



**PROTECTED AREA SPATIAL PLANNING FOR UNGUJA AND PEMBA
ISLANDS, ZANZIBAR**

A Consultancy to the UNDP-GEF - *Extending the Coastal Forest Area Protected
Area Subsystem in Tanzania*

Final Consultancy Report

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**Prepared by:
Kirstin S. Siex
Zanzibar Project Director
WCS Africa Program
2300 Southern Blvd
Bronx, NY 10460**

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Executive Summary

All regions of Unguja and Pemba, and in particular the remaining patches of coral thicket forest, are severely threatened by a very high human population density (400 individuals/km²), which is increasing at an estimated rate of five percent per year (three percent intrinsic and two percent immigration). The vast majority of Zanzibar's human population is dependent upon shifting cultivation and forest products, such as building poles, firewood, and charcoal. Due to the high price of electricity, even Zanzibar's urban population is heavily reliant on firewood and charcoal for cooking. Cutting to supply this demand continues to be a major threat to Zanzibar's wildlife. Zanzibar is currently losing an estimated 1.2 percent of its forest each year; shrinking forest patches and rapidly diminishing any potential to maintain and restore connectivity. Thus, in order to conserve Zanzibar's remaining wildlife and ensure the genetic viability of these species into the future we must act now. All of the remaining forests patches important to wildlife must be identified, protected, and linked by functional corridors in a comprehensive Protected Areas (PA) network of community and government managed forests.

The objective of this project was to work with the Zanzibar Department of Forests and Non-Renewable Natural Resources (DFNRNR) to strengthen in terms of representativeness and connectivity the Protected Area System of Zanzibar, in order to preserve the ecological and evolutionary processes necessary for the continued survival of Zanzibar's unique flora and fauna. Data from GIS analysis of aerial photographs were used to locate and map all remaining forests thought to be of importance to wildlife on Unguja and Pemba Islands, and the corridors that could be created to link these areas to ensure wildlife movements and gene flow which are necessary for long term species survival. Reconnaissance surveys and camera trapping were then used to fine tune the proposed protected areas network, by determining the current state of the forests and proposed corridors and their importance for wildlife. Throughout this project we worked closely with DFNRNR staff members from Unguja and Pemba and with communities in order to build their capacity, increase their awareness of the importance for the development of a PA network, and develop community and government support for this process.

On Unguja, the remaining best habitat for Zanzibar's unique wildlife and those which must be included in the PA network include: Jozani-Chwaka Bay National Park (JCBPN), Kiwengwa Pongwe Forest Reserve (KPFR), Masingini Forest Reserve, the "High Protection" and "Low Impact Use" zones of the community forests surrounding JCBNP (17 Communities) and KPFR (10 communities), and the Proposed Muyuni-Jambiani Forest Reserve . These forests were found to be relatively well linked by a series of 5 corridors which were mainly across community lands, and overlapped the proposed Muyuni-Jambiani Forest Reserve. We also recommend the restoration of a 6th corridor to restore connectivity between Uzi/Vundwe Islands and Unguja Island.

On Pemba, the areas of greatest importance for wildlife and those we recommend be included in the PA network include: the three government PAs of Ngezi-Vumawinbi Nature Reserve, Msitu Mkuu Forest Reserve and Ras Kiuyu Proposed Forest Reserve, and the "High Protection" and "Low Impact Use" zones of the 13 community forests. There are also a number of additional forest patches which need to be further studied to determine their importance to wildlife. These include: Kwa Konondo, Ngulu, Makuwe-gando, Kangagani, and Kideke; and the community

managed forest patches of Fundo, Matambwe, Mgelema, and Mbiji/Changaweni. Unlike on Unguja, most of these important areas for wildlife on Pemba are spread out across the island and are not well connected; none of the three government PAs are connected to one another by wildlife corridors. The only potential wildlife corridor found on Pemba is between Ngezi-Vumawimbi Nature Reserve and Gando forest patch, and it is mainly via mangrove forest. Thus, additional survey work on Pemba is also recommended to determine if there is potential to restore connectivity (via enrichment planting) among any of the government PAs, community managed forests and unmanaged forests.

Given the growing threats to the proposed PA network of Unguja and Pemba, we must move swiftly to completely protect the remaining forests and corridors before many of these connections are lost forever due to agriculture expansion and cutting for building poles, firewood and charcoal production. As the Zanzibar DFNRNR moves forward to establishing this PA network we make the following recommendations: (1) as all of the proposed corridors completely overlap community lands and community managed forests are extremely important for the continued survival of Zanzibar's wildlife, continuing to work in partnership with communities to design and implement the PA network will be crucial to success; (2) as new communities develop CoFMAs (Community Forest Management Agreements), care must be exercised to ensure that the community zoning process produces zoning plans which concur with the plan for the PA network; (3) it will be necessary to explore more intensive management such as enrichment planting for the establishment/restoration of some corridors, mainly the northern section of the MJ corridor, the corridor between Uzi/Vundwe and Unguja, and any potential corridors on Pemba; (4) to ensure efficacy, the PA network plan must quickly move from paper to implementation including complete demarcation of all forests and corridors, sensitization of surrounding communities, and most importantly law enforcement to ensure the protection of the new PA network; and (5) it is also crucial that CoFMAs are properly implemented, the success of implementation audited, and if there are violations (e.g., banned activities are being conducted) fines imposed and corrective measures undertaken.

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Introduction

Zanzibar consists of two main islands, the northern island of Pemba and the southern island of Unguja. These islands lie between 4°50' - 6°30' south latitude and 39°10' - 39°90' east longitude. Unguja island is located on the continental shelf and is separated from mainland Tanzania by approximately 40 km by the Zanzibar channel. Unguja island is a small island of approximately 1650 km² and is largely old coral reef and sand bar (Harper 1974; Pakenham 1984; Nelson-Richards 1988; Hettige 1990). The island has been separated from the mainland for approximately 10,000-15,000 years due to a rise in sea level (Hamilton 1982).

The western portion of Unguja Island receives more rain, and is more fertile containing soils derived from limestone or non-calcareous sediment (Wilson 1950, Makame and Begg 1983, Hettige 1990). Historically, this portion of the island is presumed to have supported tropical high forest (Harper 1974, Pakenham 1984, Bensted-Smith 1990, Hettige 1990, Krain et al, 1993). Large scale deforestation in this region began during the early 19th century with the arrival of the Omani Arabs who replaced the original forest with coconut and clove plantations and food crops (Kingdon 1971, Harper 1974, Hettige 1990). The eastern half of the island is much drier and consists of old coral rock sparsely covered with variously sized pockets of red-brown sandy soil. These conditions would have given rise to deciduous woodland and dry evergreen bush (Harper 1974; Pakenham 1979, 1984; Bensted-Smith 1990; Hettige 1990; Krain et al 1993). Today, this area, the eastern half of the island, still supports dry evergreen bush (or coral-thicket forest) which is where most of Unguja's remaining wildlife is found.

Pemba Island, 1014km², lies approximately 50 km from the mainland and is surrounded by comparatively deep water with strong currents. Pemba has been separated from the mainland since the end of the Miocene about 10 million years ago. Unlike the relatively flat terrain of Unguja Island, Pemba has an undulating landscape with valleys, some of which are quite steep and dry river beds. The only large patches of high forest remaining on Pemba are in the North, the rest of the island is covered by a mosaic of agriculture, grassland, bushland, or forest in various stages of growth or regeneration from cultivation (Pakenham 1984).

Thus, different from the coral forest landscape on mainland Tanzania where much of the fragmentation is natural and sufficiently ancient to have led to high levels of speciation, fragmentation of the coral forests on the islands of Unguja and Pemba is a recent phenomenon. There is excellent historical evidence illustrating that until a few hundred years ago, both Unguja and Pemba Islands were covered by single contiguous blocks of coral forest. Today, however, the situation is drastically changed with the landscape consisting of a mosaic of isolated coral forest patches, many of which are too small to support viable populations of Zanzibar's larger mammals such as the endemic Zanzibar red colobus (*Procolobus kirkii*), one of Africa's most endangered primates, and Zanzibar's rare mini antelopes including Aders' duiker (*Cephalophus adersi*), the Pemba blue duiker (*Cephalophus monticola pembae*) and the endemic nominate race of Suni (*Neotragus moschatus moschatus*). In addition, there is insufficient connectivity among many of these patches to allow for seasonal movements of and gene flow between wildlife populations.

All regions of Unguja and Pemba, and in particular the remaining patches of coral thicket forest, are severely threatened by a very high human population density (400 individuals/km²), which is increasing at an estimated rate of five percent per year (three percent intrinsic and two percent immigration). The vast majority of Zanzibar's human population is dependent upon shifting cultivation and forest products, such as building poles, firewood, and charcoal. Due to the high price of electricity, even Zanzibar's urban population is heavily reliant on firewood and charcoal for cooking. Cutting to supply this demand continues to be a major threat to Zanzibar's wildlife. Zanzibar is currently losing an estimated 1.2 percent of its forest each year (DCCFF 2008); shrinking forest patches and rapidly diminishing any potential to maintain and restore connectivity. Thus, in order to conserve Zanzibar's remaining wildlife and ensure the genetic viability of these species into the future we must act now. All of the remaining forests patches important to wildlife must be identified, protected, and linked by functional corridors in a comprehensive Protected Areas (PA) network of community and government managed forests.

Goal and Objective

The ultimate long-term goal is to better protect the biological diversity, the threatened and endangered endemic species, and the catchment and carbon services of the coral forests of Zanzibar. The objective of this project is to work with the Zanzibar Department of Forests and Non-Renewable Natural Resources (DFNRNR) (formerly Department of Commercial Crops Fruits and Forestry, DCCFF) to strengthen in terms of representativeness and connectivity the Protected Area System of Zanzibar, in order to preserve the ecological and evolutionary processes necessary for the continued survival of Zanzibar's unique flora and fauna.

More specifically, the project will help DFNRNR achieve the UNDP-GEF Output 2.2: *“Terrestrial Protected Area Network expanded to include key gaps in coral rag and thicket communities of high biodiversity, with buffer and connectivity forests. This will entail using the existing and new survey data on the biodiversity and forests and thicket habitats of Zanzibar, and building on the existing proposals for new reserves, to put in place new reserves that cover the distribution of species and habitats in a more comprehensive way. Building connections between existing reserves will be a particularly important element of this work.”*

Activities and Methodologies

Through the following activities, we pulled together and analyzed data collected over the previous years across the government and community managed forests of Unguja, and collected the additional data necessary from Unguja and Pemba to design a comprehensive protected areas network to conserve Zanzibar's remaining coral forests and their biodiversity. The main project team consisted of the WCS Zanzibar Project staff and four members of the Zanzibar DFNRNR-GIS team based in Unguja. During data collection, this core team was joined by the relevant local experts who included village informants from the 40 communities across Unguja and Pemba Islands (27 communities on Unguja and 13 on Pemba) who manage their forests through Community Forest Management Agreements (CoFMAs) signed with the Government of Zanzibar, and while in Pemba by three Pemba DFNRNR Forest Officers.

The work conducted for this GEF consultancy built upon the conservation activities that WCS, in partnerships with the DFNRNR and Community Village Conservation Councils (VCCs) from the 27 Communities with CoFMAs across Unguja, has been conducting in Zanzibar since 2004. These activities include vegetation and large mammal monitoring of Jozani-Chwaka Bay National Park (JCBNP), Kiwengwa-Pongwe Forest Reserve (KPFR), Uzi Island (UI), and 16 community forests from KPFR in the north to Mtende forest on the southern tip of the island of Unguja. In addition to collecting the data necessary to design, establish and monitor the success of an island-wide protected area network, extensive work has been done to build government and community understanding of the importance of establishing, monitoring and protecting conservation areas.

In 2008, we began to collect the data necessary to feed into the development of an island-wide protected area network, including corridor development. During these last four years, we have used the methodologies elaborated below (GIS analysis, reconnaissance surveys, and camera trapping) to collect data on all existing forest patches on Unguja that could be of importance to wildlife, and on habitat corridors that link all of the remaining government, community and unprotected forest patches into an Unguja-wide PA network.

