, Dar es Salaam, Tanzania
Dr. Don Broadley	Natural History Museum	P.O. Box 240, Bulawayo, Zimbabwe

#### Invertebrates:

##### *Millipedes*

Dr. R. Hoffman	Virginia Museum of Natural History	1001 Douglas Av., Martinsville, Virginia 24112, USA
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##### *Butterflies*

Dr. Steve Collins	African Butterfly Research Institute	P.O. Box 14308, Nairobi, Kenya
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##### *Molluscs*

Dr. B. Verdcourt	Kew Gardens	Kew, Richmond, Surrey, TW7 9AF, UK
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### APPENDIX 3

#### VEGETATION PLOT DESCRIPTIONS

Plot number	Geo co-ordinates		Altitude (m a.s.l.)	Slope (degrees)	Topography	Vegetation type	Canopy height (m)	Disturbance category
	S	E						
1	06 56' 01.3"	039 03' 04.1"	200	0	VF	GS	<10	C, F
2	06 56' 01.3"	039 03' 43.2"	250	0	HT	LF	<10	C
3	06 56' 01.3"	039 04' 22.3"	240	6	UP	LF	<10	L
4	(refer to VP 26 instead)							
5								
6	06 56' 40.4"	039 04' 22.3"	180	5	VF	LF	10-20	C, Cu, T
7	06 57' 19.5"	039 02' 25.0"	190	10	GLS	LF & WO	10-20	C, Pa, Road
8	06 57' 19.5"	039 03' 04.1"	230	4	UP	LF	10-20	C, L
9	06 57' 19.5"	039 03' 43.2"	260	17	GUS	LF	10-20	C, L
10	(outside of Forest Reserve borders)							
11	06 55' 41.0"	039 03' 23.7"	200	11	SLS	LF	<10	Road
12	06 55' 41.8"	039 04' 02.8"	240	0	UP	CF	<10	-
13	06 56' 20.9"	039 03' 23.7"	170	11	GUS	LF	10-20	C
14	06 56' 20.9"	039 04' 02.8"	200	0	HT	STB	<10	-
15	06 56' 20.9"	039 04' 41.9"	160	19	HT	LF	<10	-
16	06 56' 40.4"	039 02' 25.0"	160	7	GLS	LF	<10	-
17	06 56' 59.9"	039 02' 05.5"	160	3	GLS	LF	10-20	C, F
18	06 56' 59.9"	039 02' 44.6"	180	10	UP	LF	10-20	C
19	06 56' 59.9"	039 03' 23.7"	170	5	GLS	LF	<10	-
20	06 56' 59.9"	039 04' 02.8"	100	10	GMS	PF	<10	-
21	06 57' 19.5"	039 01' 45.9"	210	14	GLS	WO	10-20	C
22	06 57' 39.0"	039 02' 05.5"	180	20	GUS	LF	10-20	C
23	06 57' 39.0"	039 02' 44.6"	180	20	GUS	LF	10-20	C
24	06 57' 39.0"	039 03' 23.7"	200	5	GUS	LF	10-20	-
25	(outside of Forest Reserve borders)							
26	06 56' 40.4"	039 03' 04.1"	200	50	HT	LF	<10	-

**Abbreviations:**

**Topography:** G - Gentle, S - Steep, LS - Lower Slope, MS - Mid Slope, US - Upper Slope, HT - Hilltop, UP - Upland Plateau, VF - Valley Floor, LP - Lowland Plain

**Vegetation type:** LF - Lowland Forest, WO - Woodland, GS - Grasslands, STB - Scrub/Thicket/Bush, PF - Plantation Forest, CF - Colonising Forest

**Disturbance category:** C - Cutting, L - Logging, F - Fire, Cu - Cultivation, Pa - Path

**APPENDIX 4**  
**SPECIES LISTS FOR COASTAL FORESTS (NOT INCLUDING DATA FROM BURGESS & CLARKE (2000))**

**VASCULAR PLANTS**

Family	Genus	species	Ruvu South		Pugu FR		Kazimzumbwi		Pande Game	
			FR	Reference		Reference	FR	Reference	Reserve	Reference
Acanthaceae	<i>Barleria</i>	<i>prionitis</i>			x	Mwa.'91	x	Rul.'95	x	Mwa.'91
	<i>Elytraria</i>	<i>acaulis</i>			x	Nda.'95				
	<i>Hypoestes</i>	<i>forskalii</i>			x	Nda.'95, Mba.'91	x	Rul.'95	x	Mwa.'91
	<i>Lankesteria</i>	<i>alba</i>			x	Nda.'95				
	<i>Pseudoranthenus</i>	<i>hildebrandtii</i>			x	Mwa.'91			x	Mwa.'91
	<i>Sclerochiton</i>	<i>holstii</i>			x	Mwa.'91			x	Mwa.'91
	<i>Sclerochiton</i>	<i>vogelii</i>			x	Mwa.'91			x	Burg.'90, Mwas.'94 Mwa.'91
	<i>Thurnibergia</i>	<i>kirkii</i>			x	Nda.'95				
	<i>Thurnibergia</i>	sp.			x	Nda.'95				
	<i>Whitfielda</i>	<i>stuhmannii</i>							x	Burg.'90, Mwas.'94
Amaranthaceae	<i>Achyranthes</i>	<i>aspera</i>								
Anacardaceae	<i>Lannea</i>	<i>schweinfurthii</i>			x	Ism.'95, Mwa.'91			x	Burg.'90, Mwas.'94 Mwa.'91
	<i>Lannea</i>	<i>stuhlmanii</i>			x	Mwa.'91				
	<i>Lannea</i>	sp.			x	Nda.'95				
	<i>Ozoroa</i>	<i>mucronata</i>			x	Nda.'95, Mwa.'91			x	Mwa.'91
	<i>Rhus</i>	<i>longipes</i>			x	Mwa.'91				
	<i>Sclerocarya</i>	<i>caffra</i>							x	Mbw.'91
	<i>Sorindeia</i>	<i>madagascariensis</i>			x	Mbw.'91	x	Rul.'95		
Annonaceae	<i>Annona</i>	<i>senegalensis</i>			x	Nda.'95, Mbw.'91 Mwa.'91			x	Mwa.'91
	<i>Artabotrys</i>	<i>sp.aff. brachypetalus</i>			x	Nda.'95, Mwa.'91			x	Mwa.'91
	<i>Artabotrys</i>	<i>modestus</i>			x	Mwa.'91	x	Rul.'95	x	Mwa.'91

Family	Genus	species	Ruvu South	Pugu FR	Kazimzumbwi		Pande Game	Reference	
			FR	Reference	FR	Reference	Reserve		
	<i>Asteranthe</i>	<i>asterias</i>		x	Nda.'95, Mwa.'91		x	Burg.'90, Mwas.'94 Mwa.'91	
	<i>Monanthataxis</i>	<i>buchananii</i>		x	Nda.'95, Mwa.'91	x	Rul.'95	x	Burg.'90, Mwa.'91
	<i>Monanthataxis</i>	<i>formicata</i>						x	Burg.'90
	<i>Monanthataxis</i>	<i>trichocarpa</i>		x	Nda.'95, Mwa.'91			x	Burg.'90, Mwas.'94 Mwa.'91
	<i>Monanthataxis</i>	<i>formicata</i>						x	Mwas.'94
	<i>Monodora</i>	<i>grandidieri</i>		x	Mwa.'91	x	Rul.'95	x	Burg.'90, Mwa.'91
	<i>Monodora</i>	<i>junodii</i>		x	Mwa.'91				
	<i>Monodora</i>	<i>minor</i>		x	Mwa.'91			x	Burg.'90, Mwas.'94 Mwa.'91
	<i>Ophrypetalum</i>	<i>odoratum</i>		x	Nda.'95, Mwas. Mwa.'91			x	Burg.'90, Mwa.'91
	<i>Uvaria</i>	<i>acuminata</i>		x	Nda.'95			x	Burg.'90, Mwas.'94
	<i>Uvaria</i>	<i>kirkii</i>		x	Mwa.'91	x	Rul.'95	x	Mwa.'91
	<i>Uvaria</i>	<i>leptocladon</i>		x	Nda.'95				
	<i>Uvaria</i>	<i>pandensis</i> **		x	Nda.'95, Mwas. Cla.'95			x	Burg.'90, Mwas.'94 Mwa.'91, Cla.'95
	<i>Uvaria</i>	<i>tanzaniae</i>						x	Burg.'90
	<i>Uvaria</i>	sp.nov. **		x	Nda.'95, Mwas. Mba.'91, Cla.'95			x	Burg.'90, Mwas.'94 Cla.'95
	<i>Uvaria</i>	sp.**						x	Cla.'95
	<i>Uvari dendron</i>	<i>kirkii</i>		x	Nda.'95			x	Burg.'90, Mwa.'91
	<i>Xylopia</i>	<i>arenaria</i> **		x	Ism.'95, Nda.'95 Mba.'91	x	Rul.'95	x	Mwa.'91

Family	Genus	species	Ruvu South		Pugu FR		Kazimzumbwi		Pande Game Reserve	
			FR	Reference		Reference	FR	Reference	FR	Reference
	<i>Xylopia</i>	<i>parviflora</i>			x	Ism.'95, Nda.'95				
	<i>Xylopia</i>	sp. B of FTEA **			x	How.'81, Mbw.'91 Cla.'95			x	Cla.'95
Annonaceae	?	sp. *			x	Cla.'95				
Aopocynaceae	<i>Carissa</i>	<i>tetramera</i>			x	Nda.'95, Mwa.'91	x	Rul.'95	x	Mwa.'91
	<i>Dictyophleba</i> <i>Holarrhena</i>	<i>lucida</i> <i>pubescens</i>			x	Nda.'95			x	Burg.'90, Mwas.'94
	<i>Landolphia</i>	<i>kirkii</i>			x	Nda.'95	x	Rul.'95	x	Burg.'90, Mwas.'94
	<i>Mascarenhasia</i>	<i>arborescens</i>			x	Mwa.'91				
	<i>Rauwolfia</i>	<i>caffra</i>			x	Nda.'95				
	<i>Rauwolfia</i>	<i>mombasiana</i>			x	Mwa.'91				
	<i>Rauwolfia</i>	<i>nigelise</i>			x	Mwa.'91				
	<i>Saba</i>	<i>comorensis</i>			x	Nda.'95	x	Rul.'95	x	Burg.'90, Mwas.'94
	<i>Schizozygia</i>	<i>coffaeoides</i>			x	Nda.'95				
	<i>Stephanostoma</i> *	<i>stenocarpus</i> *			x	How.'81				
	<i>Stropanthus</i>	<i>courmontii</i>			x	Mwa.'91			x	Mwa.'91
	<i>Stropanthus</i>	<i>kombe</i>			x	Nda.'95				
	<i>Stropanthus</i>	<i>petersiana</i>			x	Nda.'95			x	Burg.'90, Mwas.'94
	<i>Voacanga</i>	<i>africana</i>			x	Mwa.'91				
Araceae	<i>Gonatopus</i>	<i>boivinnii</i>			x	Nda.'95				
Araliaceae	<i>Cussonia</i>	<i>zimmermanii</i>			x	Ism.'95, Nda.'95	x	Rul.'95		
Aristolochiaceae	<i>Aristolochia</i>	<i>petersiana</i>			x	Mwa.'91				
Asclepiadaceae	<i>Harrisonia</i>	<i>abyssinica</i>			x	Mwa.'91				
	<i>Anchomanes</i>	<i>abbreviatus</i>			x	Nda.'95				
Asclepiadaceae	<i>Anchomanes</i>	<i>difformis</i>			x	Mwa.'91	x	Rul.'95	x	Mwa.'91
	<i>Sarcostemma</i>	<i>viminale</i>			x	Nda.'95				
Asteraceae	<i>Aspilia</i>	sp. *			x	Cla.'95				
Balanitaceae	<i>Balanites</i>	<i>wilsoniana</i>			x	Nda.'95				

Family	Genus	species	Ruvu South FR		Pugu FR		Kazimzumbwi		Pande Game Reserve	
			FR	Reference	FR	Reference	FR	Reference	FR	Reference
Bignoniaceae	<i>Fernandoa</i>	<i>magnifica</i>			x	Nda.'95, Mbw.'91			x	Mbw.'91
	<i>Kigelia</i>	<i>africana</i>			x	Nda.'95				
	<i>Markhamia</i>	<i>obtusifolia</i>			x	Nda.'95, Mwa.'91	x	Rul.'95	x	Mbw.'91
	<i>Markhamia</i>	<i>zanzibarica</i>			x	Mbw.'91			x	Burg.'90, Mwas.'94 Mwa.'91
	<i>Markhamia</i>	<i>zanzibarensis</i>			x	Nda.'95	x	Rul.'95		
Bombaceae	<i>Fernandoa</i>	<i>magnifica</i>			x	Ism.'95				
	<i>Adansonia</i>	<i>digitata</i>							x	Mbw.'91
	<i>Bombax</i>	<i>schumannianum</i>							x	Burg.'90
	<i>Bombax</i>	<i>rhodognaphalon</i>			x	Nda.'95	x	Rul.'95	x	Mwas.'94
	<i>Ceiba</i>	sp.							x	Mbw.'91
Boraginaceae	<i>Rhodognaphalon</i>	<i>schumannianum</i>							x	Mbw.'91
	<i>Ehretia</i>	<i>amoena</i>			x	Mwa.'91			x	Mwa.'91
	<i>Ehretia</i>	<i>bakeri</i>			x	Ism.'95, Nda.'95 Mwa.'91			x	Burg.'90, Mwas.'94 Mwa.'91
	<i>Ehretia</i>	<i>litoralis</i>			x	Mwa.'91			x	Mwa.'91
	<i>Ehretia</i>	sp.							x	Mbw.'91
Burseraceae	<i>Bourreria</i>	<i>petiolaris</i>			x	Mwas.				
	<i>Commiphora</i>	<i>fulvotomentosa</i>			x	Mbw.'91, Mwa.'91			x	Mwa.'91
	<i>Commiphora</i>	<i>madagascariensis</i>			x	Mwa.'91			x	Mwa.'91
	<i>Commiphora</i>	<i>serrata</i>			x	Ism.'95, Nda.'95				
	<i>Commiphora</i>	<i>zimmermanii</i>			x	How.'81, Mbw.'91			x	Mbw.'91
Cactaceae	<i>Rhipsalis</i>	sp.			x	Nda.'95				
Caesalpiniaceae	<i>Afzelia</i>	<i>quanzensis</i>			x	Mbw.'91	x	Rul.'95	x	Mbw.'91
	<i>Caesalpinia</i>	<i>bonduc</i>			x	Nda.'95				
	<i>Caesalpinia</i>	<i>volkensii</i>			x	Nda.'95				
	<i>Cassia</i>	<i>abbreviatus</i>			x	Ism.'95, Nda.'95	x	Rul.'95		
	<i>Cassia</i>	<i>afrofistula</i>			x	Mbw.'91, Mwa.'91			x	Mwa.'91
	<i>Cassia</i>	<i>petersiana</i>			x	Mwa.'91			x	Mwa.'91

