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Survey of Anthropogenic Vegetation Changes on Uzi and Vundwe Islands: A Study on Deforestation and Its Implications for People and Wildlife

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SURVEY OF ANTHROPOGENIC VEGETATION CHANGES ON UZI AND VUNDWE ISLANDS:

A STUDY ON DEFORESTATION AND ITS IMPLICATIONS FOR PEOPLE AND WILDLIFE

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1.0 ABSTRACT

Purpose:

1) To characterize the flora of Vundwe Island and Mchangamle peninsula on Uzi Island to determine the impact and implications of human disturbance.
2) To determine presence/absence of the red colobus and Sykes monkey, Ader's duiker, and suni antelope and blue duiker in Central Uzi and Vundwe as indicators of the impact of human activity on wildlife.
3) To preliminarily gauge the attitudes of the inhabitants of Uzi toward conservation and assess their position as chief stakeholders in tourism development as one approach for sustainable environmental management.

Background. The environmental health of Uzi Island, south of Unguja, Zanzibar, has not been well characterized and its inhabitants do not have the resources for conservation education or community management to prevent deforestation, establish sustainable resource use and preserve unique wildlife. One potential method to improve environmental conservation and economic stability is through culturally sensitive and appropriately scaled ecotourism.

Methods. Vegetation and wildlife surveys were conducted to evaluate the current condition of forests, regeneration in successional habitats, the presence of endemic and endangered wildlife species, and the impact of human activity on the forests of Central Uzi and Vundwe Island. Local attitudes of Uzi villagers towards conservation and tourism were assessed through interviews.

Results. The forest of Central Uzi was found to have been devastated in recent years by fires and conversion of the land to agriculture with 58% of stems cut or burned. Vundwe is exhibiting unsustainable wood cutting and increased human disturbance with a 4% increase in cut stems from four years ago. Similarly, wildlife presence, forest disturbance and human activity appear to be adversely effecting populations of red colobus monkeys, blue duiker, and suni antelope. Interviews of Uzi villagers demonstrated a wide range of attitudes about potential approaches to conservation and the benefit or harm of tourism as a means to support environmental protection and economic stability. A range of attitudes existed about the potential benefit or harm of tourism as one approach to supporting environmental protection and economic stability.

Conclusions. A significant negative impact of human activity on forest preservation was found, as well as potentially diminished populations of colobus monkeys, blue duiker and suni antelope, representative of the unique mammalian fauna of Zanzibar. Although some understanding of the impact of environmental degradation on societal health and economic development was apparent in interviews with villagers, there were mixed attitudes on the positive value of environmental protection and the potential for ecotourism as a method to promote conservation and economic benefit. Ongoing formal assessment of forest and wildlife is recommended, as is forest regeneration (of both mangrove and coral rag), and the establishment of focus groups and environmental education to determine the optimal approaches to environmental and economic sustainability, which are closely intertwined.

2.0 INTRODUCTION

Human activity is putting unsustainable pressure on the world's finite resources, especially in developing countries. Significant environmental degradation, such as deforestation, local climate change, and soil erosion, has been observed in East Africa in recent decades (McClanahan and Young, 1996). Because human history and destructive resource consumption in this region stretches back millennia, it is difficult to differentiate natural vs. anthropogenic effects on ecological variation. Forest loss began over 100,000 years ago with widespread human-ignited fires, and continues to the present day as a result of agriculture and use of forest materials for construction (WWF, 2001). Deforestation is one of the primary threats to biodiversity because entire habitats are destroyed along with the species that depend on them, especially in poorer countries where occupational alternatives and conservation plans are scarce.

Zanzibar is home to a myriad of unique ecosystems including coastal forests, mangrove swamps, intertidal zones, and marine habitats. These areas rich in biodiversity and endemism are becoming increasingly threatened as local human population increases and social and economic pressures on natural resources grow. In the Northern Zanzibar-Inhambane Coastal Forest Mosaic which stretches from Somalia to Tanzania, there are over 4,500 plant species and 1,050 genera represented, 48% of which are trees (WWF, 2001). This high biological diversity calls for significant steps in conservation to match the increasing anthropogenic demands.