Simultaneously, we have invested heavily in building government and community capacity to manage their protected areas. In addition, since much of Zanzibar's remaining wildlife and most of the proposed corridors overlap community managed forests, the partnerships that we have developed with the communities have been invaluable for accomplishing the below activities and for gaining support for the proposed corridors. This capacity and support will continue to be of importance as the Zanzibar DFNRNR works in the coming years to achieve the goals of the UNDP-GEF "Extending the Coastal Forest Area Protected Area Subsystem in Tanzania."

In order to reach the project objective, we built on work previously conducted since 2004 by undertaking the following five activities:

Activity 1. Conduct GIS analysis of aerial photographs to determine all of the remaining wildlife areas on Zanzibar and to identify potential corridors among these areas.

In 2004, a complete series of aerial photographs was taken of the islands of Unguja and Pemba. The first step of this process was to conduct a thorough analysis of this series to locate all of the remaining forest areas across the islands and to explore the potential to connect these areas via habitat corridors. This activity has now been completed for both Unguja and Pemba Islands. From this analysis, a set of rough shape files were produced; that were then ground-truthed and refined (see Activity 2).

Activity 2. Conduct reconnaissance surveys to ground-truth the areas identified by GIS work as potential yet currently unprotected wildlife areas and corridors.

Following the identification of forest patches and corridors from aerial photographs, reconnaissance surveys were conducted to ground-truth the rough shape files. These surveys were done to determine and refine the current-day dimensions of the forest patches and potential

corridors that were located using the 2004 aerial photographs. Often the corridors and patches identified from the 2004 aerial photos differed on the ground in 2011; the most common difference usually found being encroachment into potential corridors and forest patches due to agricultural expansion and cutting for firewood, charcoal and building poles. By the completion of this consultancy, we had completed reconnaissance/ground truthing of the rough shape files for government protected areas, all remaining forest patches of importance to wildlife, and all potential habitat corridors for both Unguja and Pemba.

A second set of reconnaissance surveys was then conducted to determine the current state of the habitat and the importance of these areas for wildlife. In these forest patches and potential corridors, reconnaissance lines were sampled. Along the length of these lines and in circular plots every 150 meters along the lines, data were collected on forest type and condition, and wildlife signs (mainly terrestrial and arboreal large mammal species although opportunistic data on bird and other species were also collected). Reconnaissance work has now been completed for all forest patches and corridors on Unguja. On Pemba, although not part of the proposed scope of work for this contract due to the short period of the contract, by increasing the size of our team while in Pemba (i.e., working with additional Pemba Forest officers) we were able to do preliminary habitat and wildlife reconnaissance surveys in the three government protected areas, and in five of the ten forest patches determined to be potentially important for the wildlife of Pemba.

Activity 3. Camera trap unprotected wildlife areas and potential corridors to verify their importance to wildlife.

Following reconnaissance surveys, camera trapping was conducted in Unguja in the three primary habitat corridors and in the large forest patch which is proposed as a new forest reserve (see results and recommendations). These data are extremely important as they allowed us to further determine the importance of these corridors and forest patch to Zanzibar's wildlife. Camera traps were placed in an even standardized pattern in the corridor/patch and left active for 14 days. At the end of the 14 days, cameras were downloaded and then moved to trap the next block of the forest patch/corridor. In order to cover this large area of Unguja (three main corridors and the proposed new forest reserve) sufficiently we have been camera trapping continuously since the end of 2008 for a total of 316 trap stations, and 4,335 trap days.

Activity 4. Build the capacity of the DFNRNR- GIS team and community partners.

Throughout this project, we continued to emphasize building the capacity of government and community partners. The GIS work, reconnaissance and camera trapping were done by the WCS Zanzibar team in partnership with the DFNRNR-GIS team. This joint field team consisted of the WCS Zanzibar Project Assistant Director and four members of the DFNRNR-GIS team that are seconded to WCS half-time, and an additional three Pemba Forest officers for the Pemba work. During the early GIS work, WCS Tanzania Program's GIS specialist also provide training to ensure that we continue to develop capacity within DFNRNR. During this process, all team members were exposed to new survey techniques including the use of camera traps, and we worked to strengthen their skills in biological surveys and data analysis. Similarly we increased

the capacity of community members as they were involved throughout the field work part of this project.

Activity 5. Increase the awareness of the importance for the development of a protected areas network and develop community and government support for this process.

As discussed above, DFNRNR and community members were involved in all steps of this project. In addition, sensitization meetings were held with each community whose land overlaps with the proposed corridors and the proposed new Unguja forest reserve to increase their understanding of and develop their support for the establishment of the new protected areas and habitat corridors.

Results

Unguja Island - Mapping

From the GIS analysis of the 2004 aerial photographs and the reconnaissance/ground truthing field work, all government protected areas (Jozani Chwaka-Bay National Park-JCBNP, Kiwengwa-Pongwe Forest Reserve-KPFR, Kichwele Forest Reserve, Masingini Catchment Forest, and three government plantations Chaani, Kibele and Dunga)(Figure 1) and the 27 community forest management areas (Figure 2, Table 1) were mapped. Each community forest management area is further zoned in a series of use and protection zones and these have also been mapped (Figure 3). Of the government PAs and the community forests, the remaining best habitat for Zanzibar's unique wildlife and those that must be included in the development of the PA network include: Jozani-Chwaka Bay National Park (IUCN Cat II PA, 5000 ha), Kiwengwa Pongwe Forest Reserve (3325 ha), Masingini Forest Reserve (566 ha) (Figure 1), and the "High Protection" and "Low Impact Use" zones of the community forests surrounding JCBNP (17 Communities) and KPFR (10 communities) (Figure 3) (Table 1).

In addition to the government PAs and community "High Protection" and "Low Impact Use" zones, the entire proposed Muyuni-Jambiani Forest Reserve (6100 ha)(Figure 4) is crucial for the continued survival of Unguja's unique flora and fauna and must be part of the PA network. This forest reserve overlaps the "High Protection" and "Low Impact Use" zones of 5 communities (Muyuni, Muungoni, Paje, Jambiani and Kajengwa)(Figure 4).

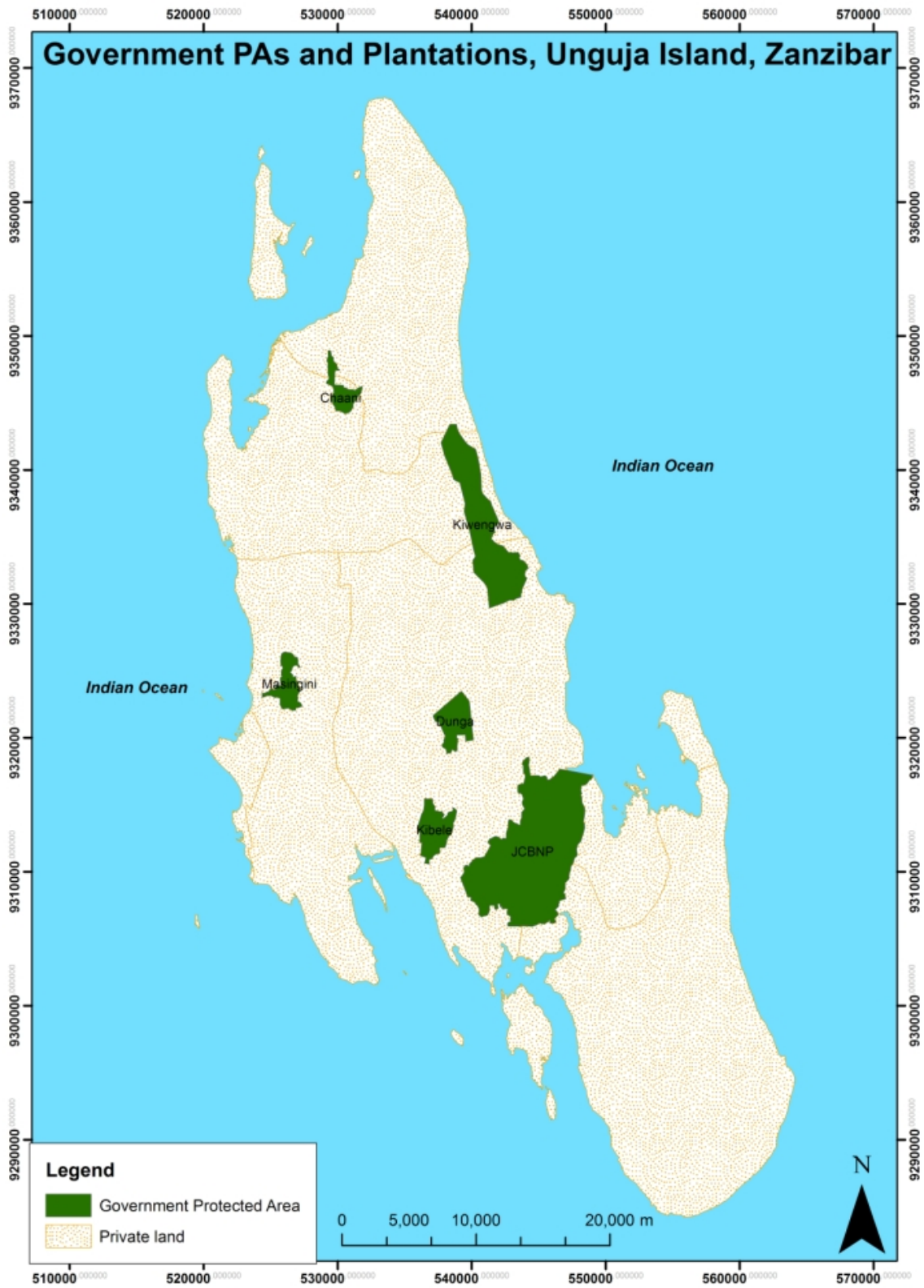


Figure 1. Government Protected Areas and Plantations, Unguja Island Zanzibar.