Family	Genus	species	Ruvu South	Pugu FR	Kazimzumbwi		Pande Game	Reference	
			FR	Reference	FR	Reference	Reserve		
	<i>Cynometra</i>	<i>webberi</i>		x	Ism.'95, Nda.'95	x	Rul.'95	x	Burg.'90, Mwa.'91
	<i>Cynometra</i>	<i>suahelensis</i>						x	Burg.'90
	<i>Cynometra</i>	sp.		x	How.'81				
	<i>Dialium</i>	<i>holtzii</i>		x	Ism.'95, Nda.'95	x	Rul.'95		
					How.'81				
				x	Mbw.'91				
	<i>Hymeneae</i>	<i>verrucosa</i>		x	Ism.'95, Nda.'95	x	Rul.'95	x	Mbw.'91, Mwa.'91
					How.'81, Mbw.'91				
					Mwa.'91				
	<i>Julbernadia</i>	<i>magnistipulata</i>		x	Mbw.'91, Mwa.'91			x	Mwa.'91
	<i>Mezoneuron</i>	<i>angolense</i>		x	Mwa.'91				
	<i>Scorodophloeus</i>	<i>fischeri</i>		x	Ism.'95, Nda.'95	x	Rul.'95	x	Burg.'90, Mwas.'94
					How.'81, Mbw.'91				Mwa.'91
					Mba.'91				
	<i>Tessmania</i>	<i>mauritania</i> **		x	Ism.'95, Nda.'95			x	Cla.'95
					Cl.'95				
Capparaceae	<i>Trachylobium</i>	<i>verricosum</i>		x	Mbw.'91				
	<i>Capparis</i>	<i>erythrocarpos</i>		x	Nda.'95			x	Burg.'90
	<i>Capparis</i>	<i>viminea</i>		x	Nda.'95, Mwa.'91	x	Rul.'95	x	Mwa.'91
	<i>Maerua</i>	<i>holstii</i>		x	Mwa.'91			x	Mwa.'91
	<i>Maerua</i>	sp.		x	Nda.'95				
	<i>Ritchie</i>	<i>capparoides</i>		x	Nda.'95, Mwa.'91			x	Mwa.'91
Capparidaceae	<i>Thylachium</i>	<i>macrophyllum</i>		x	Mwa.'91				
Celastraceae	<i>Elaeodendron</i>	<i>buchananii</i>		x	Mwa.'91	x	Rul.'95	x	Mwa.'91
	<i>Elaeodendron</i>	<i>schlecterianum</i>		x	Mwa.'91			x	Mwa.'91
	<i>Hippocratea</i>	<i>africana</i>						x	Burg.'90
	<i>Hippocratea</i>	<i>clematoides</i>						x	Burg.'90
	<i>Maytenus</i>	<i>heterophylla</i>		x	Nda.'95				

Family	Genus	species	Ruvu South	Pugu FR		Kazimzumbwi		Pande Game	Reference
			FR	Reference	Reference	FR	Reference	Reserve	
	<i>Maytenus</i>	<i>mossambicence</i>			x	Nda.'95, Mwa.'91		x	Mwa.'91
	<i>Maytenus</i>	<i>senegalensis</i>			x	Nda.'95, Mwa.'91	x	Rul.'95	Mwa.'91
	<i>Maytenus</i>	<i>undata</i>			x	Nda.'95, Mwa.'91	x	Rul.'95	Burg.'90, Mwas.'94 Mwa.'91
	<i>Salacia</i>	<i>elegans</i>			x	Nda.'95, Mwa.'91		x	Burg.'90, Mwas.'94 Mbw.'91, Mwa.'91
	<i>Salacia</i>	<i>leptoclada</i>			x	Nda.'95			
	<i>Salacia</i>	<i>madagascariensis</i>			x	Nda.'95, Mwa.'91	x	Rul.'95	Burg.'90, Mwas.'94 Mwa.'91 Mbw.'91
	<i>Salacia</i>	sp.						x	Mbw.'91
Chenopodiaceae	<i>Spirostachis</i>	<i>africana</i>						x	Mbw.'91
Clusiaceae	<i>Harungana</i>	<i>madagascariensis</i>						x	Burg.'90
Colchicaceae	<i>Gloriosa</i>	<i>superba</i>					x	Rul.'95	
Combretaceae	<i>Combretum</i>	<i>butyrosom</i>			x	Nda.'95, Mwa.'91		x	Mwa.'91
	<i>Combretum</i>	<i>celastroides</i>			x	Nda.'95, Mwa.'91		x	Mwa.'91
	<i>Combretum</i>	<i>harrisii</i> **	x	Cla.'95	x	Nda.'95, Mbw.'91 Mwa.'91, Cla.'95	x	Rul.'95	Burg.'90, Mbw.'91 Mwa.'91, Cla.'95
	<i>Combretum</i>	<i>holtzii</i>					x	Rul.'95	
	<i>Combretum</i>	<i>illiarii</i>			x	Nda.'95		x	Mwas.'94, Mbw.'91 Burg.'90
	<i>Combretum</i>	<i>molle</i>					x	Rul.'95	
	<i>Combretum</i>	<i>padoides</i>			x	Nda.'95			
	<i>Combretum</i>	<i>pentagonum</i>			x	Nda.'95, Mwa.'91	x	Rul.'95	Burg.'90, Mwas.'94 Mwa.'91
	<i>Combretum</i>	<i>schumannii</i>						x	Burg.'90
	<i>Combretum</i>	sp.			x	Nda.'95		x	Burg.'90

Family	Genus	species	Ruvu South	Pugu FR		Kazimzumbwi		Pande Game	Reference	
			FR	Reference	Reference	FR	Reference	Reserve		
Compositae	<i>Pteleopsis</i>	<i>myrtifolia</i>			x	Mbw.'91, Mwa.'91	x	Rul.'95	x	Mbw.'91, Mwa.'91
	<i>Pteleopsis</i>	<i>stuhmannii</i>			x	Ism.'95				
	<i>Terminalia</i>	<i>sericey</i>							x	Mbw.'91
	<i>Terminalia</i>	<i>spinosum</i>							x	Mbw.'91
	<i>Ageratum</i>	<i>conyzoides</i>							x	Burg.'90, Mwas.'94
	<i>Aspilia</i>	sp. *			x	How.'81, Mba.'91				
	<i>Bidens</i>	<i>pilosa</i>							x	Burg.'90, Mwas.'94
	<i>Blepharispermum</i>	<i>zanguebaricum</i>			x	Mwa.'91			x	Burg.'90, Mwa.'91
	<i>Blumea</i>	<i>aurita</i>							x	Burg.'90, Mwas.'94
	<i>Brachylaena</i>	<i>huillensis</i>			x	Ism.'95, Nda.'95 Mwa.'91			x	Burg.'90, Mwas.'94 Mwa.'91
	<i>Emilia</i>	<i>japonica</i>							x	Burg.'90
	<i>Emilia</i>	<i>coccinea</i>							x	Mwas.'94
	<i>Pluchea</i>	<i>discorides</i>			x	Mwa.'91	x	Rul.'95		
	<i>Psiadia</i>	<i>arabia</i>			x	Mwa.'91			x	Mbw.'91, Mwa.'91
	<i>Psiadia</i>	<i>puctulata</i>			x	Mwa.'91			x	Mwa.'91
<i>Tridax</i>	<i>procumbens</i>							x	Burg.'90, Mwas.'94	
<i>Veronia</i>	<i>cinerea</i>							x	Burg.'90, Mwas.'94	
Connaraceae	<i>Brysocarpus</i>	<i>boivinianus</i>			x	Mwa.'91			x	Mwa.'91
	<i>Brysocarpus</i>	<i>brownii</i>			x	Nda.'95				
	<i>Brysocarpus</i>	<i>orientalis</i>			x	Mwa.'91	x	Rul.'95	x	Mwa.'91
	<i>Cnestis</i>	<i>confertiflora</i>			x	Nda.'95, Mwa.'91			x	Mwa.'91
Convolvulaceae	<i>Bonamia</i>	<i>mossambicensis</i>			x	Nda.'95			x	Burg.'90, Mwas.'94

Family	Genus	species	Ruvu South FR		Pugu FR		Kazimzumbwi		Pande Game Reserve	
			FR	Reference	Reference	FR	Reference	FR	Reference	
Convolvulaceae	<i>Jacquemontia</i>	<i>paniculata</i>			x	Nda.'95				
	<i>Ipomoea</i>	<i>ochracea</i>					x	Rul.'95		
Cucurbitaceae	<i>Coccinia</i>	<i>grandis</i>			x	Nda.'95				
	<i>Coccinia</i>	sp.							x	Burg.'90, Mwas.'94
	<i>Momordica</i>	<i>trifoliata</i>					x	Rul.'95		
Cycadaceae	<i>Encephalartos</i>	<i>hildebrandtii</i>			x	Mwa.'91, Cla.'95	x	Rul.'95	x	Mwas.'94, Mwa.'91 Burg.'90, Cla.'95
		(CITES Appendix 1)								
Cyperaceae	<i>Mariscus</i>	sp.							x	Burg.'90, Mwas.'94
	<i>Scleria</i>	<i>lithosperma</i>							x	Burg.'90, Mwas.'94
	<i>Scleria</i>	<i>racemose</i>			x	Nda.'95				
	<i>Pycerus</i>	sp. *					x	Cla.'95		
Dichapetalaceae	<i>Dichapetalum</i>	<i>arenarium</i>			x	Nda.'95, Mwa.'91			x	Burg.'90, Mwa.'91
	<i>Dichapetalum</i>	<i>braunii</i>			x	Mwa.'91				
	<i>Dichapetalum</i>	<i>mossambicensis</i>			x	Nda.'95, Mwa.'91			x	Mwas.'94, Mwa.'91
	<i>Dichapetalum</i>	<i>stuhlmannii</i>			x	Nda.'95, Mbw.'91 Mwa.'91	x	Rul.'95	x	Burg.'90, Mwas.'94 Mbw.'91, Mwa.'91
Dilliniaceae	<i>Tetracera</i>	<i>boiviana</i>							x	Mwa.'91
	<i>Tetracera</i>	<i>littoralis</i>			x	Nda.'95				
Ebenaceae	<i>Diospyros</i>	<i>brucei</i>			x	Ism.'95, Nda.'95 Mwa.'91			x	Burg.'90
	<i>Diospyros</i>	<i>capricornuta</i> **			x	Cla.'95				
	<i>Diospyros</i>	<i>engleri</i> *			x	How.'81, Mba.'91 Mwa.'91				
	<i>Diospyros</i>	<i>ferruginea</i>			x	Mwa.'91				
	<i>Diospyros</i>	<i>greenwayi</i>							x	Burg.'90
	<i>Diospyros</i>	<i>mafiensis</i>			x	Nda.'95				
	<i>Diospyros</i>	<i>menispiliformis</i>			x	Nda.'95				
	<i>Diospyros</i>	<i>squarrosa</i>							x	Mwas.'94

Family	Genus	species	Ruvu South FR		Pugu FR		Kazimzumbwi		Pande Game Reserve	
			FR	Reference		Reference	FR	Reference	FR	Reference
	<i>Diospyros</i>	<i>verrucosa</i>			x	Ism.'95, Nda.'95 Mwa.'91	x	Rul.'95	x	Burg.'90, Mbw.'91 Mwa.'91
	<i>Diospyros</i>	sp.nov. *			x	Nda.'95, Mwas.				
Erythroxylaceae	<i>Euclea</i>	<i>natalensis</i>			x	Mwa.'91	x	Rul.'95	x	Mwa.'91
	<i>Erythroxylum</i>	<i>emarginatum</i>							x	Mwa.'91
	<i>Erythroxylum</i>	sp.							x	Burg.'90
Euphorbiaceae	<i>Acalypha</i>	<i>engleri</i>			x	Nda.'95				
	<i>Acalypha</i>	<i>gillmanii</i> **							x	Cla.'95
	<i>Acalypha</i>	<i>neptunica</i>							x	Burg.'90, Mwas.'94
	<i>Acalypha</i>	<i>oillimani</i>							x	Mwa.'91
	<i>Acalypha</i>	<i>racemosa</i>			x	Mwa.'91	x	Rul.'95	x	Mwa.'91
	<i>Alchemes</i>	<i>engleri</i> **			x	Mba.'91				
	<i>Alchornea</i>	<i>laxiflorai</i>			x	Mwa.'91			x	Mwa.'91
	<i>Alichomea</i>	<i>engleri</i>			x	Mwa.'91			x	Mwa.'91
	<i>Antidesma</i>	<i>membranaceum</i>			x	Mbw.'91				
	<i>Antidesma</i>	<i>venosum</i>			x	Mwa.'91			x	Mwa.'91
	<i>Bridelia</i>	<i>cathartica</i>			x	Mwa.'91	x	Rul.'95	x	Mwa.'91
	<i>Bridelia</i>	<i>micrantha</i>			x	Mwa.'91	x	Rul.'95	x	Burg.'90, Mwa.'91
	<i>Croton</i>	<i>jatrophoides</i> **							x	Cla.'95
	<i>Croton</i>	<i>pseudopulchellus</i>			x	Nda.'95, Mwa.'91			x	Burg.'90, Mwa.'91
Euphorbiaceae	<i>Croton</i>	<i>steenkampianus</i>	x	Cla.'95						
	<i>Croton</i>	<i>sylvaticus</i>			x	Ism.'95, Nda.'95				
	<i>Drypetes</i>	<i>arguta</i>			x	Mwa.'91			x	Burg.'90, Mwas.'94 Mbw.'91, Mwa.'91
	<i>Drypetes</i>	<i>natalensis</i>			x	Nda.'95, Mwa.'91	x	Rul.'95	x	Mwa.'91
	<i>Drypetes</i>	<i>reticulata</i>							x	Burg.'90
	<i>Drypetes</i>	sp.							x	Burg.'90
	<i>Erythrococea</i>	<i>bongensis</i>			x	Mwa.'91				
	<i>Euphorbia</i>	<i>hirta</i>					x	Rul.'95		