Healthy coastal forests are characterized by a mosaic of vegetation structures, species richness, and regeneration potential (McClanahan and Young, 1996). A number of factors compromise forest health, the majority of which are of human origin. As markets expand from artisanal to commercial industries, land is cleared for homes, trees are burned for charcoal production, and timber is removed for domestic purposes, devastating entire forest ecosystems (UNEP, 2001). Conversion of forests into timber plantations, unregulated land ownership, and a paucity of environmental education are also problems that have lasting negative consequences on both human and natural ecology (McClanahan and Young, 1996). Without knowing the composition and extent of disturbance, as well as regenerative capacity, from forest surveys, it is difficult to generate effective, sustainable management plans for coastal forests.

Uzi is a small island off the south end of Unguja Island, Zanzibar. Uzi's shores are sandy and rocky with mangroves in the north, northwest, south, and southwest. The coastal forests of Uzi are highly threatened due to the reliance of the local community on its resources. Almost all the forests of Northern and Central Uzi have been converted into farmland, most of which now lay fallow. Cultivation includes products for domestic consumption and for export to mainland Unguja, including coconuts, papaya, mango, banana, cassava, and yams (pers. obs., 2009).

Land use on Uzi has a complex and layered history. Most land in Central Uzi, the location of current deforestation, is owned by the local municipality. The community is not allowed to clear for cultivation unless given a permit by the government. Fires are not sanctioned (Aliy. per. comm.). When using slash and burn methods, fields are fertile for 3 to 4 years and then they are left to lay fallow. Unused land, or shamba, is then recolonized with pioneer species such as *Trema orientalis*, *Dondonae viscosa*, *Ricinus comunis*, and *Pteridium aquilium*. Optimally efficient land use will require the introduction of more sustainable agriculture such as agroforestry which can incorporate native forest structure into domestic land cultivation.

Conservation efforts on Uzi Island have grown over the last decade. Menai Bay Conservation Area, with headquarters in Stone Town, has a post in the village of Uzi Uzi. Created in 1994, this non-governmental organization is funded by the World Wildlife Fund (WWF) and represents traditional methods of conservation (Mesaki, S, Lecture 10/20/2009). Originally this effort was exemplified by a women's beekeeping cooperative, but now has grown to encompass reforestation programs and monitoring of local fisheries (Nowak, 2007). Fishermen have been resistant to regulations because they claim these restrictions are principally benefiting tourism and not benefiting local communities (Mesaki, S, Lecture 10/20/2009). Unfortunately, due to centralization of the organization in town, few resources reach the post on Uzi and employees feel ill-equipped to enforce conservation initiatives (Hussein, Iss-haka per. comm.).

The Wildlife Conservation Society and the Department of Commercial Crops, Fruits, and Forestry (DCCFF) are currently working with the local community to discuss resource use and management of the southern forests of Uzi and Vundwe Island. Focus groups have shown that villagers understand they will need occupational alternatives and

further education if community-based conservation initiatives are to be implemented. DCCFF is currently awaiting funds from the Wildlife Conservation Society for continued efforts in empowering the people of Uzi to enforce sustainable land use management (Fakih, per. comm. 2009). Sensitivity to traditional lifestyles and cultural norms in the process of engineering socioeconomic improvement and conservation is vital for sustainable protection (White and Edwards, 2000).

Endemic mammals to the Zanzibar archipelago including Uzi and Vundwe Islands include the Red Colobus monkey (*Procolobus kirkii*), Sykes monkeys (*Cercopithecus mitis albogularis*), and the Ader's duiker (*Cephalophus adersi*). Expanding agricultural land and wood cutting practices on Uzi are impinging on the native habitats of these island endemics and threatening their survival. The suni antelope (*Neotragus moshatus moschatus*) and blue duiker (*Cephalophus monticola sundevalli*), found in Uzi and Vundwe's coastal forests, is threatened by hunting and habitat destruction on Uzi, although no formal census has been conducted, and therefore population decline is unknown. The Ader's duiker, endemic to Zanzibar, once populated Uzi but is now suspected to have gone locally extinct.