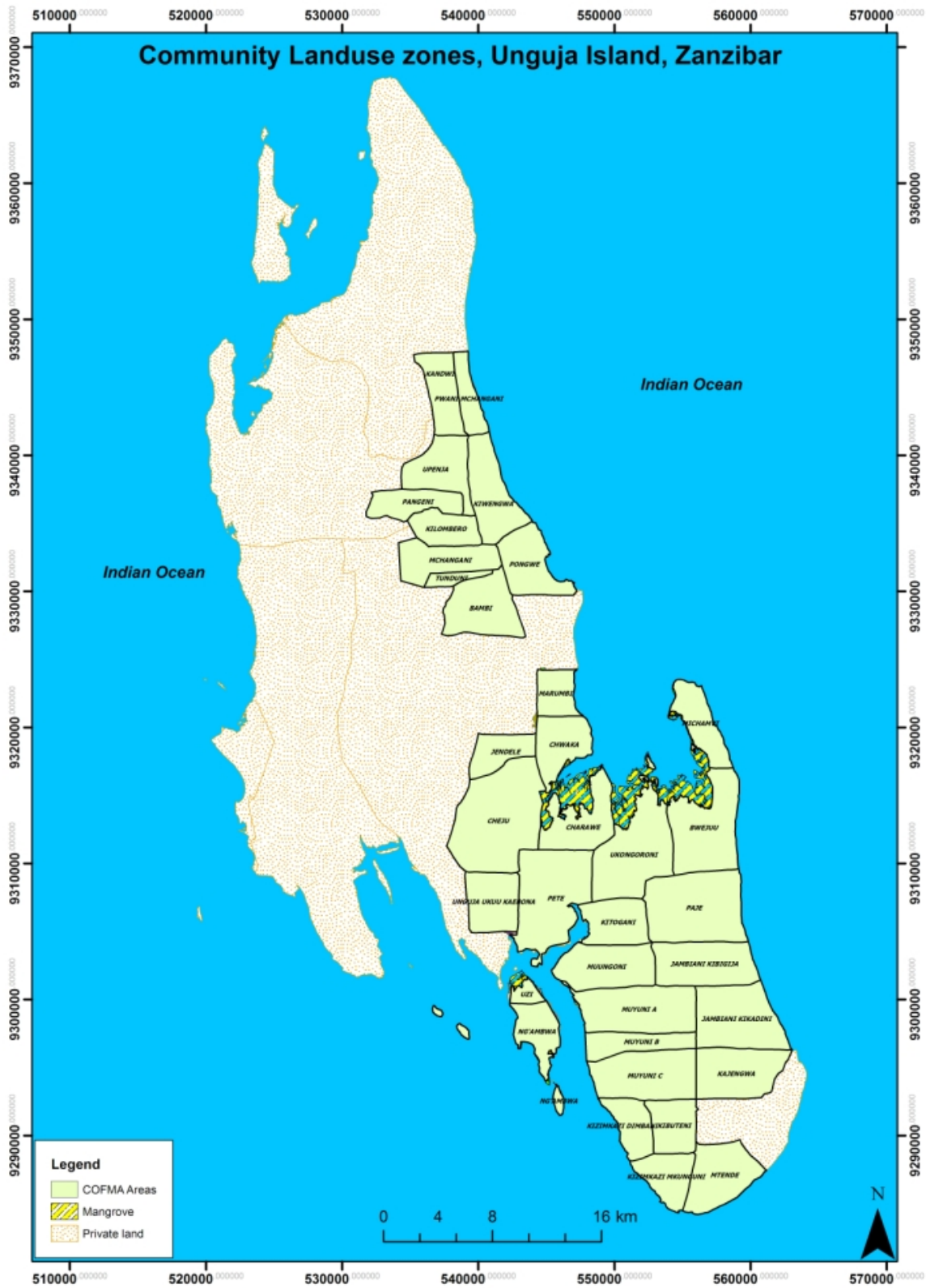


Figure 2. Twenty-seven Community Land Use Zones, Unguja Island, Zanzibar.

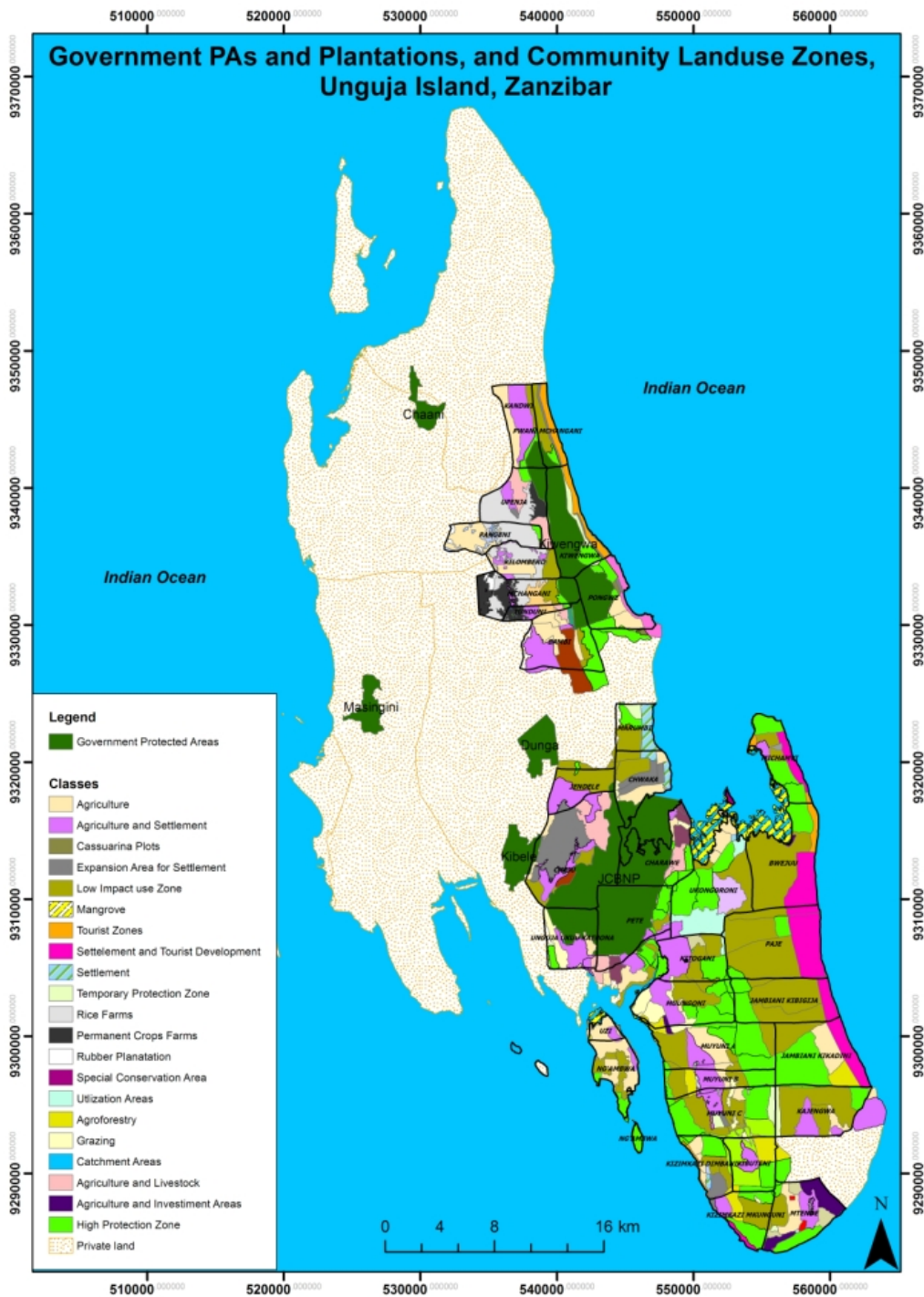


Figure 3. Government Protected Areas and Plantations (dark green) and Community Landuse Zones, Unguja Island, Zanzibar. Each Community management area is divided into a series of protection and use zones; including “High Protection” (medium green) and “Low Impact Use” (olive green) zones the protection of which is crucial for the continued survival of Zanzibar’s wildlife.

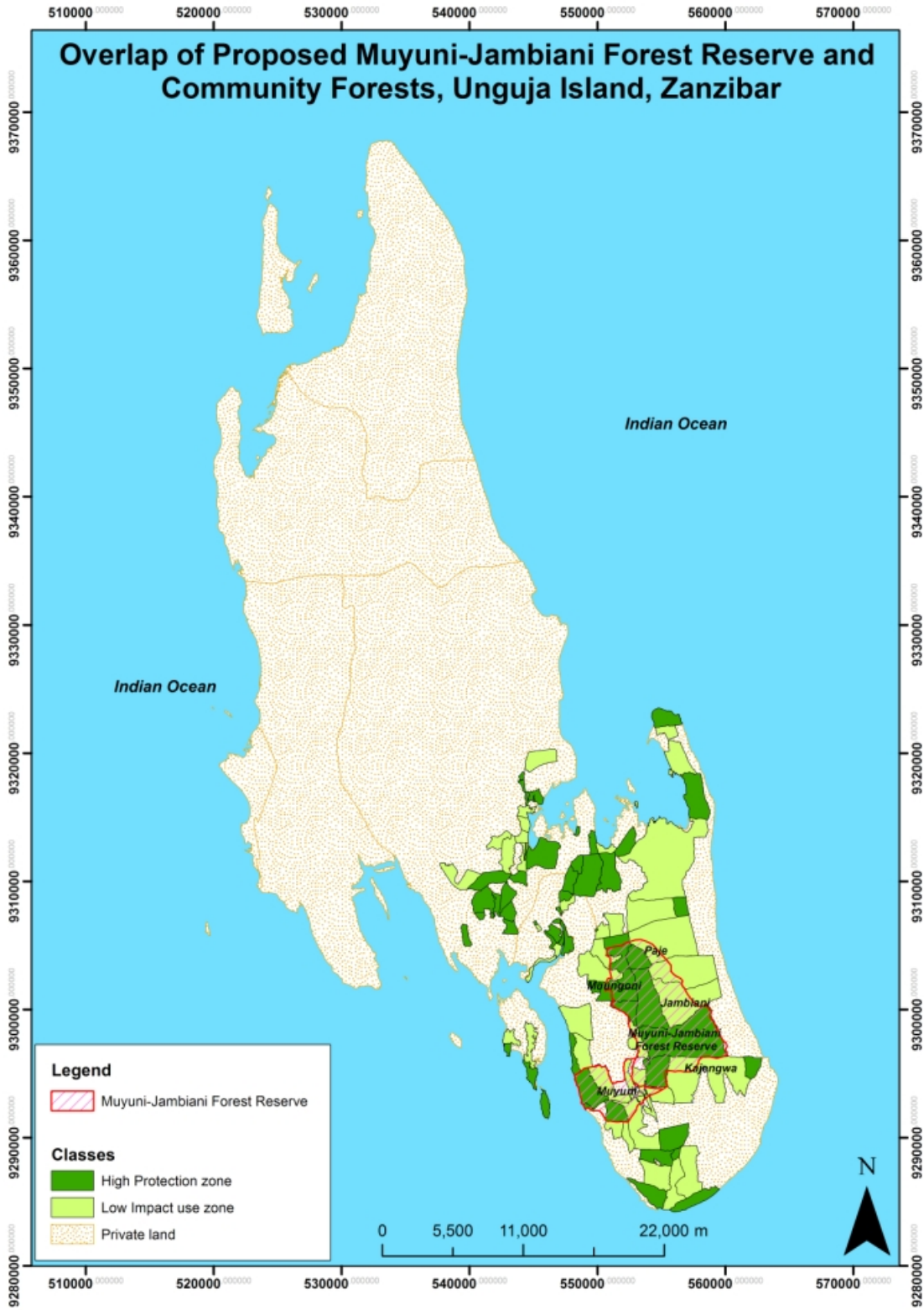


Figure 4. Overlap of proposed Muyuni-Jambiani Forest Reserve and Community managed “High Protection” and “Low Impact Use” zones.

Table 1. Communities of Unguja and Pemba Islands with Community Forest Management Agreements (CoFMAs), and Communities with CoFMAs in the process of development.

Unguja Island	Pemba Island
Jozani and Jozani Wider Area	
Unguja Ukuu - Kaebona	Bandari Kuu
Pete-Jozani	Changaraweni
Kitogani	Fundo
Charawe	Gabani Msuka
Ukongoroni	Kipangani
Cheju	Kisiwapanza
Chwaka	Mgelema
Muongoni	Mjimbini
Paje	Mkia wa Ng'ombe
Bwejuu	Mtambwe Kakazini
Michamvi	Mtambwe Kusini
Jambiani	Shumba mjini
Muyuni*	Wingwi mjini
Kibuteni	
Kizimkazi – Mkunguni	
Kizimkazi – Dimbani	
Mtende	
Kiwengwa	
Bambi	
Pongwe	
Kiwengwa	
Mchangani	
Tunduni	
Kilombero	
Pangeni	
Kandwi	
Pwani Mchangani	
Upenja	
CoFMAs in the process of development	
Uzi (both villages-Uzi and Ngambwa)	
Unguja Ukuu-Kaepwani	
Kajengwa	
Marumbi	
Jendele	
Umbuji	

* Currently 1 CoFMA; to be split into 3, one for each Muyuni Village (A, B, C)

Five potential habitat corridors that could link all of these remaining forest patches thus forming a comprehensive, functional protected areas network were identified, mapped and surveyed (Figure 5). There are three main corridors: “JK” which connects KPFR to JCBNP; “KJ” connecting Kizimkazi Mkunguni, Kubuteni, Kajengwa, Jambiani, Muyuni A, Paje, Muungoni, Kitogani, Ukongoroni, Charawe, and JCBNP; and MJ connecting Mtende, Kizimkazi Mkunguni, Kizimkazi Dimbani, Kibuteni, Muyuni C, B, A, Muungoni, Kitogani, and JCBNP. There are, in addition, two smaller but also important corridors: MBU which connects the forests of Michamvi, Bwejuu, and Ukongoroni with JCBNP, and MZU which connects the eastern side of Mtende forest (an important area for Aders’ duiker conservation) to the KJ corridor

The habitat corridors are mainly on community lands and a large portion of them are already somewhat protected as Community “High Protection” and “Low Impact Use” zones (Figure 5). However, sections of the identified corridors still lie outside of these zones and although currently being covered by a forest mosaic, they are zoned for future use by communities. There are also additional communities which are currently developing CoFMAs (Table 1) which will add additional “High Protection” and “Low Impact Use” zones to the PA network. Three of these communities (Marumbi, Jendele, and Umbuji) are between KPFR and JCBNP and their lands overlap the northern half of the proposed JK corridor. Thus, during zoning, these communities must be encouraged to zone any areas which overlap the proposed corridor as “High Protection” areas.