Family	Genus	species	Ruvu South		Pugu FR		Kazimzumbwi		Pande Game Reserve	
			FR	Reference		Reference	FR	Reference		Reference
	<i>Euphorbia</i>	<i>nyikae</i>			x	Nda.'95			x	Mbw.'91
	<i>Euphorbia</i>	sp.			x	Nda.'95, Mbw.'91				
	<i>Mallotus</i>	<i>oppositifolia</i>			x	Nda.'95				
	<i>Manihot</i>	<i>glazionii</i>			x	Mbw.'91				
	<i>Margaritaria</i>	<i>discoides</i>			x	Nda.'95				
	<i>Margaritaria</i>	sp.			x	Nda.'95				
	<i>Mildbraedia</i>	<i>carpinifolia</i>			x	Nda.'95, Mwa.'91			x	Burg.'90, Mwa.'91
	<i>Oldfieldia</i>	<i>somalensis</i>			x	Mwa.'91			x	Mwa.'91
	<i>Phyllanthus</i>	<i>nummulariformis</i>			x	Mwa.'91				
	<i>Pycnocomia</i>	<i>littoralis</i>			x	Mbw.'91, Mwa.'91				
	<i>Riciniodendron</i>	<i>heudelotii</i>			x	How.'81, Mbw.'91				
	<i>Sapium</i>	<i>triloculare</i> **			x	Ism.'95, Nda.'95, How.'81, Mbw.'91, Mba.'91, Cla.'95	x	Rul.'95	x	Mbw.'91, Mwa.'91
	<i>Sapium</i>	sp. *							x	Mwa.'91, Cla.'95
	<i>Securinega</i>	<i>verrosa</i>			x	Mwa.'91			x	Mwa.'91
	<i>Suregada</i>	<i>zanzibarensis</i>			x	Nda.'95, Nda.'91	x	Rul.'95	x	Burg.'90, Mwa.'91
	<i>Tragia</i>	<i>acalyphoides</i> **			x	Cla.'95	x	Cla.'95		
	<i>Tragia</i>	<i>furialis</i>			x	Nda.'95				
	<i>Tragia</i>	<i>jatrophosides</i> *			x	Mwas.				
	<i>Flueggea</i>	<i>virosa</i>					x	Rul.'95		
	?	sp. *			x	Cla.'95				
Flacourtiaceae	<i>Bivea</i>	<i>jalbertii</i>			x	Mbw.'91, Mwa.'91				
	<i>Casearia</i>	<i>gladiformis</i>			x	Nda.'95, Mbw.'91, Mwa.'91			x	Mwa.'91
	<i>Casearia</i>	<i>holtzii</i> **			x	Mba.'91, Mwa.'91				

Family	Genus	species	Ruvu South	Pugu FR		Kazimzumbwi		Pande Game Reserve	Reference
			FR	Reference	Reference	FR	Reference	Reference	
	<i>Dovyalis</i>	<i>macrocalyx</i>			x	Nda.'95			
	<i>Flacourtia</i>	<i>indica</i>			x	Mwa.'91	x	Rul.'95	
	<i>Grandidiera</i>	<i>boivinnii</i>			x	Nda.'95			
	<i>Ludia</i>	<i>mauritiana</i>			x	Nda.'95, Mwa.'91			
	<i>Paropsia</i>	<i>braunii</i>			x	Mbw.'91, Mwa.'91			
	<i>Xylothea</i>	<i>tettensis</i>			x	Nda.'95, Mwa.'91	x	Rul.'95	x Mwa.'91
Graminae	<i>Digitaria</i>	<i>milanjiana</i>							x Burg.'90, Mwas.'94
	<i>Eragrostis</i>	<i>ciliaris</i>							x Burg.'90, Mwas.'94
	<i>Flagellaria</i>	<i>guineense</i>			x	Nda.'95, Mwa.'91			x Mwa.'91
	<i>Humbertochloa</i>	<i>greenwayii</i> **			x	Nda.'95, How.'81 Mba.'91	x	Rul.'95	
	<i>Megastachya</i>	<i>mucronata</i>							x Burg.'90
	<i>Olyra</i>	<i>latifolia</i>			x	Nda.'95			
	<i>Panicum</i>	<i>trichocaldium</i>			x	Nda.'95			x Mwas.'94
	<i>Panicum</i>	<i>deustum</i>							x Burg.'90
	<i>Panicum</i>	<i>trichocladum</i>							x Burg.'90
	<i>Pennisetum</i>	<i>purpureum</i>							x Burg.'90, Mwas.'94
Guttiferae	<i>Garcinia</i>	<i>acutifolia</i> **			x	Nda.'95, Mwa.'91 Cla.'95	x	Rul.'95	x Mwa.'91
	<i>Garcinia</i>	<i>buchananii</i>			x	Mwa.'91			x Burg.'90, Mwa.'91
	<i>Garcinia</i>	<i>livingstonei</i>			x	Nda.'95, Mbw.'91			x Mbw.'91
Guttiferae	<i>Garcinia</i>	sp.							x Burg.'90
	<i>Vismia</i>	<i>orientalis</i>			x	Mwa.'91			x Burg.'90, Mwas.'94 Mwa.'91
Hymenocardiaceae	<i>Hymenocardia</i>	<i>ulmoides</i>			x	Ism.'95, Nda.'95			x Burg.'90, Mwa.'91

Family	Genus	species	Ruvu South	Pugu FR	Kazimzumbwi		Pande Game Reserve		
			FR	Reference	Reference	FR	Reference	FR	Reference
Icacinaceae	<i>Apodytes</i>	<i>dimidiata</i>		x	Mbw.'91				
Labiatae	<i>Hoslundia</i>	<i>opposita</i>		x	Nda.'95				
	<i>Plectrabthus</i>	<i>seretii</i>		x	Mwa.'91	x	Rul.'95	x	Mwa.'91
	<i>Tinnea</i>	<i>aethiopica</i>		x	Nda.'95				
Lecythidaceae	<i>Barringtonia</i>	<i>racemosa</i>		x	Mwa.'91				
					Nda.'95,				
					Mbw.'91				
					Mwa.'91				
	<i>Foetidia</i>	<i>africana</i>							
	<i>Foetidia</i>	<i>spinov</i>		x	Mbw.'91				
Leguminosae	<i>Brachystegia</i>	<i>spiciformis</i>		x	How.'81, Mbw.'91	x	Rul.'95	x	Mbw.'91
	<i>Erythrophleum</i>	<i>suaveolens</i>		x	How.'81, Mbw.'91				
	<i>Erythrophleum</i>	sp.		x	Mbw.'91				
	<i>Guibortia</i>	<i>schliebenii</i>		x	Mbw.'91	x	Rul.'95	x	Mbw.'91
	<i>Pirostigma</i>	<i>thorningii</i>		x	Mbw.'91				
	<i>Tamarindus</i>	<i>indica</i>						x	Mbw.'91
	<i>Baphiopsis</i>	<i>africana</i>						x	Burg.'90, Mwas.'94
Liliaceae	<i>Asparagus</i>	<i>africana</i>		x	Nda.'95				
	<i>Asparagus</i>	<i>falcatus</i>				x	Rul.'95	x	Burg.'90
	<i>Hugonia</i>	<i>castaneifolia</i>		x	Nda.'95, Mwa.'91	x	Rul.'95	x	Mwas.'94, Mwa.'91
	<i>Hugonia</i>	sp.						x	Burg.'90
	<i>Sansvaeria</i>	<i>zanzibarica</i>		x	Nda.'95				
Loganiaceae	<i>Mostuea</i>	<i>brunonis</i>		x	Nda.'95, Mwa.'91			x	Burg.'90, Mwa.'91
	<i>Mostuea</i>	<i>microphylla</i>		x	Mwa.'91				
	<i>Strychnos</i>	<i>lucens</i>		x	Mwa.'91				
	<i>Strychnos</i>	<i>madagascariensis</i>						x	Mwa.'91
	<i>Strychnos</i>	<i>panganensis</i>		x	Nda.'95, Mwa.'91	x	Rul.'95	x	Burg.'90, Mwa.'91
	<i>Strychnos</i>	<i>scheffleria</i>		x	Mwa.'91				
	<i>Strychnos</i>	<i>usambarensis</i>						x	Burg.'90
	<i>Strychnos</i>	sp.						x	Mbw.'91

Family	Genus	species	Ruvu South FR		Pugu FR		Kazimzumbwi FR		Pande Game Reserve	
				Reference		Reference		Reference		Reference
Loranthaceae	<i>Tapinanthus</i>	<i>longipes</i> **			x	How.'81, Mba.'91 Cla.'95				
Lovanthuaceae	<i>Lovanthus</i>	<i>hildebrandtii</i>			x	Mbw.'91				
Malphiaceae	<i>Acridocarpus</i>	<i>chloropterus</i>			x	Nda.'95, Mwa.'91			x	Mwa.'91
	<i>Acridocarpus</i>	<i>pauciglandulosus</i> **			x	Cla.'95				
	<i>Acridocarpus</i>	sp.			x	Nda.'95				
	<i>Tristellateia</i>	<i>africana</i>			x	Mwa.'91				
Malvaceae	<i>Abutilon</i>	<i>mauritanum</i>			x	Mwa.'91				
	<i>Gossypiodes</i>	<i>kirkii</i>			x	Mwa.'91			x	Burg.'90, Mwa.'91
	<i>Hibiscus</i>	<i>vitifolius</i>			x	Mwa.'91				
	<i>Thespesia</i>	<i>danis</i>			x	Mwa.'91			x	Mwa.'91
Melastomataceae	<i>Memecylon</i>	<i>myrianthum</i>			x	Mwa.'91				
	<i>Memecylon</i>	<i>sansibaricum</i>			x	Mwa.'91	x	Rul.'95	x	Burg.'90
Meliaceae	<i>Khaya</i>	<i>nyasica</i>			x	Mwa.'91				
	<i>Lepidotrichilia</i>	<i>volkensii</i>							x	Mbw.'91
	<i>Pseudobersama</i>	<i>mossambicensis</i>			x	Nda.'95				
	<i>Turraea</i>	<i>floribunda</i>			x	Mwa.'91				
	<i>Turraea</i>	<i>mombassana</i>			x	Mwa.'91			x	Mwa.'91
	<i>Turraea</i>	<i>wakefieldii</i>			x	Mwa.'91			x	Mwa.'91
Meliantaceae	<i>Bersoma</i>	<i>suffruticosa</i>			x	Mbw.'91, Mwa.'91				
Menispermaceae	<i>Jateorhiza</i>	<i>palmata</i>			x	Nda.'95				
	<i>Tiliacora</i>	<i>funifera</i>			x	Nda.'95				
	<i>Tinospora</i>	<i>caffre</i>			x	Nda.'95			x	Burg.'90, Mwas.'94
Mimosaceae	<i>Acacia</i>	<i>adenocalyx</i>							x	Burg.'90, Mwas.'94
Mimosaceae	<i>Acacia</i>	<i>brevispica</i>			x	Nda.'95				
	<i>Acacia</i>	<i>nergescens</i>			x	Ism.'95, Nda.'95				
	<i>Acacia</i>	<i>pentagona</i>					x	Rul.'95		
	<i>Acacia</i>	<i>rovumae</i>			x	Mbw.'91				
	<i>Albizia</i>	<i>glabberima</i>			x	Ism.'95, Nda.'95				

Family	Genus	species	Ruvu South	Pugu FR	Kazimzumbwi		Pande Game Reserve			
			FR	Reference	Reference	FR	Reference	FR	Reference	
	<i>Albizia</i>	<i>petersiana</i>		x	Ism.'95, Nda.'95 Mbw.'91		x	Rul.'95	x	Mbw.'91
	<i>Albizia</i>	<i>gummerifera</i>		x	Nda.'95, How.'81 Mwa.'91					
	<i>Albizia</i>	<i>versicolor</i>		x	Ism.'95					
	<i>Dichrostachys</i>	<i>cinerea</i>		x	Mwa.'91		x	Rul.'95	x	Mbw.'91, Mwa.'91
	<i>Newtonia</i>	<i>paucijuga</i>		x	Ism.'95, Nda.'95 How.'81, Mbw.'91 Mwa.'91		x	Rul.'95	x	Burg.'90
	<i>Parkia</i>	<i>filicoides</i>		x	Nda.'95, How.'81 Mbw.'91, Mwa.'91					
	<i>Xylia</i>	<i>africana</i>		x	Ism.'95, Nda.'95					
Moraceae	<i>Antiaris</i>	<i>toxicaria</i>		x	Ism.'95, Nda.'95 How.'81, Mbw. '91 Mba.'91		x	Rul.'95		
	<i>Bosqueia</i>	<i>phoberos</i>		x	How.'81, Mbw. '91					
	<i>Chlorophora</i>	<i>excelsa</i>		x	Mbw.'91				x	Mbw.'91
				x	How.'81, Mwa.'91					
	<i>Ficus</i>	<i>exasperata</i>		x	Nda.'95		x	Rul.'95		
	<i>Ficus</i>	sp.		x	Mbw.'91				x	Mbw.'91
	<i>Milicia</i>	<i>excelsa</i>		x	Ism.'95, Nda.'95		x	Rul.'95		
	<i>Sloetiopsis</i>	<i>usambarensis</i>		x	Nda.'95					
	<i>Trilepisium</i>	<i>madagascariensis</i>		x	Ism.'95, Nda.'95					
Myrtaceae	<i>Eugenia</i>	sp.		x	Nda.'95					