The red colobus monkey (*Procolobus kirkii*) is sensitive to habitat degradation and vulnerable to hunting, and thus serves as an indicator of a healthy forest ecosystem (Struhsaker, 2005). A population census in 2005 estimated between 1000 and 1800 red colobus inhabit Uzi and Vundwe, the second largest population in Zanzibar (Nowak, 2007). Although the red colobus population of Uzi depends on the local forests for food and shelter, this animal's existence has, historically, been culturally unaccepted (Aylward, 2001). Due to the purported detrimental effects of the red colobus on surrounding agriculture, the local Uzi community has been reported to poison, trap, and beat the monkeys. As the remaining forest continues to be cut and the red colobus are forced out of their natural habitats into human settlement, the relationship between people and red colobus will likely further deteriorate. Monitoring of these primates on Uzi Island is imperative for future conservation and management, as the species is seriously threatened by habitat loss. The Uzi red colobus inhabit a unique mangrove-coral rag matrix habitat which would be attractive to tourists seeking nature-based experiences off the beaten path. Subsequent revenue from such enterprises could finance habitat

protection and motivate community involvement and education in red colobus conservation.

Tourism contributes 35% to Tanzania's GDP and Zanzibar welcomes over a million visitors each year (Makame and Boon, 2008). Tourism could potentially be economically beneficial to Uzi. When managed with cultural sensitivity and community awareness, it can yield positive benefits for the community, but can also have the opposite effect when managed poorly. A positive alternative for the people and environment alike would be local empowerment to make decisions that allow for sustainable eco-tourism and enhanced livelihoods for their community.[1] Currently there is no infrastructure for tourism on Uzi Island and, if implemented, may pose a threat to responsible environmental stewardship. In other locales, there are many examples of large expanses of land being cleared for hotel development and increasing demand on local wood products to serve tourists (McClanahan and Young, 1996). Developers and managers are often unconcerned about long-term sustainability because they are not acquainted with the environmental implications of commercial development in the community (Gössling, 2006). The social costs incurred by tourism can also be degrading. The disturbance of community value systems, communal places, and local occupations have all been problems faced by villages in the past (Makame and Boon, 2008).

Although hotel development has been proposed on Uzi, no action has been taken and the details are not known (Nowak et. al., 2009). Various villagers have proposed small-scale tourism initiatives such as canoeing through the Northern mangroves or cultural village visits (Hussein, per. comm). These plans would employ locals as guides and bring revenue directly to island inhabitants. Tourism on Uzi should only be permitted if it could involve the community, employ proper benefit-sharing mechanisms, educate locals, and avoid deleterious degradation of its coastal forests (Makame and Boon, 2008). The establishment of a conservation area in conjunction with eco-tourism would raise environmental awareness and pave the road for eco-conscious tourism.

Conservation efforts are generated and facilitated by constructive ecological research. Biodiversity encompasses genetic, species, and ecosystem variation, and must

[1] While nature-based tourism is tourism with the purpose of viewing or enjoying nature, eco-tourism entails eco-friendly behavior (Naidoo and Adamowicz, 2005). Eco-tourism is also characterized as including cultural respect, community involvement, and local education.

be assessed to determine ecosystem health. Biodiversity in Zanzibar is at risk from habitat loss, fragmentation, over-exploitation, and introduction of non-native species (Howell, K.M, Lecture 10/26/2009). Vegetation and wildlife surveys are pertinent for understanding localized ecosystem function and biological productivity as well as providing opportunities for education (White and Edwards, 2000). Flora analysis can reveal basic characteristics of a natural habitat and its biotic distinctions. These data can then be used to craft strategies for sustainable use of forest resources.

Until recently, the Western coast of Uzi, including Mchangamle peninsula, was heavily forested. These forests extended through the mangroves of Northern Uzi to Jozani Forest National Park, forming a complete corridor of intact habitat that native fauna were able to navigate. This study will determine whether this corridor is still unbroken as well as the suitability of the southern forests on Mchangamle peninsula as a persistent sanctuary for endemics on Uzi Island. Without this habitat, ecosystem health will suffer and the welfare of the people of Uzi will be compromised. Conservation can accompany economic and social development, but not without coordination and care taken to anticipate negative repercussions of any intervention program. Carefully managed coastal ecosystems can lead to a reduction in poverty and an improved standard of living without negatively impacting cultural tradition (Tobey and Torell, 2006).