The KJ and MJ corridors also overlap the proposed Muyuni-Jambiani Forest Reserve (Figure 6). If this forest block is upgraded to a forest reserve; this will provide much greater protection to a large and extremely important portion of these corridors.

All corridors are currently functional and are actively used by wildlife (as determined by reconnaissance surveys and camera trapping, see below results). However, we must move very quickly to completely protect all five corridors before many of these connections are lost forever due to agriculture expansion and cutting for building poles, firewood and charcoal production.

There is also a potential 6th corridor which would be very important to restore. This corridor would connect the forests on the southern tip of Uzi and adjacent Vundwe Island (two small islands directly south of JCBNP and very important habitat for Zanzibar red colobus) with Unguja Ukuu and thus to JCBNP (Figure 5). Any current link between the forests of Uzi and Vundwe Islands with Unguja are tenuous at best (via the Pete Inlet/Unguja Ukuu mangroves). The two villages of Uzi Island (Uzi Uzi and Uzi Ngambwa) and the adjacent Unguja Ukuu-Kaepwani (area south of Unguja Ukuu-Kaebona; Figure 2) are currently in the process of developing CoFMAs (Table 1) to help protect their remaining forests. This is a step in the right direction; but will probably not be sufficient. Enrichment planting of both upland and mangrove forests will probably be warranted to restore functional connectivity between Uzi/Vundwe and Unguja.

Thus, if all five corridors can be adequately protected (and the Uzi – JCBNP connection re-established) there will only be one small forest of importance to wildlife on Unguja that is isolated from the PA network, Masingini Forest Reserve (Figure 5). Masingini serves as the

main catchment forest for Stone Town, but is also important for wildlife and supports some of Unguja's endangered species such as the Zanzibar red colobus. It is, however, now unfortunately completely isolated from all other wildlife habitat on Unguja; so special care must be given to ensure its survival and that of the wildlife that it supports.

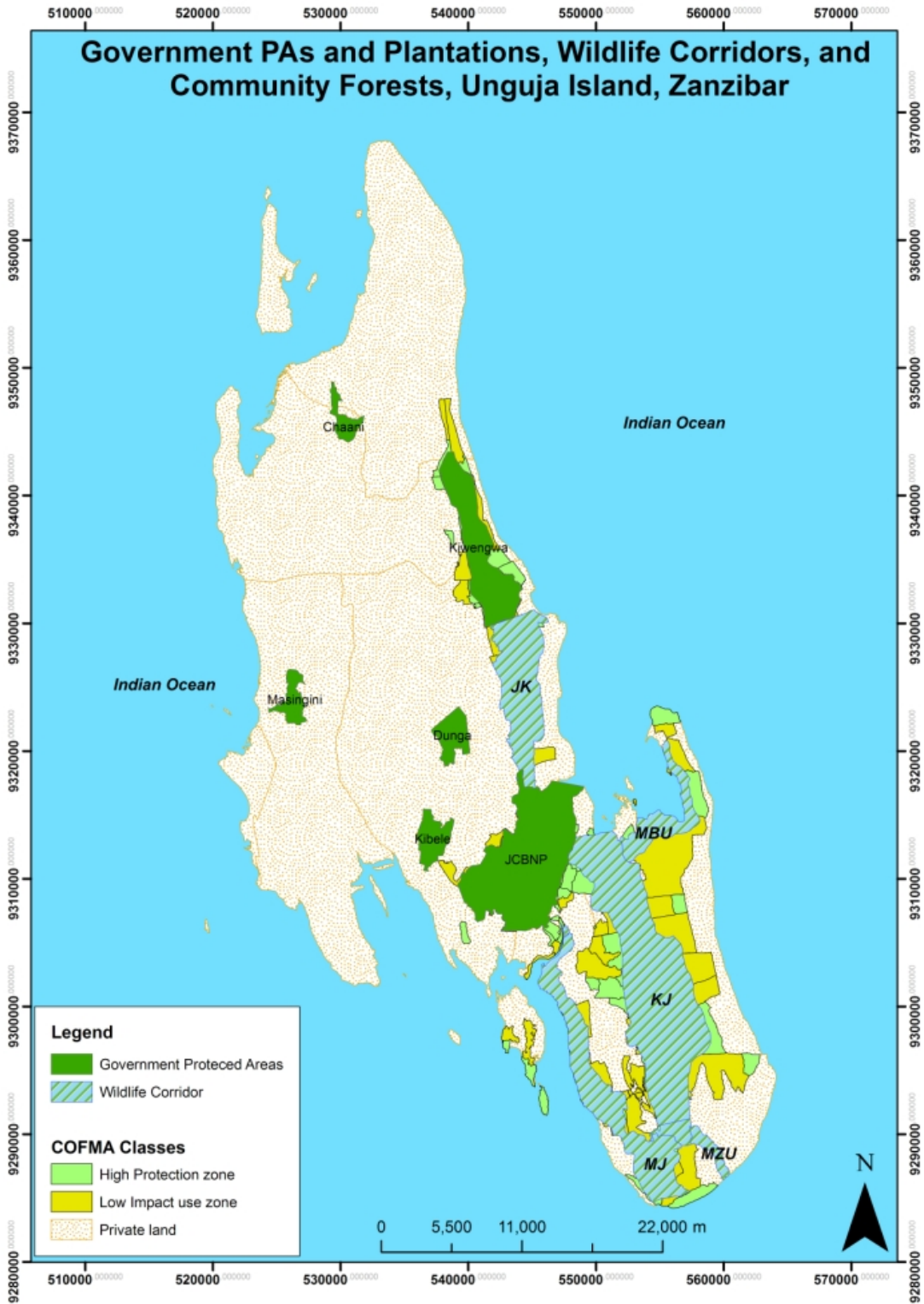


Figure 5. Government Protected Areas and Plantations, five Wildlife Corridors (JK, KJ, MJ, MBU, MZU) and Community “High Protection” and “Low Impact Use” zones, Unguja Island, Zanzibar.

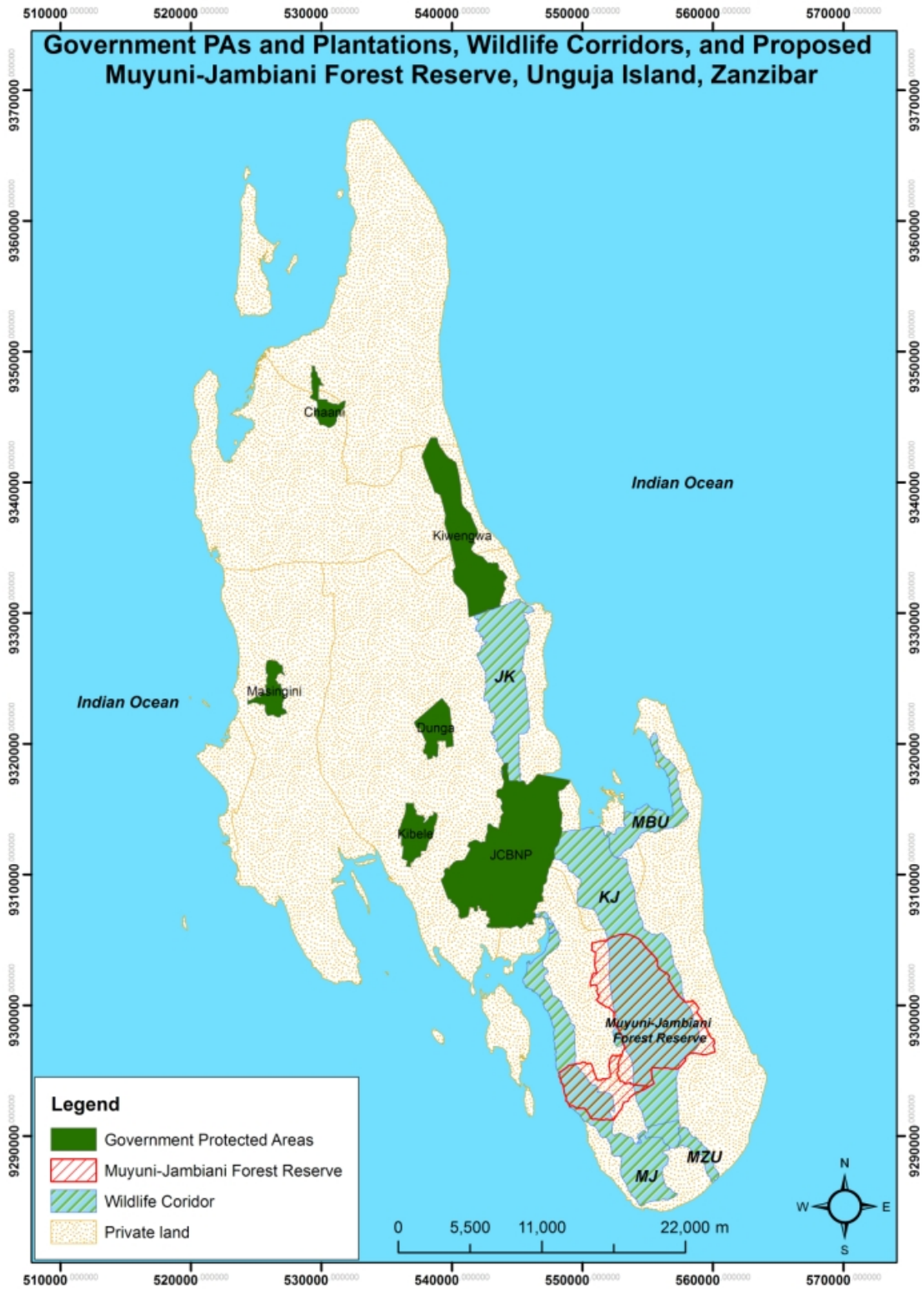


Figure 6. Government Protected Areas and Plantations, five Wildlife Corridors (JK, KJ, MJ, MBU, MZU), and the Proposed Muyuni-Jambiani Forest Reserve, Unguja Island, Zanzibar.

Unguja Corridors and Proposed Muyuni-Jambiani Forest Reserve– Habitat and Wildlife

The North corridor (JK) is approximately 14 km stretching from KPFR in the north to JCBNP in the center of the island. The corridor varies from 1 to 4.5 km in width. The South West (MJ) corridor is approximately 22 km and links JCBNP in the north and the forests of Mtende Village at the southern tip of Unguja. It ranges in width from a very narrow 0.5 km at its northern limit around Kitogani Village to 4 km further south. The South East (KJ) corridor is the longest at approximately 25 km and links the community forests of Makunduchi at the south to JCBNP at the north. This corridor is also the widest ranging from 1 to 7 km from east to west. The MBU corridor connects Michamvi, Bwejuu, and Ukongoroni forests with JCBNP. It is approximately 14 km in length and ranges from 1 to 2 km wide. The MZU corridor connects the eastern side of Mtende forest (an important area for Aders' duiker conservation) to the KJ corridor. It is the shortest of the corridors at only 4 km, and only averages 1 km in width (Figure 5).