Family	Genus	species	Ruvu South	Pugu FR	Kazimzumbwi		Pande Game Reserve		
			FR	Reference	Reference	FR	Reference	FR	Reference
Ochnaceae	<i>Ochna</i>	<i>atropurpurea</i>		x	Nda.'95				
	<i>Ochna</i>	<i>holtzii</i>		x	Nda.'95, Mwa.'91	x	Rul.'95	x	Mwa.'91
	<i>Ochna</i>	<i>mossambicensis</i>		x	Mwa.'91			x	Mwa.'91
	<i>Ochna</i>	<i>purpurea</i>		x	Mwa.'91	x	Rul.'95	x	Mwa.'91
	<i>Ochna</i>	<i>thomasiana</i>		x	Nda.'95, Mwa.'91			x	Burg.'90, Mwa.'91
	<i>Ochna</i>	sp.						x	Burg.'90
	<i>Ochna</i>	<i>mossambicensis</i>		x	Mbw.'91			x	Mbw.'91
Oleaceae	<i>Olex</i>	<i>dissitiflora</i>		x	Mbw.'91			x	Mbw.'91
	<i>Chionathus</i>	<i>battiscombei</i>		x	Nda.'95				
	<i>Olea</i>	<i>africana</i>		x	Mbw.'91				
Opiliaceae	<i>Rhopalopilium</i>	<i>umbellulata</i>		x	Mwa.'91				
Orchidaceae	<i>Microcoelia</i>	<i>exilis</i>						x	Burg.'90
Papilionaceae	<i>Polystachya</i>	<i>puguensis</i> *		x	Mwas.				
	<i>Angylocalyx</i>	<i>braunii</i>		x	Ism.'95, Nda.'95 Mwa.'91			x	Burg.'90, Mwa.'91
	<i>Baphia</i>	<i>kirkii</i>		x	Ism.'95, Nda.'95	x	Rul.'95	x	Burg.'90, Mwas.'94
	<i>Baphia</i>	<i>kirkii</i>			How.'81, Mbw.'91				Mbw.'91
	<i>Baphia</i>	<i>puguensis</i> **		x	Nda.'95, How.'81 Mba.'91, Mwa.'91 Cla.'95	x	Cla.'95		
	<i>Craibia</i>	<i>brevicandata</i>		x	Nda.'95			x	Burg.'90
	<i>Crotolaria</i>	<i>axillaris</i>		x	Mwa.'91			x	Mwa.'91
	<i>Crotolaria</i>	<i>goodiformis</i>		x	Nda.'95, Mwa.'91			x	Mwa.'91
	<i>Crotolaria</i>	<i>retusa</i>		x	Mwa.'91			x	Mwa.'91
	<i>Dalbergia</i>	<i>acariintha</i> **				x	Cla.'95		
	<i>Dalbergia</i>	<i>bracteolata</i>		x	Mwa.'91			x	Mwa.'91
	<i>Dalbergia</i>	<i>melanoxylone</i>		x	Mbw.'91			x	Mbw.'91

Family	Genus	species	Ruvu South	Pugu FR	Kazimzumbwi		Pande Game	Reference	
			FR	Reference	FR	Reference	Reserve		
Papilionaceae	<i>Dalbergia</i>	<i>obovata</i>		x	Nda.'95, Mbw.'91 Mwa.'91		x	Mwa.'91	
	<i>Dalbergia</i>	sp.		x	Nda.'95				
	<i>Desmodium</i>	<i>velutimum</i>		x	Mwa.'91				
	<i>Erythrina</i>	<i>sacleusii</i>		x	Nda.'95, How.'81 Mbw.'91	x	Rul.'95	x	Mwas.'94, Mbw.'91
	<i>Millettia</i>	<i>eetveldeana</i>		x	Mwa.'91			x	Mwa.'91
	<i>Millettia</i>	<i>impressa</i>		x	Nda.'95			x	Burg.'90, Mwas.'94
	<i>Millettia</i>	<i>puguensis</i> **		x	Nda.'95, How.'81 Mba.'91, Mwa.'91 Cla.'95	x	Rul.'95, Cla.'95	x	Mbw.'91
	<i>Millettia</i>	<i>usaramensis</i>		x	Ism.'95, Mwa.'91			x	Burg.'90, Mwas.'94
	<i>Platysepalum</i>	<i>inopinatum</i>		x	Mwa.'91			x	Mwa.'91
	<i>Rhynchosia</i>	<i>holtzii</i> *		x	Nda.'95, How.'81 Mba.'91, Cla.'95				
Passifloraceae	<i>Rhynchosia</i>	<i>sublobata</i>		x	Mbw.'91				
	<i>Schlechterina</i>	<i>mitostemmatoides</i>		x	Nda.'95, Mwa.'91			x	Burg.'90, Mwas.'94 Mwa.'91
	<i>Adenia</i>	<i>lindiensis</i>				x	Rul.'95		
	<i>Basananthe</i>	<i>zanzibarica</i>						x	Burg.'90, Mwas.'94
Polygalaceae	<i>Carpolobia</i>	<i>goetzei</i>		x	Nda.'95, Mwa.'91				
Poaceae	<i>Brachiaria</i>	<i>lindiensis</i> **		x	Cla.'95			x	Cla.'95
	<i>Eragrostis</i>	sp.nov.				x	Cla.'95		
Rhamnaceae	<i>Humbertochloa</i>	<i>greenwayi</i> *		x	Cla.'95				
	<i>Lasiodiscus</i>	<i>holtzii</i> *		x	Nda.'95, How.'81				

Family	Genus	species	Ruvu South	Pugu FR	Kazimzumbwi		Pande Game Reserve	Reference
			FR	Reference	FR	Reference	Reference	
								Mwa.'91, Cla.'95
				x				Mba.'91
				x				Mbw.'91
Rhizophoraceae	<i>Lesiodiscus</i>	<i>mildebrandtii</i>						
	<i>Cassipourea</i>	<i>malosana</i>					x	Burg.'90
Rubiaceae	<i>Aidia</i>	sp.					x	Burg.'90
	<i>Canthium</i>	<i>bibracteanum</i>		x	Mwa.'91		x	Mwa.'91
	<i>Canthium</i>	<i>mombazense</i>		x	Mwa.'91		x	Burg.'90, Mwa.'91
	<i>Canthium</i>	<i>peteri</i> **				x	Cl.'95	
	<i>Canthium</i>	<i>schimperianum</i>		x	Mwa.'91		x	Burg.'90, Mwa.'91
	<i>Canthium</i>	<i>setiflorum</i>					x	Burg.'90
	<i>Canthium</i>	<i>venosum</i>		x	Mwa.'91		x	Mwa.'91
	<i>Canthium</i>	<i>vulgare</i>		x	Mwa.'91	x	Rul.'95	x
	<i>Canthium</i>	<i>zanzibaricum</i>		x	Mwa.'91	x	Rul.'95	x
	<i>Chassalia</i>	<i>umbraticola</i>		x	Nda.'95, Mwa.'91		x	Mwa.'91
	<i>Chazallia</i>	<i>abrupta</i>		x	Nda.'95			
	<i>Cladoceras</i>	<i>subcapitatum</i>		x	Nda.'95, Mwa.'91		x	Burg.'90, Mwas.'94 Mwa.'91
	<i>Coffea</i>	<i>pseudozanguebariae</i>		x	Mwa.'91	x	Rul.'95	x
	<i>Coffea</i>	<i>sessiliflora</i> (var. Mwasumbi) **		x	Mwas., Mba.'91			
	<i>Cremaspora</i>	<i>triflora</i>		x	Nda.'95, Mwa.'91			
	<i>Crosopteris</i>	<i>febrifuga</i>					x	Mbw.'91
	<i>Fadogia</i>	sp.		x	Mwa.'91			
	<i>Gardenia</i>	<i>transvenulosa</i>		x	Nda.'95, Mwa.'91	x	Rul.'95	x
	<i>Gardenia</i>	<i>volkensii</i>			Nda.'95			x
	<i>Grumilea</i>	<i>rufescens</i> *		x	How.'81, Mba.'91 Cla.'95			Burg.'90
	<i>Heinsia</i>	<i>crinita</i>		x	Nda.'95			
	<i>Hymenodictyon</i>	<i>parvifolium</i>		x	Nda.'95			

Family	Genus	species	Ruvu South FR		Pugu FR		Kazimzumbwi FR		Pande Game Reserve	
			FR	Reference	Reference	FR	Reference	FR	Reference	
Rubiaceae	<i>Keetia</i>	<i>bibracteata</i>			x	Nda.'95				
	<i>Kraussia</i>	<i>kirkii</i>			x	Mwa.'91			x	Mwa.'91
	<i>Lamprothammus</i>	<i>zanguebaricus</i>			x	Mwa.'91				
	<i>Leptactina</i>	<i>hexamera</i>			x	Mwa.'91				
	<i>Leptactina</i>	<i>oxyloba</i> **	x	Cl'a.'95						
	<i>Leptactina</i>	<i>platyphylla</i>			x	Nda.'95, Mbw.'91 Mwa.'91	x	Rul.'95	x	Burg.'90, Mwas.'94 Mwa.'91
	<i>Leptactina</i>	sp. B of FTEA *							x	Mwa.'91, Cl'a.'95
	<i>Meyna</i>	<i>tetraphyla</i>			x	Nda.'95, Mwa.'91				
	<i>Meyna</i>	sp.			x	Nda.'95				
	<i>Multidentia</i>	<i>castaneae</i> **					x	Cl'a.'95		
	<i>Mussaenda</i>	<i>monticola</i>			x	Nda.'95, Mwa.'91				
	<i>Oxyanthus</i>	<i>zanguebaricus</i>			x	Nda.'95, Mwa.'91	x	Rul.'95	x	Burg.'90, Mwa.'91
	<i>Oxyanthus</i>	sp. **			x	Nda.'95	x	Cl'a.'95		
	<i>Pavetta</i>	<i>stenosepala</i>			x	Nda.'95, Mwa.'91	x	Rul.'95	x	Mwa.'91
	<i>Pentas</i>	<i>bussei</i>			x	Mwa.'91			x	Mwa.'91
	<i>Polysphaeria</i>	<i>parviflora</i>			x	Nda.'95, Mwa.'91			x	Mwa.'91
	<i>Psychotria</i>	<i>holtzii</i>			x	Mwa.'91	x	Rul.'95	x	Burg.'90, Mbw.'91 Mwa.'91
	<i>Psychotria</i>	<i>laurecia</i>			x	Nda.'95, Mwa.'91			x	Mwa.'91
	<i>Psychotria</i>	<i>riparia</i>			x	Mbw.'91, Mwa.'91			x	Mwa.'91
	<i>Pyrostria</i>	<i>bibracteata</i>			x	Nda.'95				
<i>Rothmania</i>	<i>macrosiphon</i>			x	Ism.'95, Nda.'95 Mwa.'91			x	Burg.'90, Mwa.'91	
<i>Rothmania</i>	<i>manganjae</i>			x	Ism.'95, Nda.'95 Mbw.'91			x	Mbw.'91	

Family	Genus	species	Ruvu South	Pugu FR	Kazimzumbwi		Pande Game Reserve		
			FR	Reference	Reference	FR	Reference	FR	Reference
	<i>Rubia</i>	sp.		x	Mbw.'91				
	<i>Rytigynia</i>	<i>binata</i> **		x	Mwa.'91, Cla.'95	x	Rul.'95	x	Mwa.'91
	<i>Rytigynia</i>	<i>celastroides</i>						x	Mwas.'94
	<i>Rytigynia</i>	<i>digacantha</i>		x	Mwa.'91			x	Mwa.'91
	<i>Rytigynia</i>	<i>microphylla</i>						x	Burg.'90
	<i>Tapiphylum</i>	sp.		x	Nda.'95				
	<i>Tarenna</i>	<i>drummondii</i>		x	Mwa.'91			x	Burg.'90, Mwas.'94
	<i>Tarenna</i>	<i>nigrescens</i>		x	Mwa.'91			x	Burg.'90, Mwa.'91
	<i>Tricalysia</i>	<i>allocalyx</i> **		x	Nda.'95, Mwa.'91, Cla.'95			x	Burg.'90, Mwas.'94
	<i>Tricalysia</i>	<i>avolifolia</i>		x	Mwa.'91			x	Mwa.'91
	<i>Tricalysia</i>	<i>bridsonia</i> var. <i>pandensis</i> *						x	Mwa.'91
	<i>Tricalysia</i>	<i>ovalifolia</i>						x	Burg.'90, Mwas.'94
	<i>Tricalysia</i>	<i>pallens</i>		x	Ism.'95, Nda.'95				
	<i>Vanaueria</i>	<i>tomentosa</i>		x	Mwa.'91				
Rutaceae	<i>Teclea</i>	<i>simplicifolia</i>						x	Burg.'90
	<i>Teclea</i>	<i>trichocarpa</i>				x	Rul.'95	x	Burg.'90
	<i>Vepris</i>	<i>lanceolata</i>				x	Rul.'95		
	<i>Zanthoxylum</i>	<i>chalybeum</i>		x	Nda.'95, Mbw.'91	x	Rul.'95		
	<i>Zanthoxylum</i>	<i>holtzianum</i>		x	Ism.'95, Nda.'95			x	Burg.'90, Mwas.'94
Sapindaceae	<i>Allophylus</i>	<i>pervillei</i>		x	Nda.'95				
	<i>Allophylus</i>	<i>stachyanthus</i>		x	Mbw.'91				
	<i>Blighia</i>	<i>unijugata</i>		x	Ism.'95, Nda.'95			x	Burg.'90, Mwas.'94
	<i>Bioghiopsis</i>	sp.		x	Mbw.'91				
	<i>Deinbollia</i>	<i>borbonica</i>		x	Ism.'95, Nda.'95	x	Rul.'95		