A vegetation and wildlife survey of Mchangamle and Vundwe will provide valuable information about the current status of these forests as well as directions for future research. This study will identify dominant species, prevalence of wildlife, site diversity, degree of human disturbance, and local perspectives on conservation and tourism. Data from vegetation and wildlife surveys will be compared to that of previous research conducted earlier in this decade (Nowak, 2003-2005). This study will document the level of disturbance at these sites and the extent of deforestation since 2005 in order to help guide conservation plans and actions in the future.

3.0 STUDY SITE

The Zanzibar archipelago is located 40 kilometers off the coast of mainland Tanzania. Unguja, the largest island of the archipelago, lies at 39º East and 6º South of the equator (Kombo, 2004). Natural vegetation consists of coral rag forests and mangrove swamps which border the island's coast (see Appendix 1.1).

Zanzibar has a tropical climate with temperatures ranging from 24 to 28 degrees Celsius. The two rainy seasons consist of the northeast monsoon and the southeast monsoon. The short rains, known as "vuli", bring an average rainfall of 400-500mm between the months of October and December. The heavy rains, known as "masika", bring an average rainfall of 1000mm between the months of April and May. This study was conducted during the northeast monsoon, or short rains, in November.

Uzi and Vundwe Islands lie within Menai Bay, approximately 25 kilometers from Stone Town (Nowak et. al, 2009)(see Appendix 1.2). The fourth largest island in the Zanzibar archipelago, Uzi is approximately 15km^2 (Nowak, 2007). Jozani Forest National Park is north of Uzi across Uzi Bay. Data from Nowak's thesis work showed Uzi and Vundwe as having a higher density and diversity of trees than Jozani National Park. Uzi Island is connected to mainland Unguja by a small isthmus of mangrove forest during low tide. The coral rag road was built in the 1950's by the people of Uzi, along with a water pipe that carries fresh water to the island from the town of Unguja Ukuu most days of the week. Because the people of Uzi have limited access to mainland resources, their community remains relatively isolated. Tourism and commercial development have thus far not been extended to Uzi although there have been proposals.

Uzi Island is home to the villages of Uzi Uzi, population 2,030 with 422 households, and Uzi Ng'ambwa, population 754 with 153 households (SONARECOD, 2008). The two villages share a common secondary school that services 890 students (Mwalimu Hamadi, per. comm.). Principal occupations include seaweed farming, fishing, and traditional agriculture. An estimated 60% of the land has been converted to agriculture or human settlement (Nowak et. al., 2009). No primary forest remains on the island although an estimated 5% of the island is still medium-height coral rag forest (Aliy, per. comm.). Forest products are used for charcoal making, lime production, and

firewood. All three study locations show signs of human disturbance and contain a number of *mizimu*, or sacred sites, that bring visitors seeking spiritual enrichment.

Mchangamle peninsula had remaining patches of high coral rag forest up until 2005 (Nowak, 2007). Approximately 2.5km^2, the peninsula is heavily utilized by the villages which lie 3.5 km to the North (Aylward). As of 2005, it harbored a diverse ecosystem with unique fauna, including the bush pig (*Potamochoerus larvatus*), red colobus monkey (*Procolobus kirkii*), and rare plant species such as the vanilla orchid (*Vanilla roscheri*) (Nowak, 2007).

Pengeleni is the southern peninsula of Uzi that reaches out to Vundwe Island. Because of its relative isolation from human settlement to the North, Pengeleni is less disturbed than Mchangamle. Though the southern end of the Pengeleni transect is still medium coral rag forest, the northern end has been heavily logged and burned with some area already converted into shamba. Villagers have spoken of a community conservation group that is helping implement a community management plan for Pengeleni but others have denied the existence of this group.

Vundwe lies 300 meters off the southern tip of Uzi Island, connected by intertidal land at low tide. It is 1.4km^2 and is uninhabited six months of the year. During the fishing season of December to February and June to August, a small fishing village is open on the northern tip of the island for fishermen with permits to camp. Permits are obtained from the local government of Uzi and an enforcer checks valid permits in the fishing village periodically (Aliy. per. comm). These fishermen come from Unguja, arriving from Kizimkazi directly to the East or from as far north as Nungwi, and come to utilize this island's marine and terrestrial resources. The people of Uzi also visit the island and its surrounding waters daily to extract resources from the intertidal zone. Women and men fish in Vundwe's shallow waters, maintain seaweed farms, and collect crustaceans and mollusks. Conservation of Vundwe has been proposed by a number of non-governmental organizations but so far little action has been taken to ensure sustainable use practices.