All identified corridors are a mosaic of habitat types. In the North Corridor (JK) a reconnaissance line of 27.39 km was sampled (Table 2). Along this line a total of five habitat types were documented (high coral rag forest, low coral rag forest, mixed thicket, shrub land, and agriculture – listed in order of least to most disturbed). The vast majority of this corridor consists of low coral rag forest.

Table 2. Reconnaissance line data from North Corridor (JK). Total distance sampled, 27.39 km.

Habitat	Species	Number of signs	Dist sampled per habitat	Index (# sign per km sampled)
Agriculture	sykes monkey	9	4.42	2.04
	african civit	1	4.42	0.23
	duiker (unidentified spp)	5	4.42	1.13
High coral rag forest	squirrel (unidentified spp)	1	4.80	0.21
	helmeted guinea fowl	3	4.80	0.63
	sykes monkey	13	4.80	2.71
	red colobus monkey	27	4.80	5.63
	crested guinea fowl	1	4.80	0.21
	elephant shrew	5	4.80	1.04
	bush pig	1	4.80	0.21
	duiker (unidentified spp)	82	4.80	17.10
	vervet	1	4.80	0.21
	Low coral rag forest	squirrel (unidentified spp)	1	15.89
helmeted guinea fowl		1	15.89	0.06
sykes monkey		8	15.89	0.50
crested guinea fowl		3	15.89	0.19
elephant shrew		4	15.89	0.25
bush pig		2	15.89	0.13
duiker (unidentified spp)		77	15.89	4.85
Aders' duiker		8	15.89	0.50
all duiker spp		85	15.89	5.35
Mixed thicket		squirrel (unidentified spp)	1	1.98
	helmeted guinea fowl	20	1.98	10.08
	bush pig	1	1.98	0.50
	duiker (unidentified spp)	13	1.98	6.55
Shrub land	red colobus monkey	1	0.31	3.27
	duiker (unidentified spp)	1	0.31	3.27

In the South West Corridor (MJ) a reconnaissance line of 39.12 km was sampled (Table 3). This area was more diverse with 7 habitat types identified within the corridor. In order of least to most disturbed the habitats in this corridor ranged from high forest, mangrove, high coral rag forest, low coral rag forest, mixed thicket, shrub, and *Casuarina* plantation. This corridor was predominantly mixed thicket and low coral rag forest.

Table 3. Reconnaissance line data from South West Corridor (MJ). Total distance sampled, 39.12 km.

Habitat	Species	Number of signs	Dist sampled per habitat	Index (# sign per km sampled)
Casuarina plantation	duiker (unidentified spp)	2	1.79	1.12
	sykes monkey	1	1.79	0.56
	red colobus monkey	1	1.79	0.56
High coral rag forest	squirrel (unidentified spp)	3	5.07	0.59
	helmeted guinea fowl	3	5.07	0.59
	sykes monkey	12	5.07	2.37
	red colobus monkey	47	5.07	9.27
	crested guinea fowl	3	5.07	0.59
	elephant shrew	3	5.07	0.59
	bush pig	4	5.07	0.79
	duiker (unidentified spp)	13	5.07	2.56
	Aders' duiker	1	5.07	0.20
	all duiker spp	14	5.07	2.76
	hyrax	7	5.07	1.38
High forest	sykes monkey	1	1.39	0.72
Low coral rag forest	squirrel (unidentified spp)	1	13.99	0.07
	helmeted guinea fowl	1	13.99	0.07
	sykes monkey	3	13.99	0.21
	red colobus monkey	3	13.99	0.21
	crested guinea fowl	7	13.99	0.50
	elephant shrew	2	13.99	0.14
	bush pig	20	13.99	1.43
	duiker (unidentified spp)	96	13.99	6.86
	Aders' duiker	3	13.99	0.21
	all duiker spp	99	13.99	7.08
Mangrove	elephant shrew	1	0.97	1.03
Mixed thicket	red colobus monkey	4	15.12	0.26
	duiker (unidentified spp)	9	15.12	0.60
Shrub land	elephant shrew	1	0.79	1.27

In the South East Corridor (KJ) a reconnaissance line of 31.06 km was sampled (Table 4). Of all five corridors, the KJ Corridor contained the most intact forest cover. The corridor was mainly high coral rag forest and low coral rag forest with very small areas being classified as mixed thicket and shrub

Table 4. Reconnaissance line data from South East Corridor (KJ). Total distance sampled, 31.06 km.

Habitat	Species	Number of signs	Dist sampled per habitat	Index (# sign per km sampled)
High coral rag forest	slender mongoose	1	10.32	0.10
	squirrel (unidentified spp)	5	10.32	0.48
	helmeted guinea fowl	1	10.32	0.10
	sykes monkey	5	10.32	0.48
	red colobus monkey	11	10.32	1.07
	crested guinea fowl	4	10.32	0.39
	African civit	1	10.32	0.10
	elephant shrew	11	10.32	1.07
	bush pig	18	10.32	1.74
	duiker (unidentified spp)	113	10.32	10.95
Low coral rag forest	Zanzibar giant rat	1	19.30	0.05
	slender mongoose	10	19.30	0.52
	squirrel (unidentified spp)	1	19.30	0.05
	helmeted guinea fowl	6	19.30	0.31
	red colobus monkey	1	19.30	0.05
	crested guinea fowl	2	19.30	0.10
	African civit	3	19.30	0.16
	elephant shrew	16	19.30	0.83
	bush pig	28	19.30	1.45
	duiker (unidentified spp)	74	19.30	3.83
	sunii	28	19.30	1.45
	all duiker spp	102	19.30	5.28
	four-toed elephant shrew	2	19.30	0.10
Mixed thicket	sykes monkey	2	0.55	3.64
	elephant shrew	1	0.55	1.82
	bush pig	2	0.55	3.64
	duiker (unidentified spp)	5	0.55	9.09
Shrub land	bush pig	1	0.89	1.12
	duiker (unidentified spp)	5	0.89	5.62
	four-toed elephant shrew	1	0.89	1.12

In the MBU Corridor a reconnaissance line of 13.87 km was sampled (Table 5). Along this line a total of five habitat types were documented (high coral rag forest, low coral rag forest, mixed thicket, shrub land, and agriculture – listed in order of least to most disturbed). The majority of the corridor consists of low coral rag forest, followed by shrub land, and high coral forest.

Table 5. Reconnaissance line data from Michamvi-Bwejuu-Ukongoroni Corridor (MBU). Total distance sampled, 13.87 km.

Habitat	Species	Number of signs	Dist sampled per habitat	Index (# sign per km sampled)
High coral rag forest	bush pig	1	3.45	0.29
	elephant shrew	4	3.45	1.16
	guinea fowl	1	3.45	0.29
	red colobus monkey	7	3.45	2.03
	sykes monkey	2	3.45	0.58
	sunni	17	3.45	4.93
	duiker (unidentified spp)	3	3.45	0.87
	all duiker spp	20	3.45	5.80
Low coral rag forest	guinea fowl	1	5.46	0.18
	sunni	1	5.46	0.18
	duiker (unidentified spp)	1	5.46	0.18
	all duiker spp	2	5.46	0.37
Shrub land	duiker (unidentified spp)	1	4.30	0.23
	elephant shrew	1	4.30	0.23
	guinea fowl	1	4.30	0.23
	sunni	1	4.30	0.23
Mixed thicket	-	-	0.37	-
Agriculture	-	-	0.30	-

In the MZU Corridor a reconnaissance line of 7.29 km was sampled (Table 6). Along this, the shortest and most disturbed of the five corridors, only four habitat types were documented (low coral rag forest, mixed thicket, shrub land, and agriculture). The majority of the corridor consists of shrub land followed by low coral rag forest.

Table 6. Reconnaissance line data from Mtende-Kibuteni-Mzuri Makunduchi Corridor (MZU). Total distance sampled, 7.29 km.

Habitat	Species	Number of signs	Dist sampled per habitat	Index (# sign per km sampled)
Agriculture	bush pig	2	0.49	4.08
	duiker (unidentified spp)	6	0.49	12.24
	hyrax	1	0.49	2.04
	monkey (unidentified spp)	1	0.49	2.04
Low coral rag forest	crested guinea fowl	1	2.33	0.43
	duiker (unidentified spp)	28	2.33	12.02
	helmeted guinea fowl	2	2.33	0.86
	monkey (unidentified spp)	1	2.33	0.43
Mixed thicket	duiker (unidentified spp)	2	0.43	4.65
Shrub land	duiker (unidentified spp)	1	4.05	0.25
	sykes monkey	1	4.05	0.25

The proposed Muyuni-Jambiani Forest Reserve is 6100 ha (Figures 4 and 6), the vast majority of which overlaps the MJ and KJ corridors and the “High Protection” and “Low Impact Use” zones of 5 communities (Muyuni, Muungoni, Paje, Jambiani and Kajengwa). In order to sufficiently sample this area, we established 5 parallel reconnaissance lines running west to east, for a total of 34.95 km sampled (Table 7). Like the corridors which it overlaps, the proposed forest reserve is a mosaic of habitat types including: high coral rag, low coral rag, mixed thicket, shrub land, grass land, and agriculture (in order of least to most disturbed). The predominant habitat type sampled was low coral rag forest (21.32 km, or 61%) followed by mixed thicket (4.82 km or 13.8%) and high coral rag (4.66 km, or 13.3%)

Table 7. Reconnaissance line data from the proposed Muyuni-Jambiani Forest Reserve. Total distance sampled, 34.95 km.

Habitat	Species	Number of signs	Dist sampled per habitat	Index (# sign per km sampled)
Agriculture	bush baby	1	2.23	0.45
	bush pig	4	2.23	1.79
	elephant shrew	5	2.23	2.24
	guinea fowl	3	2.23	1.35
	squirrel (unidentified spp)	2	2.23	0.90
	duiker (unidentified spp)	28	2.23	12.56
	sykes monkey	2	2.23	0.90
High coral rag forest	bush pig	24	4.66	5.15
	guinea fowl	5	4.66	1.07
	monkey (unidentified spp)	3	4.66	0.64
	duiker (unidentified spp)	24	4.66	5.15
Low coral rag forest	bush pig	110	21.32	5.16
	civit	1	21.32	0.05
	elephant shrew	35	21.32	1.64
	guinea fowl	24	21.32	1.13
	hyrax	3	21.32	0.14
	red colobus monkey	3	21.32	0.14
	squirrel (unidentified spp)	1	21.32	0.05
	duiker (unidentified spp)	275	21.32	12.90
	sykes monkey	3	21.32	0.14
	Mixed thicket	bush pig	18	4.82
elephant shrew		9	4.82	1.87
guinea fowl		2	4.82	0.41
duiker (unidentified spp)		44	4.82	9.13
sykes monkey		2	4.82	0.41
Shrub land	bush baby	1	1.83	0.55
	elephant shrew	7	1.83	3.83
	guinea fowl	5	1.83	2.73
	duiker (unidentified spp)	6	1.83	3.28
Grassland	sykes monkey	1	1.83	0.55
Grassland	-		0.08	

In the corridors and proposed Muyuni-Jambiani Forest Reserve, 17 mammal and three bird species were identified from signs and direct observations along reconnaissance lines and from camera trapping data. A total of 4,355 camera trap days were sampled between October 2008

and November 2011; 465 trap days in JK corridor, 1,615 trap days in KJ corridor, 1,042 trap days in MJ corridor and 1,213 trap days in the proposed Muyuni Jambiani Forest Reserve. (Table 8). Data have been collected on 17 species from six orders of mammals: Macroscelidea, Primates, Carnivora, Hyracoidea, Artiodactyla, and Rodentia. These 17 species found in the corridors and proposed forest reserve represent the vast majority of the larger bodied terrestrial and arboreal mammal species recorded for Unguja Island, Zanzibar. There are two Macroscelidea recorded for Zanzibar (the four-toed shrew and the black and rufous elephant shrew) both of which were found to utilize the three corridors and proposed forest reserve. Of the five primates recorded for Zanzibar (greater galago, lesser bushbaby, vervet monkey, sykes monkey and Zanzibar red colobus), only one, the lesser bushbaby (*Galago senegalensis*) has not been recorded in these areas. Four of the five indigenous carnivores recorded for Zanzibar were also found to use the corridors and Muyuni-Jambiani forest (bushy tailed mongoose, slender mongoose, African civit, and servalin genet). Carnivores not yet found in the corridors include the Zanzibar leopard (*Panthera pardus adersi*) (which is thought to be extinct) and two introduced species previously recorded in Zanzibar, the banded mongoose (*Mungos mungo*) and the Javan civit (*Viverricula indica rasse*). The one species of Hyracoidea and four species of Artiodactyla recorded for Zanzibar were all found to utilize the corridors and proposed forest reserve. Of the smaller mammals (Rodentia), two of the six species recorded for Unguja were recorded, the red bush squirrel and the Zanzibar giant rat. Not recorded were the red legged sun squirrel, house mouse, common rat and house rat. This is not surprising as visual reconnaissance and camera trapping surveys are not the chosen methodology for surveying rodents.