Family	Genus	species	Ruvu South	Pugu FR	Kazimzumbwi		Pande Game Reserve		
			FR	Reference	Reference	FR	Reference	FR	Reference
	<i>Haplocoelopsis</i>	<i>africana</i>		x	Ism.'95, Nda.'95				
	<i>Haplocoelum</i>	<i>foliosum</i>		x	Nda.'95	x	Rul.'95	x	Burg.'90, Mwas.'94
	<i>Haplocoelum</i>	<i>inopleum</i>		x	Ism.'95			x	Burg.'90
	<i>Haplocoelum</i>	<i>mambasence</i>		x	Mbw.'91			x	Mbw.'91
	<i>Haplocoelum</i>	<i>trigonocarpum</i>		x	Ism.'95, Nda.'95			x	Burg.'90, Mwas.'94
	<i>Lecaniodiscus</i>	sp.nov.		x	Mwas.				
	<i>Lepisanthes</i>	<i>senegalensis</i>		x	Nda.'95				
Sapindaceae	<i>Pancovia</i>	<i>golungensis</i>		x	Nda.'95				
	<i>Pancovia</i>	<i>hildebrandtii</i>				x	Rul.'95	x	Burg.'90, Mwas.'94
	<i>Pancovia</i>	<i>holtzii</i>		x	Nda.'95			x	Burg.'90
Sapotaceae	<i>Afroseralisia</i>	<i>kassneri</i> **		x	Cl.'95				
	<i>Bequaertiodendron</i>	<i>megalismo</i>		x	Nda.'95				
	<i>Malacantha</i>	<i>alnifolia</i>		x	Mba.'91	x	Rul.'95		
	<i>Manilkara</i>	<i>discolor</i>				x	Rul.'95		
	<i>Manilkara</i>	<i>sansibarensis</i>		x	Ism.'95, Nda.'95	x	Rul.'95	x	Burg.'90, Mwas.'94
	<i>Manilkara</i>	<i>sulcata</i>		x	Ism.'95, Nda.'95, Mbw.'91, Mba.'91	x	Rul.'95	x	Burg.'90, Mwas.'94, Mbw.'91
	<i>Pachystela</i>	<i>brevipes</i>		x	Ism.'95				
Solanaceae	<i>Sideroxylon</i>	<i>inerme</i>						x	Burg.'90
Sterculiaceae	<i>Solanum</i>	<i>renschii</i>		x	Nda.'95				
	<i>Cola</i>	<i>clavata</i>				x	Rul.'95	x	Burg.'90, Mwas.'94, Mbw.'91
	<i>Cola</i>	<i>microcarpa</i>		x	Nda.'95			x	Burg.'90, Mwas.'94
	<i>Dombeya</i>	<i>shupangae</i>		x	Mbw.'91				
	<i>Nesogordonia</i>	<i>holtzii</i>		x	Ism.'95, Nda.'95			x	Burg.'90, Mwas.'94, Mwa.'91
	<i>Stercularia</i>	<i>quinqueloba</i>		x	Mbw.'91	x	Rul.'95	x	Mbw.'91
	<i>Sterculia</i>	<i>schliebenii</i> **		x	Nda.'95			x	Cl.'95

Family	Genus	species	Ruvu South	Pugu FR	Kazimzumbwi		Pande Game	Reference	
			FR	Reference	FR	Reference	Reserve		
Thymeleaceae	<i>Synaptolepis</i>	<i>kirkii</i>		x	Nda.'95	x	Rul.'95	x	Burg.'90, Mwas.'94
Tiliaceae	<i>Grewia</i>	<i>cornocarpa</i>		x	Ism.'95, Nda.'95	x	Rul.'95		
	<i>Grewia</i>	<i>forbesii</i>				x	Rul.'95	x	Burg.'90
	<i>Grewia</i>	<i>goetzeana</i>						x	Burg.'90
	<i>Grewia</i>	<i>holtzii</i>		x	Nda.'95, Mbw.'91				
	<i>Grewia</i>	<i>leptopus</i>						x	Burg.'90, Mwas.'94
	<i>Grewia</i>	<i>microcarpa</i>		x	Nda.'95, Mbw.'91				
Ulmaceae	<i>Triumfetta</i>	<i>rhombifolia</i>						x	Burg.'90
	<i>Trema</i>	<i>orientalis</i>		x	Mbw.'91	x	Rul.'95		
Verbenaceae	<i>Clerodendron</i>	<i>myricoides</i>				x	Rul.'95		
	<i>Clerodendron</i>	<i>capitatum</i>						x	Burg.'90, Mwas.'94
	<i>Clerodendron</i>	sp.		x	Nda.'95				
	<i>Lantana</i>	<i>camara</i>		x	Nda.'95				
	<i>Lippia</i>	sp.		x	Nda.'95				
	<i>Vitex</i>	<i>bunguensis</i>				x	Rul.'95		
	<i>Vitex</i>	<i>doniana</i>				x	Rul.'95	x	Mbw.'91
	<i>Vitex</i>	<i>strickeri</i>		x	Nda.'95				
	<i>Vitex</i>	<i>zanzibarensis</i>		x	Ism.'95, Nda.'95				
	<i>Vitex</i>	sp. B of FTEA *							x
Violaceae	<i>Rinorea</i>	<i>angustifolia</i>		x	Nda.'95				
	<i>Rinorea</i>	<i>ferrunginea</i>		x	Nda.'95	x	Rul.'95		
	<i>Rinorea</i>	<i>illicifolia</i>		x	Nda.'95				
Vitaceae	<i>Rinorea</i>	sp.						x	Burg.'90
	<i>Cissus</i>	<i>producta</i>						x	Burg.'90, Mwas.'94
	<i>Cissus</i>	<i>quadrangularis</i>		x	Nda.'95				
	<i>Cissus</i>	<i>rotundifolia</i>				x	Rul.'95	x	Burg.'90
	<i>Cyphostemma</i>	<i>buchananii</i>						x	Burg.'90, Mwas.'94
	<i>Cyphostemma</i>	<i>hildebrandtii</i>		x	Nda.'95			x	Burg.'90
	<i>Rhoicissus</i>	<i>revoilii</i>						x	Burg.'90

Family	Genus	species	Ruvu South	Pugu FR	Kazimzumbwi		Pande Game	Reference
			FR	Reference	FR	Reference	Reserve	
?	<i>Ecobolium</i>	<i>umbrossus</i>					x	Burg.'90, Mwa.'91
?	<i>Trichaulux</i>	<i>mwasumbii</i>					x	Mwas.'94
* Endemic								
** Near Endemic								
<b>No. of species</b>			3	377	103	271		
<b>No. of endemic species</b>			0	13	1	3		
<b>No. of near endemic species</b>			2	21	12	4		
<b>No. of endemic genera</b>			0	1	0	0		

## REFERENCES

## Abbreviation:

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**MAMMALS**

Family	Genus	species	Common name	Ruvu	Pugu FR		Kazimzumbwi		Pande
				South FR	Reference	Reference	FR	Reference	Game Reserve
<b>PRIMATES</b>									
Cercopithecidae	<i>Papio</i>	<i>cynocephalus</i>	Yellow baboon			x	How.'81, Coc.a		
Cercopithecinae	<i>Cercopithecus</i>	<i>aethiops</i>	Grivet monkey			x	How.'81		
	<i>Cercopithecus</i>	<i>albogularis</i>	White-throated monkey or, Syke's Blue monkey	x	Coc.a, b	x	Coc.a	x	Coc.a, b
Galagonidae	<i>Cercopithecus</i>	<i>mitis</i>	Gentle monkey			x	How.'81		
	<i>Cercopithecus</i>	<i>pygerythrus</i>	Vervet monkey			x	Coc.a	x	Coc.a, b
	<i>Otolemur</i>	<i>crassicaudatus</i>	Greater galago			x	How.'81		
	<i>Otolemur</i>	<i>garnetti</i> ^	Small-eared galago			x	Coc.a	x	Coc.a, b
	<i>Galago</i>	<i>senegalensis</i>	Senegal galago			x	How.'81		
	<i>Galago</i>	<i>zanzibaricus</i> *	Zanzibar galago	x	Cl.a.'95	x	Coc.a, b	x	Coc.a, b
<b>CHIROPTERA</b>									
Pteropodidae	<i>Epomophorus</i>	<i>wahlbergi</i>	Wahlberg's fruit bat	x	Coc.'98, Coc.a, b	x	How.'81	x	Coc.'98, Coc.a, b
	<i>Lissonycteris</i>	<i>angolensis</i>	Angola fruit bat			x	Coc.a	x	Coc.a, b
	<i>Myonycteris</i>	<i>relicta</i> *	Collared fruit bat	x	Coc.'98, Coc.a, b, c Cl.a.'95				
Hipposideridae	<i>Rousettus</i>	<i>aegyptiacus leachi</i>	Rousette bat, Egyptian fruit bat					x	Coc.'98, Coc.a, b
	<i>Hipposideros</i>	<i>commersoni</i>	Commerson's Leaf-nosed bat	x	Coc.b	x	Coc.b	x	Coc.'98, Coc.b
	<i>Hipposideros</i>	<i>ruber ruber</i>	Noack's African Leaf-nosed bat	x	Coc.'98, Coc.b	x	How.'81	x	Coc.'98
	<i>Triaenops</i>	<i>persicus afer</i>	Persion leaf-nosed bat	x	Coc.'98, Coc.b	x	How.'81	x	Coc.'98, Coc.b
Megadermatidae	<i>Lavia</i>	<i>frons</i>	Yellow-winged bat					x	Coc.'98, Coc.b
Molossidae	<i>Tadarida</i>	<i>major</i>	Guano bat			x	How.'81		
	<i>Tadarida</i>	<i>pumila</i>	Guano bat			x	How.'81		
Nycteridae	<i>Nycteris</i>	<i>aurita</i>	Slit faced bat	x	Coc.'98				

Family	Genus	species	Common name	Ruvu	Pugu FR		Kazimzumbwi		Pande
				South FR	Reference	Reference	FR	Reference	Game Reserve
	<i>Nycteris</i>	<i>hispidus</i>	Hairy Slit faced bat	x	Coc.b			x	Coc.'98, Coc.b
	<i>Nycteris</i>	<i>thebaica</i>	Egyptian Slit faced bat			x	How.'81, Coc.b		
Rhinolophinae	<i>Rhinolophus</i>	<i>landeri lobatus</i>	Lander's Horseshoe bat	x	Coc.'98, Coc.b	x	How.'81	x	Coc.'98, Coc.b
Vespertilionidae	<i>Eptesicus</i>	<i>capensis</i>	Cape serotine					x	Coc.'98, Coc.b
	<i>Myotis</i>	<i>tricolor</i>	Cape Hairy bat					x	Coc.'98, Coc.b
	<i>Pipstrellus</i>	<i>nanus</i>	Banana bat					x	Coc.'98, Coc.b
	<i>Scotophilus</i>	<i>dinganii</i>	Yellow House bat					x	Coc.'98, Coc.b
	<i>Scotophilus</i>	<i>hirundo</i>	Dark winged House bat					x	Coc.'98, Coc.b
<b>INSECTIVORA</b>									
Soricidae	<i>Crocidura</i>	<i>hirta</i>	White-toothed shrew	x	Coc.a	x	How.'81, Coc.c		
	<i>Crocidura</i>	<i>fuscumurina</i>	White-toothed shrew					x	
	<i>Crocidura</i>	<i>sp.</i>	White-toothed shrew					x	
<b>MACROSCELIDEA</b>									
Macroscelididae	<i>Pterodromus</i>	<i>tetradactylus</i>	Four-toed elephant shrew	x	Coc.b			x	Coc.b
	<i>Rhynchocyon</i>	<i>cirnei</i>	Chequered elephant shrew			x	How.'81		
	<i>Rhynchocyon</i>	<i>petersi</i> *	Zanj elephant shrew	x	Coc.a, b	x	Coc.a, Cla.'95	x	Coc.a, b
				x	Coc.a, Cla.'95			x	Coc.a
<b>RODENTIA</b>									
Cricetomyinae	<i>Beamys</i>	<i>hindei</i> **	Lesser pouched rat	x	Coc.b, Cla.'95				

Family	Genus	species	Common name	Ruvu South FR		Pugu FR		Kazimzumbwi		Pande Game Reserve	
				FR	Reference	Reference	FR	Reference	Reference	Reference	
Gerbillinae	<i>Cricetomys</i>	<i>gambianus</i>	Giant Gambian pouched rat			x	How.'81, Coc.a, b	x	Coc.a, b		
	<i>Cricetomys</i>	<i>hindei</i>	Giant pouched rat	x	Coc.a						
	<i>Tatera</i>	<i>leucogaster</i>	Tatera (Naked-soled) gerbil			x	How.'81				
Hystriidae	<i>Hystrix</i>	sp.	Porcupine			x	How.'81	x	Coc.a, b		
Myoxidae	<i>Graphiurus</i>	<i>murinus</i>	African dormouse			x	How.'81, Coc.a	x	Coc.b		
	<i>Graphiurus</i>	<i>sp.nov. cf parvus</i>	African dormouse					x	Coc.a		
Muridae	<i>Acomys</i>	<i>spinosissimus</i>	Spiny mouse	x	Coc.a			x	Coc.a		
	<i>Acomys</i>	<i>subspinosus</i>	Spiny mouse	x	Coc.b			x	Coc.b		
	<i>Grammomys</i>	<i>dolichurus</i>	Narrow-footed woodland mouse		Coc.b			x	Coc.a		
Sciuridae	<i>Rattus</i>	<i>rattus</i>	Black rat			x	How.'81	x	Coc.b		
	<i>Thamnommys</i>	<i>dolichurus</i>	Narrow-footed thicket rat					x	Coc.b		
	<i>Paraxerus</i>	<i>palliatus</i>	Red Bellied Coast squirrel			x	Coc.b				
<b>CARNIVORA</b>											
Felidae	<i>Panthera</i>	<i>leo</i>	Lion	x	Coc.a, b			x	Coc.a, b		
Herpestidae	<i>Herpestes</i>	<i>sanguineus</i>	Slender mongoose					x	Coc.a, b		
Nandininae	<i>Nandina</i>	<i>binotata</i>	African palm civet			x	How.'81, Coc.a				
Viverridae	<i>Civettictis</i>	<i>civetta</i>	African civet			x	How.'81				
	<i>Genetta</i>	<i>tigrina</i>	Blotched genet			x	How.'81, Coc.a				
	<i>Genetta</i>	<i>sp.</i>	Genet			x	Coc.b	x	Coc.a, b		
<b>PHOLIDOTA</b>											
Manidae	<i>Manis</i>	<i>temmincki</i>	Temminck's Ground pangolin			x	How.'81, Coc.a, b				
<b>PROBOSCIDEA</b>											
Elephantidae	<i>Loxodonta</i>	<i>africana</i> ^	African elephant	x	Coc.a, b, Cla.'95						
<b>ARTIODACTYLA</b>											
Cephalophini	<i>Cephalophus</i>	<i>natalensis</i>	Natal duiker			x	Coc.a	x	Coc.a, b		
	<i>Cephalophus</i>	sp.	Forest duiker			x	How.'81				
Suidae	<i>Potamochoerus</i>	<i>porcus</i>	Red river hog			x	How.'81, Coc.a	x	Coc.a, b		

\* Endemic to Coastal Forest and Eastern Arc (After Coc.c)

\*\* Endemic to CF/EA and a few other East African forests (After Coc.c)

^ 'Rare' species (After Coc.c)

	Ruvu South FR	Pugu FR	Kazimzumbwi FR	Pande Game Reserve
No. of endemic or near endemic species	4	3	3	-
No. of bat species	8	9	14	-
No. of non-bat species	11	26	21	-
Total no. of mammal species	19	35	35	-

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*Abbreviation:*

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- How.'81 Howell K.M. (1981) Pugu Forest Reserve: biological values and development. *African Journal of Ecology*, **19**, 73-81.