4.0 METHODOLOGY

All fieldwork was carried out from November 5 to November 22, 2009. Vegetation surveys were conducted on Mchangamle peninsula and Vundwe Island. Wildlife surveys were conducted on Mchangamle, Vundwe, and Pengeleni. Interviews were conducted in both Uzi Uzi and Uzi Ng'ambwa.

4.1 Vegetation Surveys

Vegetation plots were surveyed along previously existing transects on Mchangamle peninsula and Vundwe Island. These transects were originally established by Katarzyna Nowak during her PhD thesis work during 2003 to 2005 and are now maintained by the WCS-Zanzibar Program and the Department of Commercial Crops, Fruits, and Forestry (DCCFF). The Mchangamle transect follows a bearing of 8º magnetic North and the Vundwe transect follows a bearing of 355º magnetic North. Plots were established every 200 meters along the 1850 meter transects. Plots on Mchangamle were designated using a handheld Global Positioning System (GPS), matching coordinates to plot coordinates from Nowak's thesis work. The level of human disturbance made identification of this transect difficult without the aid of a GPS. A GPS was not used on Vundwe because the transect was well marked and maintained.

Vegetation plots were surveyed in accordance with Nowak's methodology used in 2005. Vegetation plots were 5m x 50m, surveying 2.5m on either side of the transect. A graduated wooden pole was used to demarcate the edges of the plot along the transect. The transect itself was not included in the vegetation plot. Each tree, liana, and shrub over 1.5m was identified. The same graduated wooden pole, marked at 1.5m and 2.5m was used to separate the trees into two height classes and estimate tree height. Seedlings and saplings, height class 1, were defined as trees between 1.5m and 2.5m in height. Mature trees, height class 2, were defined as trees with a height greater than 2.5m. After identification, the circumference at breast height (CBH, 1.3m) was measured and later converted into diameter at breast height (DBH) using Microsoft Excel. When the tree had more than one stem, the number of live, cut, or dead stems was recorded as well as the CBH of the five largest stems of each type.

Canopy cover, primary disturbance types, and vegetation structure were also recorded for each plot. Plots were then separated into strata to reflect their vegetation composition. Strata included Shamba, Actively Disturbed, Scrub, Low Coral Rag, and Medium Coral Rag, descriptions can be found in Appendix 6.1. These strata were then compared to Nowak's strata in 2005 and evaluated by level of human disturbance.

Regeneration subplots were established every 10 meters within the vegetation plots. The subplots were 1 square meter parallel to the transect and on the western side. Six subplots were surveyed in each vegetation plot, with a total of 60 subplots for each transect. All species with a height less than 1.5 meters and more than 5 centimeters were enumerated. These subplots were used to determine principal species in ground cover not included in the tree surveys.

A local field assistant, Iss-haka Hussein Abdulla, was employed for all data collection. All trees, shrubs, and climbers were identified by common Swahili names. When a plant was not known a sample of the leaves and bark were taken along with digital pictures. Useful notes such as size of tree, color, formation, and other distinctive characteristics were recorded. A number was assigned to each unknown plant and written on the datasheet and the specimen. Leaf samples were later pressed and dried. Unknown samples were then showed to local botanist Halil Mohammed Ali, Aliy Abdurahim Aliy, and finally to Said A. Fakih and Tahir Abbas Haji at the DCCFF. 63% of trees sampled were identified to the species, 16% to the genus, 1% to the family, 8% to the Swahili name, and 11% remain unknown.

Vegetation was quantified by number of species in each plot, total number of each species, species densities and relative densities, species frequency, species dominance, sum basal area by species, diversity in each transect, regeneration in each plot and subplot, and level of human disturbance. To evaluate biodiversity, the Shannon-Wiener Diversity Index was used. The Shannon-Wiener Index assumes sample randomness, an infinitely large population, and that all species are represented. A biotic community can be characterized by an Index from 0 to 4.5. Species richness was assessed for the two transects separately.