Of the 17 total mammal species identified in the corridors and the proposed forest reserve, 16 of these species were captured by camera trapping. In all areas, the most commonly trapped species were the four toed shrew and elephant shrew (ranked numbers 1 and 2 respectively). Suni and red bush squirrel also ranked in the top five (ranking numbers 4 and 5, respectively, in the JK and MJ corridors, and the proposed Muyuni-Jambiani Forest Reserve). Also ranking in the top five were sykes monkey (ranked 3 and 5 in the JK and KJ corridors, respectively), the Zanzibar giant rat (ranked 3, 3, and 4 in the MJ corridor, Muyuni-Jambiani, and KJ corridor, respectively), and blue duiker (ranked 3 in the KJ corridor) (Table 8)

The MJ corridor was the most diverse in terms of habitat diversity (7 types) and the overall number of mammalian species found in the corridor (16 species) (Tables 3 and 8); and when compared to the other two corridors that were camera trapped, KJ and JK it had the highest indices of abundance for 14 species (Table 8, green highlights). The KJ corridor was less diverse in terms of habitats (5 habitat types) and the overall number of mammalian species found in the corridor (14 species) (Tables 4 and 8), and when compared to the other corridors in term of species abundance, it placed 2nd with only four species having the highest indices of abundance (Table 8, green highlights). However, these four species are those that are predicted to be most abundant in better protected, higher forest (red colobus, sykes monkey, Aders' and blue duiker) and this corridor was indeed the most intact. The JK corridor was the most disturbed of the three major corridors with only 5 habitat types, 11 mammalian species and most of these species were less abundant (i.e., had lower indices of abundance) than in the MJ and KJ corridors (Table 2 and Table 8, pink highlights). The MBU and MZU corridors were less diverse than the three main corridors with only 5 and 4 habitat types, and 6 and 5 mammalian species found, respectively (this could also be a reflection of the smaller areas of the corridors; and hence the much smaller

sample sizes). As expected given its overlap with the MJ and KJ corridors, the proposed Muyuni-Jambiani Forest Reserve was intermediate to the MJ and KJ corridors containing 6 habitat types and 14 mammalian species trapped. In terms of its indices of abundance for the trapped species, the proposed forest reserve most resembles the KJ corridor (Table 8).

Table 8. Seventeen terrestrial mammal (and three bird) species observed to use the five potential corridors and proposed Muyuni-Jambiani Forest Reserve on Unguja. Data are from reconnaissance and camera trapping surveys. Species without a value for “No Captures/ Trap Day” were only recorded during reconnaissance surveys. Data are for a total of 4,335 trap days between October 2008 and November 2011; 465 trap days in JK corridor, 1,615 trap days in KJ corridor, 1,042 trap days in MJ corridor and 1,213 trap days in the proposed Muyuni-Jambiani Forest Reserve. For comparison among the three corridors (JK, MJ and KJ) for each species the value shown in green is the highest index, in yellow the 2nd highest index, and in pink the lowest index.

Order	English name	Latin name	No Captures / Trap Day			
			JK	MJ	KJ	Muyuni/ Jambiani
Macroscelidea						
	Four toed shrew	<i>Petrodromus tetradactylus zanzibaricus</i>	0.167	1.370	0.731	0.766
	Black and rufous elephant shrew	<i>Rhynchocyon petersi</i>	0.167	0.342	0.165	0.197
Primates						
	Greater galago	<i>Otolemur garnettii garnettii</i>	0.014	0.035	0.022	0.034
	Sykes monkey	<i>Cercopithecus mitis albogularis</i>	0.093	0.101	0.107	0.056
	Zanzibar red colobus	<i>Procolobus kirkii</i>		0.002	0.003	0.003
	Vervet monkey	<i>Cercopithecus aethiops</i>				
Carnivora						
	African civet	<i>Civettictis civetta</i>		0.003	0.002	0.003
	Zanzibar bushy tailed mongoose	<i>Bdeogale crassicauda tenuis</i>	0.014	0.051	0.037	0.035
	Zanzibar servalin genet	<i>Genatta servaline archeri</i>	0.005	0.015	0.006	0.007
	Slender mongoose	<i>Herpestes sanguineus rufescens</i>		0.005		
Hyracoidea						
	Zanzibar tree hyrax	<i>Dendrohyra validus neumanni</i>		0.001		
Artiodactyla						
	Aders' duiker	<i>Cephalophus adersi</i>	0.005	0.009	0.011	0.006
	Blue duiker	<i>Cephalophus monticola sundevalli</i>		0.021	0.145	0.042
	Bush pig	<i>Potamochoerus porcus</i>	0.014	0.022	0.015	0.015
	Suni	<i>Neotragus moschatus moschatus</i>	0.074	0.135	0.034	0.077
	duiker - unidentified		0.019	0.025	0.026	0.003
Rodentia						
	Red bush squirrel	<i>Paraxerus palliatus frerei</i>	0.019	0.115	0.021	0.066
	Zanzibar giant rat	<i>Cricetomys gambianus cosensi</i>	0.014	0.266	0.111	0.133
Other (Class - Aves)						
	Crested guinea fowl	<i>Guttera pucherani</i>		0.008		
	Helmeted guinea fowl	<i>Numidea meleagris</i>				
	White browed coucal	<i>Centropus superciliosus</i>		0.001		

Of the 17 total mammal species found in the corridors and potential forest reserve, 14 of these species/species groups were identified in the reconnaissance surveys. When signs were found from duikers and squirrels (of which there are three and two species on Unguja, respectively), we were often not able to identify the sign to the species level, hence it would be classified as a species group. In the MJ and JK corridors, 8 and 9 species/species groups were recorded along the reconnaissance lines, respectively. In the more intact corridor, KJ, 11 species were recorded. Again the proposed Muyuni-Jambiani Forest Reserve was intermediate to the MJ and KJ corridors with 9 species recorded during the reconnaissance surveys. As explained above, in the shorter MBU and MZU corridors we recorded fewer mammalian species, 6 and 5, respectively (which may be due largely to smaller sample size).

In all five corridors, along the reconnaissance lines signs of duikers were the most abundant (Tables 2-6), and in three of the five corridors, duikers had a higher index of abundance in high coral rag forest than in low coral rag forest: 17.1 signs/km sampled in high coral rag vs. 5.35 signs/km sampled in low coral rag in the JK corridor, 10.95 vs. 5.28 signs/km sampled in the KJ corridor, and 5.08 vs. 0.37 signs/km in the MBU corridor. The shortest of the corridors, MZU, also had one of the highest indices of duiker abundance in its low coral rag forest (12.02 signs/km sampled); this proposed corridor is very important for duiker conservation as it links the east side of Mtende forest (known for its Aders' duiker population) with the remainder of the forests on the island. Along the reconnaissance lines in the proposed Muyuni-Jambiani Forest Reserve, signs from duikers were also the most abundant; with very high indices for low coral rag (12.90 signs/km sampled), agriculture (12.56 signs/km sampled) and mixed thicket (9.13 signs/km sampled) (Table 7). Signs of Zanzibar red colobus were high in the high coral rag forests of the JK corridor (5.63 signs/km sampled) and in the MJ Corridor (9.27 signs/km sampled) (Tables 2 and 3).

Pemba Island - Mapping

From the GIS analysis of the 2004 aerial photographs and the reconnaissance /ground truthing field work, all government protected areas (Ngezi-Vumawinbi Nature Reserve, Msitu Mkuu Forest Reserve, Ras Kiuyu proposed Forest Reserve, and Maziwa Ng'ombe Plantation), community forests, corridors and forest patches were mapped. On Pemba, the areas of greatest importance for wildlife and those that must be included in the PA network include: the three government PAs of Ngezi-Vumawimbi Nature Reserve (2900 ha), Msitu Mkuu Forest Reserve (180 ha) and Ras Kiuyu proposed Forest Reserve (270 ha), and the High Protection and Low Impact Use zones of the 13 community forests (Table 1, Figure 7). There are also a number of additional forest patches which need to be further studied to determine their importance to wildlife. These include: Kwa Konondo, Gando, Kojani and Kangagani; and the community managed forest patches of Fundo, Matambwe, Mgelema, Mjimbini/Ngulu, Kisiwa Panza and Mbiji/Changaweni (Figure 8).

Unlike on Unguja, most of these forest areas are spread out across the island and are not well connected; none of the three government PAs are connected to one another by wildlife corridors. There was reported to be a corridor between Msitu Mkuu and Kangagani, and Makaani and Kangagani, but our reconnaissance work showed that these potential corridors no longer exist.

There is still a corridor between Ngezi-Vumawimbi Nature Reserve and Gando forest patch but this corridor is mainly via mangrove forest rather than terrestrial forest which will limit the usefulness of the corridor to a select number of species (Figure 9).

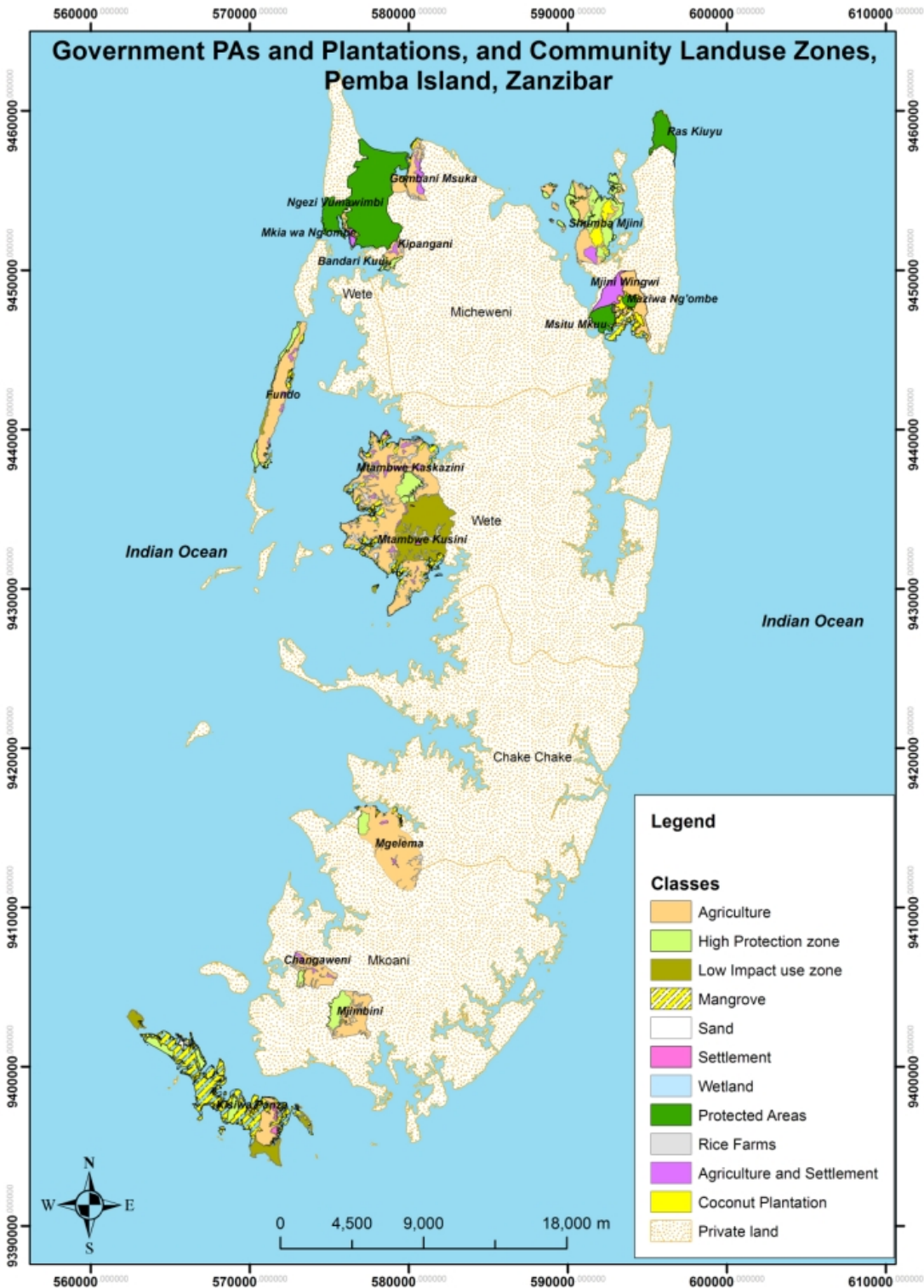


Figure 7. Government Protected Areas and Plantations (dark green), and Community Landuse Zones, Pemba Island, Zanzibar (Community “High Protection” zones = light green; “Low Impact Use” zones = olive green).