**Endemic and near endemic mammal species (After Coc.c)**

Order	Family	Genus	species	Common name	Endemic to:
Primate	Cercopethecidae	Cercocebus	galeritus	Tana mangabey	Coastal Forest
	Colobidae	Colobus	kirkii	Pied colobus	Coastal Forest
	Galagonidae	Galago	zanzibaricus	Zanzibar galago	Coastal Forest and Eastern Arc
		Galago	sp.nov. A	Galago	Coastal Forest
		Galago	sp.nov. B	Galago	Coastal Forest
Otolemur	garnetti	Small-eared galago	Rare' species		
Chiroptera	Pteropodidae	Myonycteris	relicta	Collared fruit bat	Coastal Forest and Eastern Arc
		Pteropus	seychellensis	Flying fox	Rare' species
		Pteropus	voeltzkowi	Flying fox	Coastal Forest
	Molossidae	Tadarida	brachyptera	Guano bat	Coastal Forest and Eastern Arc
	Rhinolophinae	Rhinolophus	deckeni	Horseshoe bat	Coastal Forest
		Rhinolophus	sp.nov.	Horseshoe bat	Coastal Forest
Vespertilionidae	Kerviflora	africana	Wooly bat	Coastal Forest	
Insectivora	Soricidae		4 spp.	Shrew	Coastal Forest
Macroscelidea	Rhynchocyoninae	Rhynchocyon	chrysopygus	Golden-rumped elephant shrew	Coastal Forest
		Rhynchocyon	petersi	Zanj elephant shrew	Coastal Forest and Eastern Arc
Rodentia	Funisciurus	Funiscirus	pallitus	Rope squirrel	Coastal Forest and Eastern Arc
	Cricetomyinae	Beamys	hindei	Lesser pouched rat	CF/EA and a few other East African forests
	Myoxidae	Graphiurus	sp.nov.	African dormouse	Coastal Forest
Hyracoidea	Procaviidae	Dendrohyrax	validus	Tree hyrax	CF/EA and a few other East African forests
Proboscidea	Elephantidae	Loxodonta	africana	African elephant	Rare' species
Perissodactyla	Rhinocerotidae	Diceros	bicornis	Browse (Black) rhinoceros	Rare' species
Artiodactyla	Cephalophini	Cephalophus	adersi	Ader's duiker	Coastal Forest
		Cephalophus	spadix	Abbot's duiker	CF/EA and a few other East African forests

**BIRDS**

Family	Genus	species	Common name	Ruvu South FR Reference	Pugu FR Reference	Kazimzumbwi FR Reference	Pande Game Reserve Reference
Accipitridae	<i>Ardeola</i>	<i>striatus</i>	Green-backed heron		x	How.'81	
	<i>Accipiter</i>	<i>tachiro</i>	African goshawk		x	How.'81, Burg.	x Hux.
	<i>Accipiter</i>	<i>melanoleucus</i>	Great sparrowhawk		x	Burg., Ogl.	
	<i>Accipiter</i>	<i>minullus</i>	Little sparrowhawk			x Hux.	
	<i>Circaetus</i>	<i>fasciolatus</i>	Southern Banded Snake eagle	x Cla.'95	x	Dav.'95, Cla.'95	x Hux., Ogl., Burg.b
	<i>Macheirhamphus</i>	<i>alcinus</i>	Bat-eating buzzard		x	How.'81	
	<i>Pernis</i>	<i>apivorus</i>	Honey buzzard		x	How.'81	
	<i>Terathopius</i>	<i>ecauddatus</i>	Bateleur		x	How.'81	x Hux.
	<i>Gypohierax</i>	<i>angolensis</i>	Palm-nut vulture		x	How.'81	x Hux.
	<i>Neophron</i>	<i>monachus</i>	Hooded vulture		x	How.'81	
	<i>Stephanoaetus</i>	<i>coronatus</i>	Crowned eagle		x	Burg., Ogl.	x Hux., Ogl.
Numididae	<i>Guttera</i>	<i>pucherani</i>	Kenya crested guineafowl		x	How.'81, Dav.'95 Burg., Ogl.	x Hux., Ogl.
Rallidae	<i>Sarothrura</i>	<i>elegans</i>	Buff-spotted pigmy crake		x	Burg.	
Columbidae	<i>Streptopelia</i>	<i>semitorquata</i>	Red-eyed dove		x	How.'81	
	<i>Turtur</i>	<i>chalcospilos</i>	Emerald-spotted wood dove		x	How.'81	x Hux.
	<i>Turtur</i>	<i>tympanistria</i>	Tambourine dove		x	How.'81, Dav.'95 Burg., a, Ogl.	x Hux., Ogl.
	<i>Aplopelia</i>	<i>larvata</i>	Lemon dove		x	Burg., Ogl.	
Musophagidae	<i>Tauraco</i>	<i>livingstonii</i>	Livingstone's tauraco		x	How.'81, Dav.'95 Burg., Ogl.	x Hux., Ogl.
Cuculidae	<i>Centropus</i>	<i>superciliosus</i>	White-browed coucal		x	How.'81	x Hux.

Family	Genus	species	Common name	Ruvu South FR Reference	Pugu FR Reference	Kazimzumbwi FR Reference	Pande Game Reserve Reference	
	<i>Ceuthmochares</i>	<i>aereus</i>	Yellow-bill / Green coucal		x	How.'81, Burg. Ogl.	x	Burg.'90, Burg., a Ogl.
Strigidae	<i>Ciccaba</i>	<i>woodfordii</i>	African wood owl		x	How.'81, Burg. Ogl.	x	Burg.'90, Burg., a Ogl.
Caprimulgidae	<i>Glaucidium</i>	<i>perlatum</i>	Pearl-spotted owl			x	Hux.	
	<i>Caprimulgus</i>	<i>fossii</i>	Mozambique nightjar		x	How.'81		
	<i>Caprimulgus</i>	<i>pectoralis</i>	Fiery-necked nightjar			x	Hux.	x
Alcedinidae	<i>Apus</i>	<i>affinus</i>	Little swift		x	How.'81		
	<i>Cypsiurus</i>	<i>parvus</i>	Palm swift		x	How.'81	x	Hux.
	<i>Neafrapus</i>	<i>boehmi</i>	Bodini's Spinetail				x	Hux.
	<i>Colius</i>	<i>striatus</i>	Speckled mousebird		x	How.'81		
	<i>Halcyon</i>	<i>albiventris</i>	Brown-hooded kingfisher		x	How.'81	x	Hux., Ogl.
Trogonidae	<i>Halcyon</i>	<i>chelicuti</i>	Striped kingfisher				x	Hux.
	<i>Halcyon</i>	<i>senegalensis</i>	Woodland kingfisher				x	Hux.
	<i>Ispidina</i>	<i>picta</i>	Pygmy kingfisher		x	Dav.'95, Burg.	x	Hux.
	<i>Apaloderma</i>	<i>narina</i>	Narina's trogon		x	How.'81, Burg. Ogl.	x	Hux., Ogl.
Bucerotidae	<i>Merops</i>	<i>boehmi</i>	Boehm's bee-eater		x	How.'81	x	Hux.
	<i>Merops</i>	<i>superciliosus</i>	Blue-cheeked bee-eater		x	How.'81		
	<i>Phoeniculus</i>	<i>purpureus</i>	Green Wood hoopoe				x	Hux.
Capitonidae	<i>Bycanistes</i>	<i>bucinator</i>	Trumpeter hornbill		x	Burg., Ogl.	x	Hux.
	<i>Tockus</i>	<i>alboterminatus</i>	Crowned hornbill		x	How.'81, Ogl.	x	Hux., Ogl.
	<i>Buccanodon</i>	<i>leucotis</i>	White-eared barbet		x	How.'81		
	<i>Pogoniulus</i>	<i>bilineatus</i>	Yellow-rumped tinkerbird		x	How.'81, Burg. Ogl.	x	Hux., Ogl.
	<i>Pogoniulus</i>	<i>simplex</i>	Green tinkerbird		x	How.'81, Dav.'95	x	Hux., Ogl.
							x	Burg.'90, Burg., a Ogl.
							x	Burg.'90, Burg., a Ogl.

Family	Genus	species	Common name	Ruvu South FR Reference	Pugu FR Reference	Kazimzumbwi FR Reference	Pande Game Reserve Reference
						Burg., b, Ogl. How.'81	Burg.b Ogl.
Indicatoridae	<i>Indicator</i>	<i>meliphilus</i>	Pallid honeyguide		x		
	<i>Indicator</i>	<i>minor</i>	Lesser honeyguide			x Hux., Ogl.	x Burg.'90, Burg.a
	<i>Indicator</i>	<i>variegata</i>	Scaly-throated honeyguide		x Burg.	x Hux.	
Picidae	<i>Campethera</i>	<i>abingoni</i>	Golden-tailed woodpecker		x Burg., Ogl.		
	<i>Campethera</i>	<i>cailliautii</i>	Little spotted woodpecker		x How.'81, Burg. Ogl.	x Hux., Ogl.	x Burg.'90, Burg., a Ogl.
Eurylaimidae	<i>Smithornis</i>	<i>capensis</i>	African broadbill		x How.'81, Burg. Ogl.	x Hux., Ogl.	x Burg.'90, Burg., a Ogl.
Pittidae	<i>Pitta</i>	<i>angolensis</i>	African pitta		x Dav.'95, Burg. Ogl.		
Hirundidae	<i>Hirundo</i>	<i>abyssinica</i>	Striped swallow		x How.'81	x Hux.	
	<i>Hirundo</i>	<i>duarica</i>	Red-rumped swallow		x How.'81		
	<i>Psalidoprocne</i>	<i>pristoptera</i>	Black rough-wing		x How.'81, Burg. Ogl.		
	<i>Anthus</i>	<i>sokokensis</i> **	Sokoke pipit	x Cla.'95	x How.'81, Dav.'95 Burg.b, Cla.'95		
? Motacillidae	<i>Campephaga</i>	<i>phoenicea</i>	Black-cuckoo-shrike		x How.'81	x Hux.	
	<i>Motacilla</i>	<i>alba</i>	African pied wagtail		x How.'81		
Pycnonotidae	<i>Andropadus</i>	<i>importunus</i>	Zanzibar sombre greenbul		x How.'81		
	<i>Andropadus</i>	<i>virens</i>	Little greenbul		x How.'81, Burg. Ogl.	x Hux., Ogl.	
	<i>Chlorocichla</i>	<i>flaviventris</i>	Yellow-bellied greenbul		x How.'81, Burg. Ogl.	x Hux., Ogl.	x Burg.'90, Burg., a Ogl.
	<i>Nicator</i>	<i>chloris</i>	Nicator		x How.'81, Burg.	x Hux., Ogl.	x Burg.'90, Burg., a

Family	Genus	species	Common name	Ruvu South FR Reference	Pugu FR Reference	Kazimzumbwi FR Reference	Pande Game Reserve Reference
Turidae	<i>Phyllastrephus</i>	<i>fischeri</i> **	Fisher's greenbul		x	Ogl. How.'81, Dav.'91 Burg., Ogl., Cla.'95	x Hux., Ogl. x Burg.'90, Burg., a Ogl., Cla.'95
	<i>Phyllastrephus</i>	<i>terrestris</i>	Brownbul		x	Burg., Ogl.	
	<i>Phyllastrephus</i>	<i>flavostriatus</i>	Yellow-streaked greenbul		x	How.'81, Burg.	x Hux. x Burg.'90, Burg., a
	<i>Phyllastrephus</i>	<i>debilis</i>	Tiny greenbul		x	Dav.'95, Burg. Ogl., Burg.b	x Hux., Ogl. x Burg.'90, Burg., a, b Ogl.
	<i>Pycnonotus</i>	<i>barbatus</i>	Common bulbul				x Hux.
	<i>Pycnonotus</i>	<i>barbatus</i>	Dark-capped bulbul		x	How.'81	
	<i>Cercotrichas</i>	<i>quadrivirgata</i>	Eastern bearded scrub robin		x	How.'81, Burg. Ogl.	x Hux., Ogl. x Burg.'90, Burg., a Ogl.
	<i>Cercotrichas</i>	<i>leocophrys</i>	White-browed scrub robin				x Hux.
	<i>Cossypha</i>	<i>natalensis</i>	Red-capped robin chat		x	How.'81, Dav.'95 Burg., Ogl.	x Hux., Ogl. x Burg.'90, Burg., a Ogl.
	<i>Neocossyphus</i>	<i>rufus</i>	Red-tailed ant thrush		x	Dav.'95, Ogl.	x Hux., Ogl. x Burg.'90, a, Ogl.
	<i>Turdus</i>	<i>fischeri</i>	Spotted ground thrush		x	Ogl., Dav.'95 Burg.b, Cla.'95	
	<i>Pogonocichla</i>	<i>stellata</i>	White-starred bush robin		x	How.'81, Burg. Ogl.	
	<i>Sheppardia</i>	<i>gunningi</i>	East coast akalat	x	Cla.'95	x	How.'81, Dav.'95 Burg., Ogl., Burg.b

Family	Genus	species	Common name	Ruvu South FR Reference	Pugu FR Reference	Kazimzumbwi FR Reference	Pande Game Reserve Reference	
Sylviidae	<i>Turdus</i>	<i>gurneyi</i>	Orange ground thrush		x	cla.'95 Ogl.		
	<i>Camaroptera</i>	<i>brachyura</i>	Green-backed camaroptera		x	How.'81, Ogl.	x Hux., Ogl. Burg.'90, Burg.a Ogl.	
	<i>Macrosphenus</i>	<i>kretschmeri</i>	Kretschmer's longbill		x	How.'81, Dav.'95 Ogl., Burg.b	x Hux., Ogl. Burg.b	
	<i>Prinia</i> <i>Apalis</i>	<i>subflava</i> <i>flavida</i>	Tawny-flanked prinia Coastal green-tailed apalis		x x	How.'81 How.'81		
Muscicapidae	<i>Apalis</i>	<i>melanocephala</i>	Black-headed apalis		x	How.'81, Ogl.	x Hux., Ogl.	
	<i>Batis</i>	<i>mixta</i>	Puffback flycatcher		x	How.'81, Ogl.		
	<i>Erythrocerus</i>	<i>holochlorus</i> **	Little yellow flycatcher	x	Cl.'95	x	How.'81, Dav.'95 Ogl., Burg.b, Cl.'95	x Hux., Ogl. Burg.b Burg.'90, a, Ogl. Burg.b, Cl.'95
	<i>Platysteira</i>	<i>peltata</i>	Black-throated wattle eye		x	How.'81		
	<i>Terpsiphone</i>	<i>viridis</i>	Paradise flycatcher		x	How.'81, Ogl.	x Hux., Ogl. Burg.'90, Burg.a Ogl.	
	<i>Trochocercus</i>	<i>cyanomelas</i>	Crested flycatcher		x	How.'81, Ogl.	x Hux., Ogl. Burg.'90, Burg.a Ogl.	
	Timaliidae	<i>Trichastoma</i>	<i>rufipennis</i> <i>ssp.puguensis</i> *	Pale-brested illadopsis		x	How.'81, Dav.'95 Ogl., Cl.'95	x Hux., Ogl.
Zosteropidae		<i>Zosterops</i>	<i>senegalensis</i>				x Burg.'90, Burg.a	
Nectariniidae	<i>Anthreptes</i>	<i>collaris</i>	Collared sunbird		x	How.'81, Ogl.	x Hux., Ogl. Burg.'90, Burg.a Ogl.	