To calculate sum basal areas of live and cut stems, the basal area of each stem was enumerated and then all basal areas were summed. These figures were used to

graph overall disturbance density and calculate species dominance. An Index of disturbance was also created for all plots. The index calculated number of cut or burned stems over total number of stems. Total stems included both live stems and snags (standing dead trees). Number of cut stems for each transect and number of cut stems per ha were also calculated for each transect.

The following calculations were made to analyze data:

1. Species Area Curves – All trees

   Number of species by cumulative area sampled.

2. Sum Basal Areas of live and cut stems in each plot (mature trees only)

   Basal Area = $2\pi R$

   Sum Basal Area = Σ (b.a. for all species)

3. Average Basal Area for each species
4. Number of individuals of each species by plot – All trees
5. Densities and relative densities of each species in each transect –All trees

   $$\text{Relative Density} = \frac{\text{\# of individuals of a species}}{\text{Total \# of all individuals of all species}}$$

6. Frequency and relative frequencies of each species in each transect

   $$\text{Relative Frequency} = \frac{\text{Frequency of a species}}{\text{Total frequencies of all species}}$$

7. Relative dominance of each species in each transect

   $$\text{Relative Dominance} = \frac{\text{Combined b.a. of a species}}{\text{Total b.a. of all species}}$$

8. Importance Value Index

   IVI = (Relative density + Relative dominance + Relative frequency) x 100

9. Human disturbance – Matures trees only

   $$\text{Index of Disturbance} = \frac{\text{\# of cut or burned stems}}{\text{Total stems}}$$

   $$\text{Cut or burned stems per ha} = \frac{\text{\# of cut or burned stems}}{\text{Hectares sampled}}$$

10. Regeneration

a. Number of cut stumps coppicing for each species
b. Relative dominance of species in height class 1
c. Relative dominance of species in subplots (ground cover regeneration)

11. Shannon Diversity Index – mature trees only

$H^1 = -\Sigma\, p_i \ln p_i$

Where P_i = abundance of i^{th} species as proportion of total cover (relative density), S = number of species in the community

12. Simpson's Index of Diversity

$D = 1 - \Sigma\, (p_i^2)$

Where P_i = abundance of i^{th} species as proportion of total cover (relative density), Σ = all of species in the community

13. Sorensen's Index

$$QS = \frac{2C}{A + B}$$

Where A, B = the number of species at each site respectively, C = the number of species the two sites share

To see further descriptions of these equations, see Appendix 2.0.

4.2 Wildlife

Both the Mchangamle and Vundwe transects were walked twice for evidence of wildlife at a speed of approximately 1km/hr. The transect on Pengeleni, which runs along the peninsula between Vundwe and Mchangamle on a bearing of 335º magnetic North, was also surveyed for wildlife. Each transect was surveyed with a transect width of 2 meters, one meter on either side of the transect. All dung encountered was recorded along with its location along the transect and whether it was fresh or old. Fresh dung is often categorized as up to one day old. Old dung is categorized, given local climate and vegetation type, as up to one month old (Aliy, Per. Comm.). If wildlife was either seen or heard the species was recorded along with distance from transect and bearing from observer's location on the transect.

4.3 Interviews

Semi-structured interviews were conducted with villagers from both Uzi Uzi and Uzi Ng'ambwa. A total of 23 people were interviewed, 12 from Ng'ambwa and 11 from Uzi Uzi. A list of interviewees' names, ages, and occupations can be found in Appendix 3.1. All interviews were conducted in Swahili and recorded using a handheld digital tape recorder. Translations to English were later completed with the help of Iss-haka Hussein Abdulla. A sample questionnaire can be found in Appendix 3.2. 87% of the individuals were chosen at random while talking through the villages. The doctor, teacher, and Sheha were contacted personally. The average age of those interviewed is 32.2 years old. Data from interviews were both qualitatively and quantitatively analyzed.

5.0 RESULTS

A total of 32 families and 83 species were found within the 20 plots. The most represented family was Sapindaceae. A total of 5000m^2 were sampled for vegetation and 11,500m^2 were sampled for wildlife.

5.1 Vegetation Survey

The total number of species was plotted against cumulative area sampled to assess whether or not the sample size was large enough (see figure 1). When the species area curve reaches plateau, it is assumed enough area was sampled to adequately represent the vegetation in the region. The Vundwe transect species curve does not level out, suggesting that the data did not sufficiently capture the species diversity of the area sampled. The Mchangamle transect species curve begins to stabilize with only three additional new species found in the last three plots respectively.