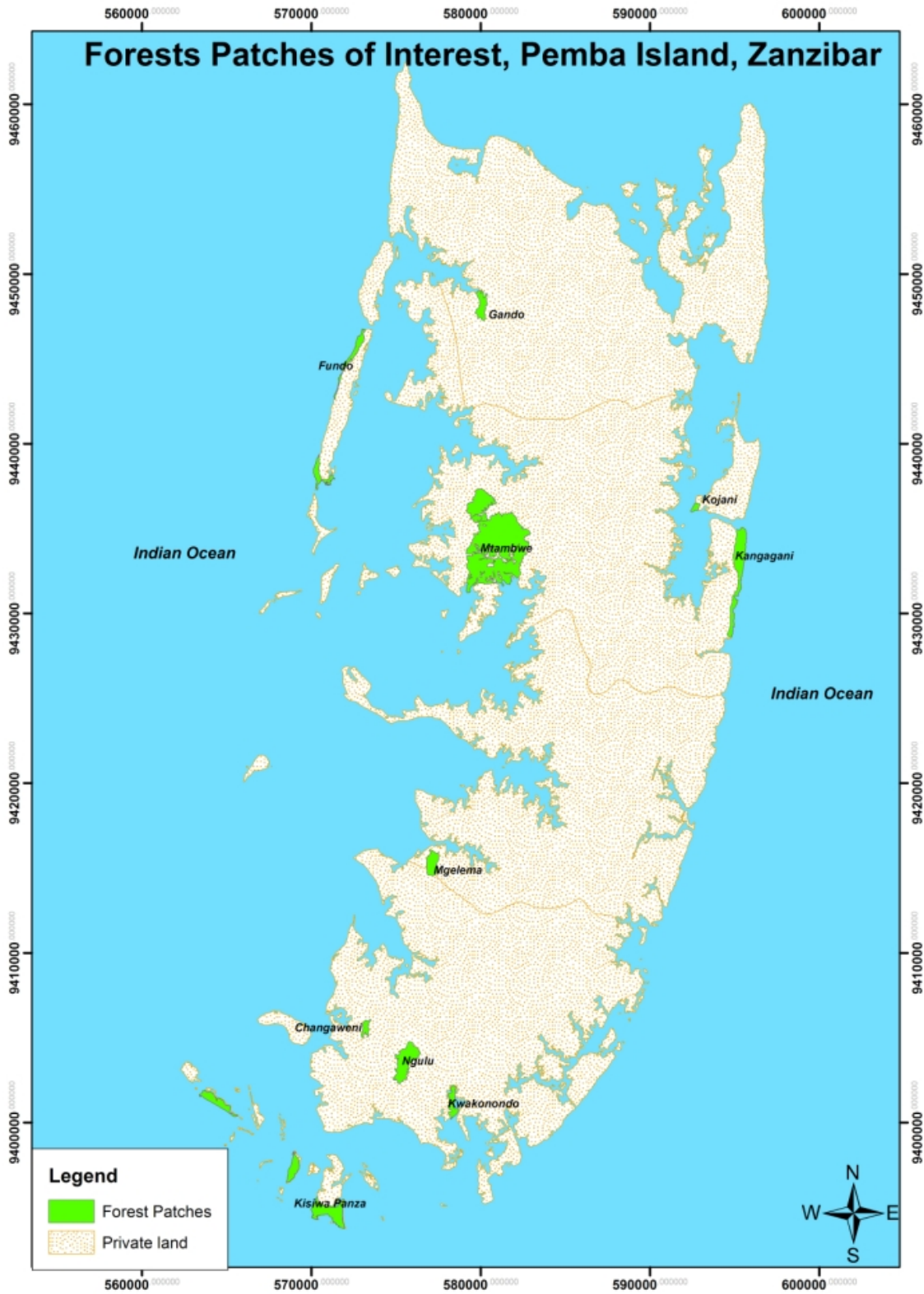


Figure 8. Forest Patches of potential importance to wildlife, Pemba Island, Zanzibar.

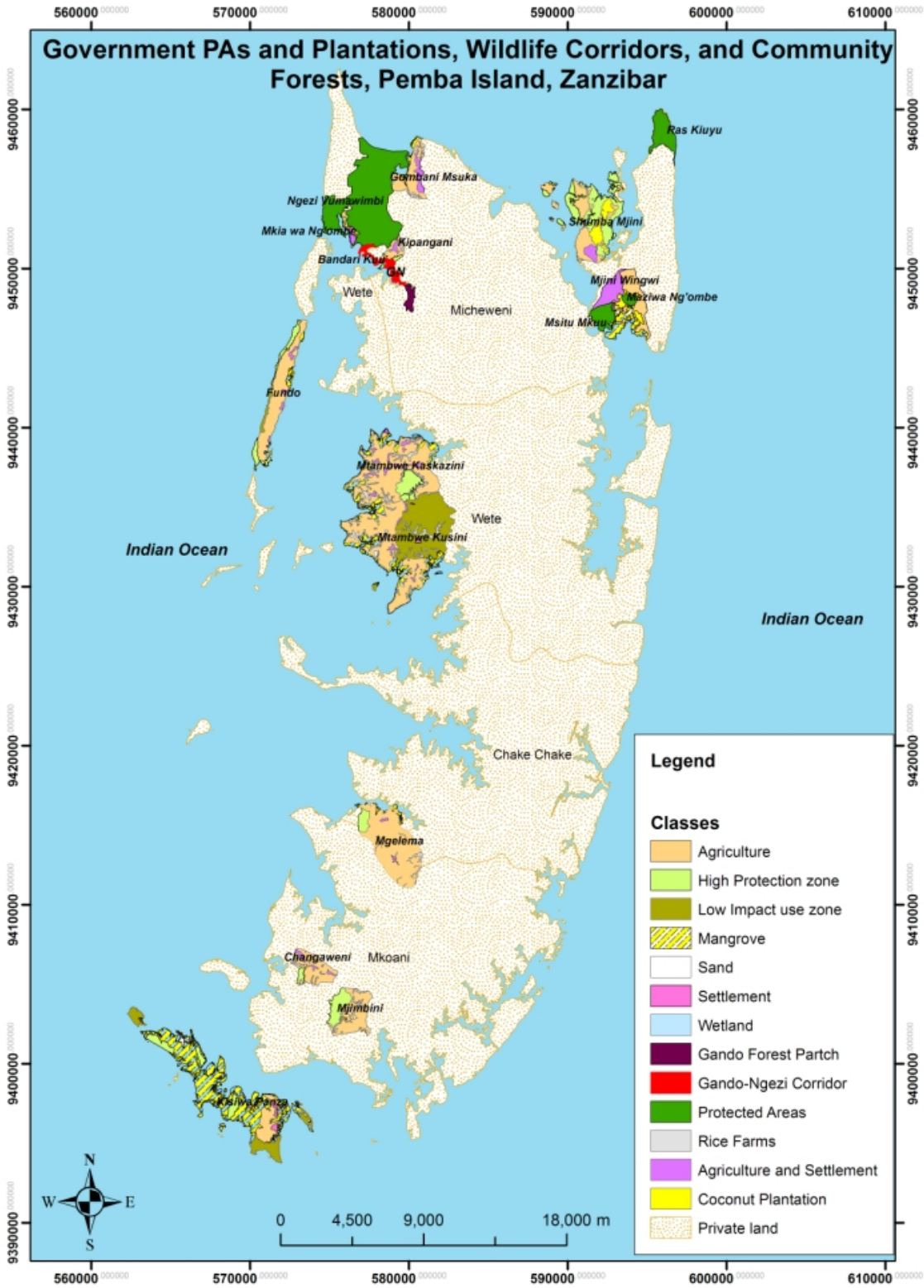


Figure 9. Government Protected Areas and Plantations, Gando-Ngezi Wildlife Corridor, and Community Forests, Pemba Island Zanzibar.

Pemba – Habitat and Wildlife

On Pemba, although not part of the proposed scope of work for this contract due to the short period of the contract, by increasing the size of our team while in Pemba (i.e., working with additional Pemba Forest officers) we were able to conduct preliminary habitat and wildlife reconnaissance surveys in the three government protected areas, and in five of the ten forest patches determined to be potentially important for the wildlife of Pemba.

In Ngezi-Vumawimbi a reconnaissance line of 11.75 km was sampled. This line covered 5 habitat types, with the predominant habitat being high forest (7.62 km, 65% of the sample). Signs of only 4 mammalian species were found; with sightings of vervet monkeys evenly distributed across habitat types and signs of Javan civit being very abundant in the *Philippia* habitat (Table 9). Given that Ngezi-Vumawimbi is a protected Nature Reserve, surprisingly few wildlife signs were detected. This is most likely due to the fact that most areas of the forest were flooded and had a thick undergrowth when sampled, making detection of terrestrial signs (such as duiker dung) very difficult or impossible. Indeed most wildlife signs were detected in the more open forest/thicket habitats. In addition, there was heavy rain on the day that Ngezi-Vumawimbi was sampled making detection of arboreal mammals (such as primates) more difficult.

Table 9. Reconnaissance line data from Ngezi-Vumawimbi. Total distance sampled, 11.75 km.

Habitat	Species	Number of signs	Dist sampled per habitat	Index (# sign per km sampled)
Agriculture	vervet	1	0.84	1.19
High forest	blue duiker	6	7.62	0.79
	flying fox	2	7.62	0.26
	Javan civit	1	7.62	0.13
	vervet	7	7.62	0.92
Mixed thicket	blue duiker	1	2.02	0.50
	Javan civit	1	2.02	0.50
	vervet	2	2.02	0.99
<i>Philippia</i>	flying fox	1	1.09	0.92
	Javan civit	2	1.09	1.83
	vervet	1	1.09	0.92
Swamp	-		0.19	

In Ras Kiuyu a reconnaissance line of 4.04 km was sampled. This line covered only 2 habitat types, with high coral rag being the predominant type (77%). The only wildlife sighted were vervet monkeys in the high coral rag (Table 10). The Ras Kiuyu forest is good quality, high coral rag forest with high tree diversity. The low number of wildlife signs detected; was thought to be due not to habitat quality, but rather to the high presence of feral dogs and human activities in this forest.

Table 10. Reconnaissance line data from Ras Kiuyu. Total distance sampled, 4.04 km.