Family	Genus	species	Common name	Ruvu South FR Reference	Pugu FR Reference	Kazimzumbwi FR Reference	Pande Game Reserve Reference
	<i>Anthreptes</i>	<i>neglectus</i>	Uluguru violet-backed sunbird		x	How.'81, Dav.'95 Ogl., Burg.b	x Hux., Ogl.  Burg.b
	<i>Anthreptes</i>	<i>reichenowi</i>	Plain-backed sunbird				x Burg.'90, Burg.a Ogl., Burg.b, Cla.'95
	<i>Nectarinia</i>	<i>olivacea</i>	Olive sunbird		x	How.'81, Ogl.	x Hux., Ogl.  Burg.'90, Burg.a Ogl.
	<i>Nectarinia</i>	<i>senegalensis</i>	Scarlet-chested sunbird		x	How.'81	
?	<i>Oriolus</i>	<i>auratus</i>	African Golden oriole				x Hux.
	<i>Oriolus</i>	<i>larvatus</i>	Black-headed oriole				x Hux.
Malaconotidae	<i>Dryoscopus</i>	<i>hamatus</i>	Black puff-back		x	How.'81	
	<i>Dryoscopus</i>	<i>cubla</i>	Zanzibar puff-back		x	How.'81, Ogl.	x Hux.
	<i>Laniarus</i>	<i>ferrungineus</i>	Tropical boubou		x	How.'81, Ogl.	x Hux., Ogl.  Burg.'90, Burg.a Ogl.
	<i>Malaconotus</i>	<i>blanchoti</i>	Grey-headed bush shrike		x	How.'81, Ogl.	
	<i>Malaconotus</i>	<i>quadricolour</i>	Four-coloured bush shrike				x Burg.'90, Burg.a
	<i>Malaconotus</i>	<i>sulfureopectus</i>	Sulphur-breasted bush shrike		x	How.'81	
Prionopidae	<i>Prionops</i>	<i>scopifrons</i>	Chestnut-fronted helmet shrike		x	How.'81, Dav.'95 Ogl., Burg.b	x Hux., Ogl.  Burg.b  Burg.'90, Burg.a, b Ogl.
	<i>Tchagra</i>	<i>australis</i>	Brown-headed bush shrike		x	How.'81	
Sturmidae	<i>Cinnyricinclus</i>	<i>leucogaster</i>	Violet-backed starling		x	How.'81	
	<i>Lamprotornis</i>	<i>corruscus</i>	Black-brested glossy starling		x	How.'81, Ogl.	x Hux., Ogl.
Dicruridae	<i>Dicurus</i>	<i>adsimilis</i>	Drongo		x	How.'81	

Family	Genus	species	Common name	Ruvu South FR Reference	Pugu FR Reference	Kazimzumbwi FR Reference	Pande Game Reserve Reference
	<i>Dicurus</i>	<i>ludwigii</i>	Square-tailed drongo		x	How.'81, Burg. Ogl.	x Hux., Ogl.
Ploceidae	<i>Passer</i>	<i>griseus</i>	Grey-headed sparrow		x	How.'81	
	<i>Ploceus</i>	<i>bicolor</i>	Dark-backed weaver		x	How.'81, Ogl.	x Hux., Ogl.
Estrildidae	<i>Ploceus</i>	<i>ocularis</i>	Spectacled weaver		x	How.'81	
	<i>Euplectus</i>	<i>capensis</i>	Yellow bishop		x	How.'81	
	<i>Estrilda</i>	<i>astrild</i>	Waxbill		x	How.'81	x Hux.
	<i>Hypargos</i>	<i>niveoguttatus</i>	Peter's twinspot		x	How.'81, Dav.'95 Ogl.	x Hux., Ogl.
	<i>Hypargos</i>	<i>nitidula</i>	Green-backed twinspot		x	Ogl.	x Hux., Ogl.
	<i>Lonchura</i>	<i>bicolor</i>	Rufous-backed mannikin		x	How.'81	
	<i>Pirinestes</i>	<i>minor</i>	Lesser seed-cracker		x	How.'81, Burg.b	x Burg.b
* Endemic		** Near endemic					
<b>No. of endemic species</b>				-	1	-	-
<b>No. of near endemic species</b>				2	3	2	-
<b>Total no. of bird species</b>				4	97	69	40

**REFERENCES.***Abbreviation*

- Burg.'90 Burgess N.D. (1990) Preliminary results of biological surveys in seven Coastal Forests of Tanzania. *Frontier*.
- Burg. Burgess N.D., Huxham M.J., Baker N.E., Mlingwa C., Davis S.J. & Cutts C.J. Preliminary assessment of forest-birds in Kiono, Pande, Kisiju and Kiwengoma Coastal Forests, Tanzania.
- Burg.a Burgess N.D., Huxham M.J., Mlingwa C., Davis S.J. & Cutts C.J. Preliminary assessment of forest-birds in Kiono, Pande, Kisiju and Kiwengoma Coastal Forests, Tanzania.
- Burg.b Burgess N.D. & Mlingwa C.O.F. Forest-birds of Coastal Forests in Tanzania and Kenya.
- Cl.'95 Clarke G.P. & Dickinson A. (1995) Status reports for 11 Coastal Forests in Coast Region, Tanzania. *Frontier*.
- Dav.'95 Davies S.G.F. (1995) Birds of Tanzania's Coastal Forests with special reference to the Pugu Hills. (eds. K.M. Howell, F.A. Mturi, F.M. Urasa) *Coastal Forest Biodiversity*. Pp.55-58. University of Dar es Salaam.
- How.'81 Howell K.M. (1981) Pugu Forest Reserve: biological values and development. *African Journal of Ecology*, **19**, 73-81.
- Hux. Huxham M.J., Mlingwa C.O.F & Burgess N.D. A preliminary assessment of the birds of Kazimzumbwi Forest Reserve, Kisarawe District, Tanzania.
- Ogl. Ogle S.M. & Colledge C. Bird species diversity, area and habitat complexity in the Coastal Forests of Tanzania.

**REPTILES**

	Family	Genus	species	Common name	Ruvu South FR Reference	Pugu FR Reference	Kazimzumbwi FR Reference	Pande Game Reserve Reference
Chameleons	Chamaeleonidae	<i>Rhampholeon</i>	<i>brevicaudatus</i> **	Bearded pygmy chameleon			x Cla.'95	
Snakes	Colubridae	<i>Aparallactus</i>	<i>weneri</i> **	Usambara centipede eater			x Cla.'95	
Lizards	Laceritidae	<i>Dasypeltis</i>	<i>medici</i> **	East African Egg Eater		x Cla.'95		
		<i>Heliobolus</i>	<i>neumanni</i>	Neumann's Sand-lizard		x Cla.'95		
** Near endemic								
<b>No. of near-endemic species</b>					-	1	2	-
<b>No. of forest dependent species (Cla.'95)</b>					7	-	16	-
<b>No. of known reptile species (Cla.'95)</b>					7	5	16	2

**REFERENCES***Abbreviation:*

Cla.'95 Clarke G.P. & Dickinson A. (1995) Status reports for 11 Coastal Forests in Coast Region, Tanzania.

**AMPHIBIANS**

Family	Genus	species	Common name	Ruvu South FR	Pugu FR	Kazimzumbwi FR	Pande Game Reserve
				Reference	Reference	Reference	Reference
Bufonidae	<i>Bufo</i>	<i>lindneri</i>	Toad		x		
	<i>Bufo</i>	<i>gutturalis</i>	Guttural toad		x	x	
	<i>Mertensophryne</i>	<i>micranotis</i> **	Tree toad		x	x	
Microhylidae	<i>Breviceps</i>	<i>mossambicus</i>	Mozambique rain frog		x	x	
Ranidae	<i>Ptychadena</i>	<i>anchietae</i>	Plain grass frog		x		
	<i>Phrynobatrachus</i>	<i>acridoides</i>	East African puddle frog		x	x	
Arthroleptidae	<i>Phrynobatrachus</i>	<i>mababiensis</i>				x	
	<i>Arthroleptus</i>	<i>affinis</i>	Squeaker		x		
	<i>Arthroleptus</i>	<i>globosa</i>				x	
	<i>Arthroleptus</i>	<i>stenodactylus</i>	Shovel-footed squeaker		x	x	
	<i>Arthroleptus</i>	<i>xenodactyloides</i>	Squeaker		x		
Rhacophoridae	<i>Chiromantis</i>	<i>xerampelina</i>	Foam nest frog		x	x	x
Hyperolidae	<i>Afrixalus</i>	<i>brachycnemis</i>				x	
	<i>Afrixalus</i>	<i>sylvaticus</i> **	Leaf-folding frog			x	
	<i>Afrixalus</i>	sp.	Leaf-folding frog			x	
	<i>Hyperolius</i>	<i>mitchelli</i>				x	
	<i>Hyperolius</i>	<i>tuberilinguis</i>				x	
	<i>Leptopelis</i>	<i>flavomaculatus</i> **	Treefrog			x	

\*\* Near endemic

No. of near endemics species

-

1

3

-

No. of known amphibian species (Cla.'95)

3

11

15

2

**REFERENCES**

Abbreviation:

- Cla.'95 Clarke G.P. & Dickinson A. (1995) Status reports for 11 Coastal Forests in Coast Region, Tanzania.  
 Poynt. Poynton J.C. Amphibians of Coastal Forests. Natural History Museum, London.  
 Dic.'92 Dickinson A. (1992) Amphibians of Coastal Forests and surrounding areas. Frontier Tanzania.

**BUTTERFLIES**

Family	Genus	species	Ruvu South		Pugu FR		Kazimzumbwi		Pande Game	
			FR	Reference	FR	Reference	FR	Reference	Reserve	Reference
Acraeidae	<i>Acraea</i>	<i>admantha</i>			x	Gra.'84				
	<i>Acraea</i>	<i>aerita acrita</i>			x	Gra.'84				
	<i>Acraea</i>	<i>amenosa</i>			x	Gra.'84				
	<i>Acraea</i>	<i>cabria</i>			x	Gra.'84				
	<i>Acraea</i>	<i>caldera neluska</i>			x	Gra.'84				
	<i>Acraea</i>	<i>cuva</i>			x	Gra.'84				
	<i>Acraea</i>	<i>egina areca</i>			x	Gra.'84				
	<i>Acraea</i>	<i>encedon</i>			x	Gra.'84				
	<i>Acraea</i>	<i>eponina</i>			x	Gra.'84				
	<i>Acraea</i>	<i>esebria</i>			x	Gra.'84				
	<i>Acraea</i>	<i>guirna</i>							x	O'Har
	<i>Acraea</i>	<i>insignis balbina</i>			x	Gra.'84				
	<i>Acraea</i>	<i>johnstoni johnstoni</i>			x	Gra.'84				
	<i>Acraea</i>	<i>machequena</i>			x	Gra.'84				
	<i>Acraea</i>	<i>natalica natalica</i>			x	Gra.'84				
	<i>Acraea</i>	<i>onsaea</i>			x	Gra.'84				
	<i>Acraea</i>	<i>perpsichore neobule</i>			x	Gra.'84				
	<i>Acraea</i>	<i>petraea</i>			x	Gra.'84				
	<i>Acraea</i>	<i>pseudolycia</i>			x	Gra.'84				
		<i>astrigera</i>								
	<i>Acraea</i>	<i>pudeorella detecta</i>			x	Gra.'84				
	<i>Acraea</i>	<i>quirina rosa</i>			x	Gra.'84				
	<i>Acraea</i>	<i>rabbaiiae mombasae</i>			x	Gra.'84				
	<i>Acraea</i>	<i>satis</i>			x	Gra.'84				
	<i>Acraea</i>	<i>sonata</i>			x	Gra.'84				
	<i>Acraea</i>	<i>zetes acara</i>			x	Gra.'84				
	<i>Bematistes</i>	<i>epaea epitellus</i>			x	Gra.'84			x	O'Har
Danaiidae	<i>Amaris</i>	<i>niavius dominicanus</i>			x	Gra.'84				
	<i>Amaris</i>	<i>ochlea ochlea</i>			x	Gra.'84				
	<i>Danaus</i>	<i>chrysippus</i>			x	Gra.'84				
	<i>Pardopsis</i>	<i>punctatissima</i>			x	Gra.'84			x	O'Har
Hepseriidae	<i>Tagiades</i>	<i>flesus</i>							x	O'Har
	?	sp.							x	O'Har
Libythea	<i>Libythea</i>	<i>labdaca laius</i>			x	Gra.'84				
Lycaenidae	<i>Hemiolaus</i>	<i>coeculus littoralis</i>					x	Kie.'93		
	<i>Iolaus</i>	sp.							x	O'Har
	<i>Azanus</i>	<i>mirza</i>					x	Kie.'93		