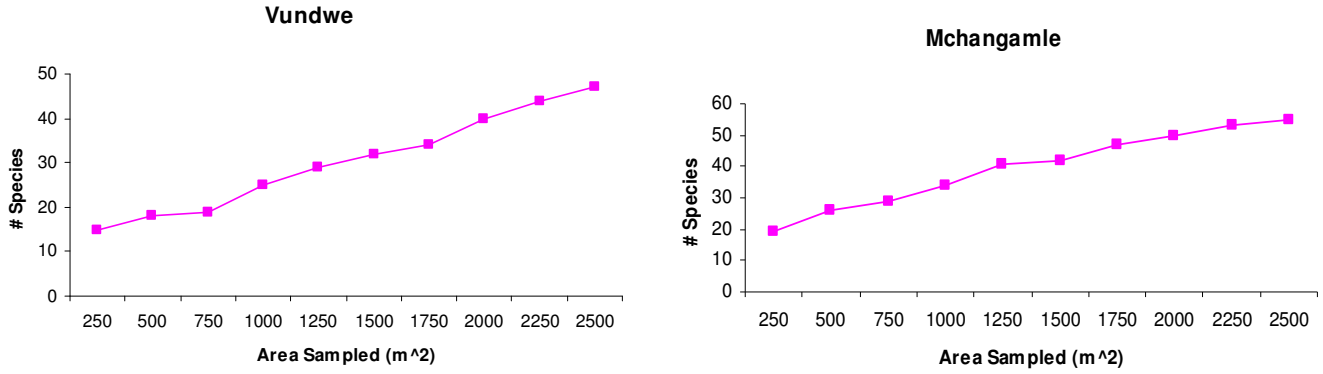


Figure 1: Species area curve for the Vundwe and Mchangamle transects. Number of species over cumulative area sampled.

There were 52 species found within the study plots on Mchangamle peninsula and 50 species found within the study plots on Vundwe Island, with 19 species in common. The Shannon-Wiener Diversity Index for all live individuals was 3.13 for Mchangamle and 2.66 for Vundwe (see table 1). Transect diversity was also evaluated using Simpson's Index of Diversity. The Simpson's Index for Mchangamle is 0.91. The Simpson's Index for Vundwe is 0.90, meaning there is a 90% likelihood that two individuals chosen at random will not be the same. To compare diversity between

transects, beta diversity values were calculated. The Sorensen Index was used to compare the number of taxon unique to each ecosystem. The value for Mchangamle and Vundwe was 0.37.

	Mchangamle	**Vundwe**
Shannon-Wiener	3.13	2.66
Simpson's Index	0.91	0.90
Sorensen's	0.37	

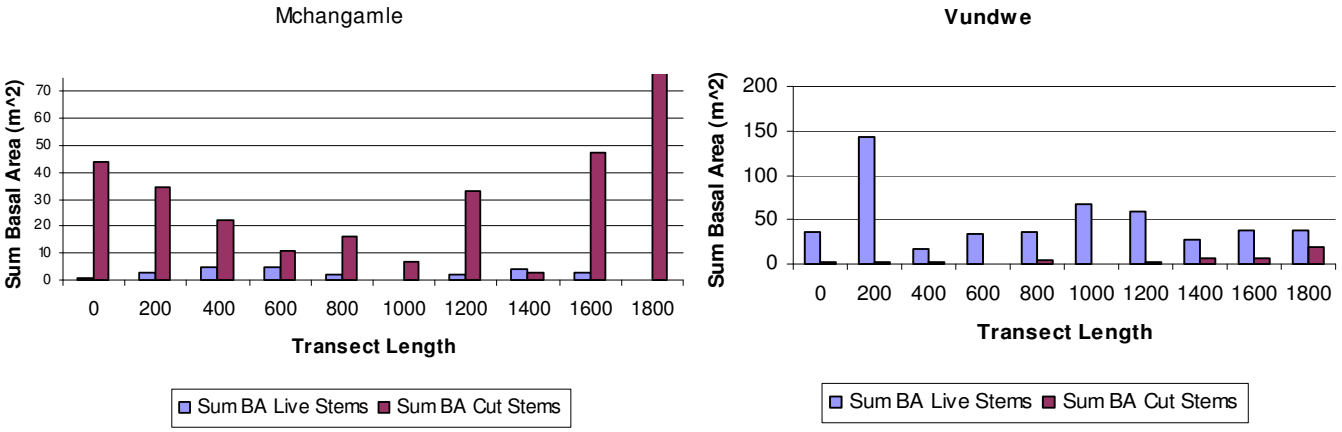
Table 1: Shannon-Wiener Diversity Index, Simpson's Index, and Sorensen's Index for each transect.