Habitat	Species	Number of signs	Dist sampled per habitat	Index (# sign per km sampled)
High coral rag forest	vervet	3	3.09	0.97
Low coral rag forest	-		0.95	

In Msitu Mkuu a reconnaissance line of 3.13 km was sampled. This line passed through 5 habitat types, with high coral rag and low coral rag being predominant (41% and 24%, respectively). Only 3 mammal species were recorded. Blue duiker indices were extremely high (the highest index of abundance for duikers on Pemba or Unguja); however this result could be due to very small sample size (Table 11).

Table 11. Reconnaissance line data from Msitu Mkuu. Total distance sampled 3.13km.

Habitat	Species	Number of signs	Dist sampled per habitat	Index (# sign per km sampled)
High coral rag forest	blue duiker	23	1.27	18.11
	flying fox	1	1.27	0.79
	vervet	2	1.27	1.57
Low coral rag forest	blue duiker	27	0.81	33.33
Agriculture	-		0.91	
Mangrove	-		0.07	
Mixed Thicket	-		0.07	

The community forests (“High Protection” and “Low Impact Use” zones) and unprotected forest patches on Pemba are quite small and isolated. Like the government protected areas of Ngezi-Vumawimbi and Ras Kiuyu, the five forest patches sampled were also relatively depauperate of wildlife (Table 12).

Matambwe is a large patch managed by the community; the main threat to which is the expansion of clove farms/planting of new clove trees. In this forest, we sampled 5.30 km of reconnaissance line; the line covered 5 habitat types, predominated by mixed thicket (48%) and high forest (22%). We only found signs of 2 mammal species/species groups (civit/unidentified carnivore, vervet) along the reconnaissance line, although this forest is reported to also support Pemba flying foxes (Table 12).

Changaweni is a small community managed forest in which we sampled 1.81 km, 39% of which was high forest. Two mammalian species were identified in Changaweni, Pemba flying fox and vervet monkeys (Table 12).

Mgelema is a community managed woodland area with scattered thicket; it is threatened mainly by agricultural encroachment. In this forest we sampled 1.44 km of reconnaissance line which consisted of 3 habitat types, and was dominated by woodland (72%). Along this line there were signs/sightings of 2 species, vervet monkey and an unidentified carnivore (Table 12).

Kangagani is a low coral rag forest mixed with shrub land and is highly disturbed, and threatened by shifting cultivation and livestock grazing. In this forest, a total of 3.76 km were sampled, covering 4 habitat types, mainly coral thicket – 49%. Only 1 mammalian species was detected along this line, Pemba blue duiker. A concentrated conservation effort will be needed in order to conserve this forest and the Pemba blue duikers which it supports (Table 12).

Gando forest is currently a good forest patch, but it is already a little disturbed and threatened by clearing for the planting of new clove trees. In this forest, we sampled 2.78 km along the reconnaissance line. This line covered 4 habitat types (predominated by mixed thicket, 55%). Although this forest is reported to support Pemba flying foxes, civits, and vervets; only vervets were recorded along this line. Gando forest is connected with Ngezi through a mangrove corridor (Table 12).

Table 12. Reconnaissance line data from Pemba forest patches. Distances sampled: Mtambwe–5.30 km, Changaweni–1.81 km, Mgelema–1.44 km, Kangagani – 3.76 km, Gando – 2.78 km.

Habitat	Species	Number of signs	Dist sampled per habitat	Index (# sign per km sampled)
Mtambwe				
High Forest	carnivore - unidentified	7	1.18	5.91
	Civet	5	1.18	4.22
Mixed	carnivore - unidentified	5	2.56	1.95
Rice farm	Vervet	1	0.57	1.74
Low coral rag	-		0.16	
Clove plantation	-		0.30	
Agriculture	-		0.53	
Changaweni				
High forest	Vervet monkey	1	0.71	1.41
	Pemba Flying Fox	3	0.71	4.23
Mixed thicket	Pemba Flying Fox	2	0.37	5.41
Clove plantation	-		0.67	
Rice farm	-		0.07	
Mgelema				
woodland	Vervet	1	1.04	0.96
	carnivore-unidetified	2	1.04	1.92
Mixed thicket	-		0.31	
Agriculture	-		0.09	
Kangagani				
Coral rag thicket	Pemba blue duiker	2	1.84	1.09
Shrub land	-		0.85	
Agriculture	-		0.86	
Philippia	-		0.22	
Gando				
High forest	vervet	1	0.7	1.43
Mixed thicket	-		1.52	
Rice farm	-		0.48	
Agriculture	-		0.09	

Conclusion and Recommendations

On Unguja the remaining best habitat for Zanzibar’s unique wildlife and those which must be included in the PA network include: Jozani-Chwaka Bay National Park (JCBPN), Kiwengwa Pongwe Forest Reserve (KPFR), Masingini Forest Reserve, the “High Protection” and “Low Impact Use” zones of the community forests surrounding JCBNP (17 Communities) and KPFR (10 communities), and the Proposed Muyuni-Jambiani Forest Reserve . These forests are all still relatively well linked by a series of 5 corridors. These habitat corridors are mainly on community lands, overlap the proposed Muyuni-Jambiani Forest Reserve, and are all actively

used by wildlife. Reconnaissance surveys and camera trapping showed that although the five proposed corridors varied immensely in habitat quality both within and among corridors, the vast majority of the indigenous larger bodied terrestrial and arboreal mammal species recorded for Unguja Island were found to use these corridors (15 of 17 or 88% of the previously recorded indigenous large bodied mammals were found in the corridors, 17 of 23 or 74% if rodents are also included). However, despite the fact that all five corridors are currently functional, we must move swiftly to completely protect them before many of these connections are lost forever due to agriculture expansion and cutting for building poles, firewood and charcoal production.

There is also a potential 6th corridor on Unguja which would be very important to restore. This corridor would connect the forests on the southern tip of Uzi and adjacent Vundwe Island (which together support an important population of Zanzibar red colobus) with Unguja Ukuu and from there to JCBNP. Any current link between the forests of Uzi and Vundwe Islands with Unguja are tenuous at best (via the Pete Inlet/Unguja Ukuu mangroves). The two villages of Uzi Island (Uzi Uzi and Uzi Ngambwa) and the adjacent Unguja Ukuu- Kaepwani on Unguja are currently in the process of developing CoFMAs to help protect their remaining forests. This is a step in the right direction; but will probably not be sufficient. Enrichment planting of both upland and mangrove forests will probably be warranted to restore functional connectivity between Uzi/Vundwe and Unguja.

Thus, if all five corridors can be adequately protected (and the Uzi – JCBNP connection restored) there will only be one small forest of importance to wildlife on Unguja that is isolated from the rest of the PA network, Masingini Forest Reserve. Masingini serves as the main catchment forest for Stone Town, but is also important for wildlife and supports some of Unguja's endangered species such as the Zanzibar red colobus. It is, however, now unfortunately completely isolated from all other wildlife habitat on Unguja; so special care must be given to ensure its survival and that of the wildlife that it supports.

On Pemba, the areas of greatest importance for wildlife and those we recommend be included in the PA network include: the three government PAs of Ngezi-Vumawinbi Nature Reserve, Msitu Mkuu Forest Reserve and Ras Kiuyu Proposed Forest Reserve, and the "High Protection" and "Low Impact Use" zones of the 13 community forests. There are also a number of additional forest patches which need to be further studied to determine their importance to wildlife. These include: Kwa Konondo, Ngulu, Makuwe-gando, Kangagani, and Kideke; and the community managed forest patches of Fundo, Matambwe, Mgelema, and Mbiji/Changaweni. Unlike on Unguja, most of these important areas are spread out across the island and are not well connected; none of the three government PAs are connected to one another by wildlife corridors. There is still a corridor between Ngezi-Vumawimbi Nature Reserve and Gando forest patch but this corridor is mainly via mangrove forest rather than terrestrial forest which will limit the usefulness of the corridor to a select number of species. Additional survey work on Pemba is warranted to determine if there is potential to restore connectivity (via enrichment planting) among any of the government PAs, community managed forests and unmanaged forests.

The establishment of this PA network will represent a major conservation development, and will involve the upgrading of the conservation status and protection of some forest patches, and linking all of these habitats via functional wildlife corridors. Corridors need to incorporate not

only government lands, but also dry forests and mangrove forests managed as community conservation areas, and those which are currently unprotected. Connecting all of the most important forests on Unguja and Pemba via functional corridors will greatly increase their conservation status and the likelihood of long-term survival of these forests and the endemic species which they support. It is expected that once all newly protected forests and corridors are in place, the amount of land under increased protection on Zanzibar will be nearly double, ensuring the conservation of the most important habitats and faunal populations in Zanzibar, as well as the main water catchment forests for Zanzibar's most important agricultural areas.

As the Zanzibar DFNRNR moves forward to establishing this PA network there are a series of issues to keep in mind:

- 1) The current project was undertaken in partnership with government and communities (across whose lands the proposed corridors and Muyuni-Jambiani Forest Reserve are located). By working with these partners at all stages of this project we have been able to build their capacity to survey and monitor wildlife, increase their understanding of the importance of developing a network of multiple protected areas linked by functional corridors, and garner their support for the next step, the development and implementation of the protected areas network. Continuing to develop the PA network by working in partnership with all stakeholders will be key to ensuring its success.
- 2) From this project it is very evident that all of the proposed corridors will completely overlap community lands. Thus, in order for the proposed PA network to succeed it is crucial that communities not only understand but support the development of corridors. Moving forward these relationships will be increasingly important. As new communities develop CoFMAs (Community Forest Management Agreements), care must be exercised to ensure that the community zoning process produces zoning plans which concur with the plans for the PA network. For example, there are three communities whose lands overlap the northern half of the proposed north corridor (JK) and who are currently developing CoFMAs (Marumbi, Jendele, and Umbuji). During the zoning process for the development of these CoFMA, these communities must be encouraged to zone any areas which overlap the proposed corridor as "High Protection" zones. Similarly, it will be important to work with the communities South of JCBNP whose lands overlap the South East and South West Corridors (KJ and MJ), to perhaps rezone their lands so that all proposed corridors are provided a higher level of protection.
- 3) In other community areas, for example at the very northern section of the South West Corridor (MJ) where the corridor is extremely narrow (less than 0.5 km) we will need to explore more intensive management with the communities such as enrichment planting of tree species that provide cover and food for wildlife, but which are ideally also of use to the communities. Other areas where enrichment planting will be necessary to develop functional corridors include the re-establishment of a corridor between Unguja and Uzi Island, and the establishment of any corridors on Pemba. As we move toward implementation of the plan, these types of more management intensive activities will have to be expanded in order to achieve success on the ground.

- 4) It will not be sufficient to solely increase the protection status of the forests/corridors that are proposed as part of the PA network on paper. The PA network plan must then be implemented with complete demarcation of all forests and corridors, sensitization of surrounding communities, and most importantly law enforcement to ensure the protection of the new PA network.

- 5) On the same note, as the community managed forests (especially the “High Protection” and “Low Impact Use” zones) are being found to be extremely important for the conservation of many of Zanzibar species, it is crucial that CoFMAs are not only developed but implemented, the success of implementation audited, and if there are violations (e.g., banned activities are being conducted) fines imposed and corrective measures undertaken. Over the past 7 years WCS has jointly implemented with community VCCs wildlife monitoring projects in 16 community managed forests. Though this process we have witnessed that more often than not, communities do not strictly adhere to their established zoning plans so they are failing to properly implement their CoFMAs; and there are no repercussions for failure. CoFMAs if properly implemented have the potential to greatly advance the conservation of Zanzibar unique flora and fauna, but only if they are properly implemented and there is an audit and penalty system in place to ensure proper implementation/compliance. We recommend a complete audit of the implementation of all CoFMAs on Unguja and Pemba occur in the coming months to dovetail with the process of developing the PA network. This study is needed to determine if CoFMAs once designed are properly implemented, what are the variables that affect relative success or failure of communities to implement their CoFMAs, and where signed CoFMAs are not being properly implemented to correct for their failures.

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