Family	Genus	species	Ruvu South		Pugu FR		Kazimzumbwi		Pande Game	
			FR	Reference	FR	Reference	FR	Reference	Reserve	Reference
Nymphalidae	<i>Euxanthe</i>	<i>tiberius tiberius</i>			x	Gra.'84	x	Kie.'93		
	<i>Euxanthe</i>	<i>wakefieldi</i>	x	Kie.'93	x	Gra.'84	x	Kie.'93		
	<i>Euphaedra</i>	<i>eleus orientalis</i>							x	O'Har
	<i>Euphaedra</i>	<i>nephron</i>							x	O'Har
	<i>Charaxes</i>	<i>achaemenes</i>			x	Gra.'84				
	<i>Charaxes</i>	<i>baumanni granti</i>			x	Gra.'84				
	<i>Charaxes</i>	<i>brutus alcyone</i>			x	Gra.'84	x	Kie.'93		
	<i>Charaxes</i>	<i>candioppe</i>			x	Gra.'84	x	Kie.'93		
	<i>Charaxes</i>	<i>castor flavifasciatus</i>			x	Gra.'84	x	Kie.'93		
	<i>Charaxes</i>	<i>cithaeron kenneti</i>	x	Kie.'93	x	Gra.'84	x	Kie.'93		
	<i>Charaxes</i>	<i>etesipe tavetensis</i>			x	Gra.'84				
	<i>Charaxes</i>	<i>ethalion littoralis</i>			x	Gra.'84				
	<i>Charaxes</i>	<i>guderiana</i>			x	Gra.'84				
	<i>Charaxes</i>	<i>guderiana</i>								
	<i>Charaxes</i>	<i>jahlusa argynnides</i>	x	Kie.'93	x	Gra.'84				
	<i>Charaxes</i>	<i>jasius-saturnus</i>			x	Gra.'84				
	<i>Charaxes</i>	<i>lasti lasti</i>			x	Gra.'84				
	<i>Charaxes</i>	<i>protoclea azota</i>	x	Kie.'93	x	Gra.'84	x	Kie.'93		
	<i>Charaxes</i>	<i>tavetensis</i>					x	Kie.'93		
	<i>Charaxes</i>	<i>varanes vologeses</i>	x	Kie.'93	x	Gra.'84	x	Kie.'93		
	<i>Charaxes</i>	<i>violetta maritima</i>			x	Gra.'84				
	<i>Charaxes</i>	<i>zoolina zoolina</i>	x	Kie.'93	x	Gra.'84	x	Kie.'93		
	<i>Euptera</i>	<i>kinugnana</i>					x	Kie.'93		
	<i>Euptera</i>	<i>pluto kinugnana</i>			x	Gra.'84				
	<i>Euphaedra</i>	<i>neophron neophron</i>			x	Gra.'84				
	<i>Euryphura</i>	<i>achylus achylus</i>			x	Gra.'84	x	Kie.'93		
	<i>Hamanumida</i>	<i>daedalus</i>	x	Kie.'93	x	Gra.'84	x	Kie.'93		
	<i>Aterica</i>	<i>galene theophanes</i>	x	Kie.'93	x	Gra.'84	x	Kie.'93	x	Kie.'93
	<i>Pseudacraea</i>	<i>boisduvali crimenti</i>			x	Gra.'84				
	<i>Pseudacraea</i>	<i>boisduvali trimeni</i>					x	Kie.'93		
	<i>Pseudacraea</i>	<i>lucretia expanca</i>			x	Gra.'84	x	Kie.'93		
	<i>Neptis</i>	<i>goochi</i>					x	Kie.'93		
	<i>Neptis</i>	<i>kiriakofi</i>			x	Gra.'84			x	Kie.'93
<i>Neptis</i>	<i>laeta</i>			x	Gra.'84					
<i>Neptis</i>	<i>nina</i>			x	Gra.'84					
<i>Neptis</i>	<i>rogersi</i>			x	Gra.'84					
<i>Neptis</i>	<i>saelava marpessa</i>			x	Gra.'84					
<i>Neptis</i>	<i>serena</i>			x	Gra.'84			x	Kie.'93	
<i>Neptis</i>	<i>trigonophora</i>				Gra.'84			x	O'Har	

Family	Genus	species	Ruvu South		Pugu FR		Kazimzumbwi		Pande Game	
			FR	Reference		Reference	FR	Reference	Reserve	Reference
Nymphalidae	<i>Neptis</i>	<i>trigonophora</i>			x	Gra.'84				
		<i>trigonophora</i>								
	<i>Cyrestis</i>	<i>camillus sublineata</i>			x	Gra.'84	x	Kie.'93	x	O'Har
	<i>Byblia</i>	<i>anvatara acheloya</i>			x	Gra.'84	x	Kie.'93		
	<i>Byblia</i>	<i>ilithya</i>			x	Gra.'84				
	<i>Neptidopsis</i>	<i>fulgurata platyptera</i>			x	Gra.'84				
	<i>Neptidopsis</i>	<i>ophione velleda</i>	x	Kie.'93	x	Gra.'84				
	<i>Eurythela</i>	<i>dryope angulata</i>	x	Kie.'93	x	Gra.'84	x	Kie.'93	x	O'Har
	<i>Hypolimnas</i>	<i>deceptor deceptor</i>			x	Gra.'84				
	<i>Hypolimnas</i>	<i>dubius</i>				Gra.'84			x	O'Har
		<i>dubius/drucei</i>								
	<i>Hypolimnas</i>	<i>dubius wahlbergi</i>			x	Gra.'84			x	Kie.'93
	<i>Hypolimnas</i>	<i>misippus</i>			x	Gra.'84			x	Kie.'93, O'Har
	<i>Hypolimnas</i>	<i>usambara</i>			x	Gra.'84				
	<i>Salamis</i>	<i>anacardii</i>			x	Gra.'84				
	<i>Salamis</i>	<i>parhassus</i>			x	Gra.'84	x	Kie.'93	x	O'Har
	<i>Junonia</i>	<i>artaxia</i>			x	Gra.'84				
	<i>Junonia</i>	<i>hierta cebrene</i>			x	Gra.'84				
	<i>Junonia</i>	<i>natalica natalica</i>			x	Gra.'84				
	<i>Junonia</i>	<i>oenone oenone</i>			x	Gra.'84				
	<i>Junonia</i>	<i>orithya</i>			x	Gra.'84				
		<i>madagascariensis</i>								
	<i>Junonia</i>	<i>terea elgiva</i>			x	Gra.'84	x	Kie.'93		
	<i>Precis</i>	<i>actia</i>			x	Gra.'84	x	Kie.'93		
	<i>Sallya</i>	<i>boisduvali</i>			x	Gra.'84				
		<i>boisduvali</i>								
	<i>Sallya</i>	<i>moranti</i>			x	Gra.'84				
	<i>Sallya</i>	<i>natalensis</i>			x	Gra.'84				
	<i>Hachnoptera</i>	<i>iole ayresi</i>			x	Gra.'84	x	Kie.'93		
	<i>Phalanta</i>	<i>eurytis columbina</i>			x	Gra.'84				
<i>Phalanta</i>	<i>eurytis eurytis</i>					x	Kie.'93			
<i>Phalanta</i>	<i>phalantha</i>					x	Kie.'93	x	Kie.'93	
<i>Phalanta</i>	<i>phalantha aethiopia</i>			x	Gra.'84					
<i>Hamma</i>	<i>theobene blassi</i>			x	Gra.'84					
<i>Bebaeria</i>	<i>mardania oreintis</i>			x	Gra.'84					
<i>Vanessa</i>	<i>cardui</i>			x	Gra.'84					
Papilionidae	<i>Papilio</i>	<i>angolensis</i>			x	Gra.'84			x	Kie.'93
	<i>Papilio</i>	<i>constantinus</i>			x	Gra.'84				

Family	Genus	species	Ruvu South		Pugu FR		Kazimzumbwi		Pande Game	
			FR	Reference		Reference	FR	Reference	Reserve	Reference
Papilionidae	<i>Papilio</i>	<i>dardanus cenea</i>							x	O'Har
	<i>Papilio</i>	<i>dardanus ochracea</i>							x	O'Har
	<i>Papilio</i>	<i>dardanus tibullus</i>			x	Gra.'84	x	Kie.'93		
	<i>Papilio</i>	<i>demodocus</i>			x	Gra.'84			x	Kie.'93
	<i>Papilio</i>	<i>f. hippocooides</i>				Gra.'84				
	<i>Papilio</i>	<i>nireus lyaeus</i>	x	Kie.'93	x	Gra.'84	x	Kie.'93		
	<i>Graphium</i>	<i>antheus</i>			x	Gra.'84				
	<i>Graphium</i>	<i>colonna</i>			x	Gra.'84	x	Kie.'93		
	<i>Graphium</i>	<i>leonidas</i>			x	Gra.'84	x	Kie.'93	x	Kie.'93, O'Har
	<i>Graphium</i>	<i>ophidicephalus</i>	x	Kie.'93	x	Gra.'84	x	Kie.'93		
	<i>Graphium</i>	<i>philnonoe</i>			x	Gra.'84	x	Kie.'93		
	<i>Graphium</i>	<i>polistratus</i>	x	Kie.'93	x	Gra.'84				
	<i>Graphium</i>	<i>polycenes</i>			x	Gra.'84				
	<i>Graphium</i>	<i>porthaon</i>			x	Gra.'84			x	Kie.'93
Pieridae	<i>Catopsilia</i>	<i>florella</i>	x	Kie.'93	x	Gra.'84	x	Kie.'93		
	<i>Anaphaeis</i>	<i>creona</i>							x	O'Har
	<i>Eurema</i>	<i>brigitta</i>			x	Gra.'84	x	Kie.'93	x	O'Har
	<i>Eurema</i>	<i>desjardinsi</i>			x	Gra.'84				
	<i>Eurema</i>	<i>florica nivea</i>			x	Gra.'84				
	<i>Eurema</i>	<i>hapale</i>			x	Gra.'84				
	<i>Eurema</i>	<i>hecabe solifera</i>			x	Gra.'84	x	Kie.'93		
	<i>Eurema</i>	<i>senegalensis</i>					x	Kie.'93		
	<i>Nepheronia</i>	<i>argia mhondana</i>			x	Gra.'84	x	Kie.'93	x	O'Har
	<i>Nepheronia</i>	<i>buquetti</i>			x	Gra.'84				
	<i>Nepheronia</i>	<i>thalassina sinalata</i>			x	Gra.'84	x	Kie.'93		
	<i>Eronia</i>	<i>cleodora dilatata</i>			x	Gra.'84	x	Kie.'93		
	<i>Eronia</i>	<i>leda</i>			x	Gra.'84				
	<i>Colotis</i>	<i>amata calais</i>							x	Kie.'93
	<i>Colotis</i>	<i>antevippe gavis</i>			x	Gra.'84				
	<i>Colotis</i>	<i>euippe</i>							x	O'Har
	<i>Colotis</i>	<i>evagore antigone</i>			x	Gra.'84				
<i>Colotis</i>	<i>evenina evenina</i>							x	O'Har	
Pieridae	<i>Colotis</i>	<i>evenina sipylus</i>			x	Gra.'84				
	<i>Colotis</i>	<i>evigpe complexivus</i>							x	O'Har
	<i>Colotis</i>	<i>evippe omphale</i>			x	Gra.'84	x	Kie.'93		
	<i>Colotis</i>	<i>hetaera</i>			x	Gra.'84				
	<i>Colotis</i>	<i>incretus</i>			x	Gra.'84				
	<i>Colotis</i>	<i>ione</i>			x	Gra.'84	x	Kie.'93		

Family	Genus	species	Ruvu South		Pugu FR		Kazimzumbwi		Pande Game	
			FR	Reference	Reference	FR	Reference	Reserve	Reference	
Satyridae	<i>Colotis</i>	<i>regina</i>							x	O'Har
	<i>Colotis</i>	<i>vest catachrysops</i>			x	Gra.'84				
	<i>Belenois</i>	<i>aurota aurota</i>			x	Gra.'84				
	<i>Belenois</i>	<i>creona severina</i>			x	Gra.'84	x	Kie.'93	x	Kie.'93, O'Har
	<i>Belenois</i>	<i>gidica</i>			x	Gra.'84				
	<i>Belenois</i>	<i>thysa thysa</i>	x	Kie.'93	x	Gra.'84	x	Kie.'93	x	O'Har
	<i>Appias</i>	<i>lasti lasti</i>			x	Gra.'84	x	Kie.'93		
	<i>Dixeia</i>	<i>doxa costata</i>			x	Gra.'84				
	<i>Dixeia</i>	<i>orbona vidua</i>			x	Gra.'84				
	<i>Dixeia</i>	<i>pigea</i>			x	Gra.'84				
	<i>Mylothris</i>	<i>agathina</i>			x	Gra.'84				
	<i>Leptosia</i>	<i>alcesta inalcesta</i>			x	Gra.'84				
	<i>Melanitis</i>	<i>leda</i>					x	Kie.'93		
	<i>Melanitis</i>	<i>leda helena</i>			x	Gra.'84				
	<i>Gnophodes</i>	<i>betsimena dicersa</i>			x	Gra.'84				
	<i>Ypthima</i>	<i>granulosa</i>			x	Gra.'84				
	<i>Ypthima</i>	<i>impura paupera</i>			x	Gra.'84				
	<i>Bicyclus</i>	<i>anynana</i>			x	Gra.'84				
	<i>Bicyclus</i>	<i>campinus</i>			x	Gra.'84				
	<i>Bicyclus</i>	<i>ocelligerus</i>								
	<i>Bicyclus</i>	<i>safitza</i>			x	Gra.'84			x	O'Har
	<i>Henotesia</i>	<i>persicua persicua</i>			x	Gra.'84				
<i>Physcaeneura</i>	<i>jacksoni</i>			x	Gra.'84	x	Kie.'93			
<i>Physcaeneura</i>	<i>pione</i>							x	O'Har	
<b>No. of butterfly species (listed here)</b>			15		138		48		37	
<b>No. of known butterfly species (Gra.'84)</b>			-		225		-		-	

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