Densities, relative densities, mean DBH, frequency, relative frequency, and relative dominance was calculated for each species in each transect. A table of these figures can be found in Appendix 5.3 and 5.4. Index of Importance was determined by summing relative density, relative frequency, and relative dominance. Species with the highest Index of Importance on Mchangamle are *Eugenia* spp., *Diospyros consolatae*, *Tricalysia microphylla*, *Monothotaxis* spp., *Polysphaeria* spp., *Clausena anisata*, and *Grewia bicolor* in that order. Species with the highest Index of Importance on Vundwe are *Lanea bicolor*, *Polysphaeria parvifolia*, *Monothotaxis* spp., *Eugenia* spp., *Diospyros consolatae*, *Mallotus opposifolius*, *Monothotaxis* spp., *Macphersonia gracilis*, and *Carpiodictera Africana*, in that order. A figure of the species with the highest IVI can be found in Appendix 5.5.

Each plot was placed into its appropriate stratum. In 2005, 40% of the plots on Mchangamle were high coral rag, 30% medium coral rag, and 30% low coral rag. In 2009, 10% of the plots were low coral rag, 30% shamba, 10% scrub, and 50% Actively Disturbed. For Vundwe, 25% were high coral rag, 40% were medium coral rag, 25% were low coral rag and 10% were mangrove. In 2009, 10% were medium coral rag and 90% were low coral rag. Comparisons show increases in strata with lower vegetation and more human disturbance in 2009 (see Appendix 6.3).

For disturbance, the sum basal area of all live stems was compared to the sum basal area of all cut stems. The sum basal area of all stems dead due to burning was also included in comparisons as human activity directly caused these mortalities. No dead trees attributable to human caused fires were found on Vundwe. Figures 2 and 3 compare

sum basal areas for live and cut stems between plots in both transects. The Mchangamle transect shows higher levels of disturbance in plots closer to human settlement in the north. The plot at 1800 meters, plot 10, exhibited 100% human disturbance. Sum basal areas for each plot on Mchangamle were compared to sum basal areas in 2005, graphs can be found in Appendix 7.3. On Vundwe Island, plots closer to the fishing village had higher numbers of cut stems. The sum basal area for live stems in plot 9 at 1600 meters, categorized as Medium Coral Rag, is higher than the other plots, categorized as Low Coral Rag.



Figures 2 and 3: Sum basal areas for live and cut stems between plots for Mchangamle and Vundwe transects.

An Index of Disturbance was also calculated using both height classes. Figure 4 shows the index of disturbance values for Mchangamle and Vundwe transects. Values close to one, represented by plots 1, 6, and 10, have almost complete disturbance with few live stems. Mchangamle has alternating rates of total disturbance along the transect. Vundwe has higher rates of human disturbance closer to the fishing village (plot 10). See Appendix 7.6 and 7.7 for graphs.

The Index of Disturbance was also enumerated for strata across both transects using trees in both height classes. A graph representing this stratification can be found in Appendix 6.4. The highest disturbance was found in Shamba, followed by Actively Disturbed, Scrub, Low Coral Rag, and Medium Coral Rag.

Number of cut stems for each species in each transect was summed. Species with the greatest percentage of total stems cut and highest relative densities on Mchangamle were *Carpiodictera africana*, *Clausena anisata*, *Ficus* spp., *Tricalysia microphylla*, and *Diospyros consolatae*, in that order. Species with the greatest percentage of total stems cut and highest relative densities on Vundwe were *Sorindeia madagascarensis*, *Polysphaeria* spp., *Aprodytes dimediata*, and *Diospyros consolatae*. Graphs and tables of these figures can be found in Appendix 7.0.

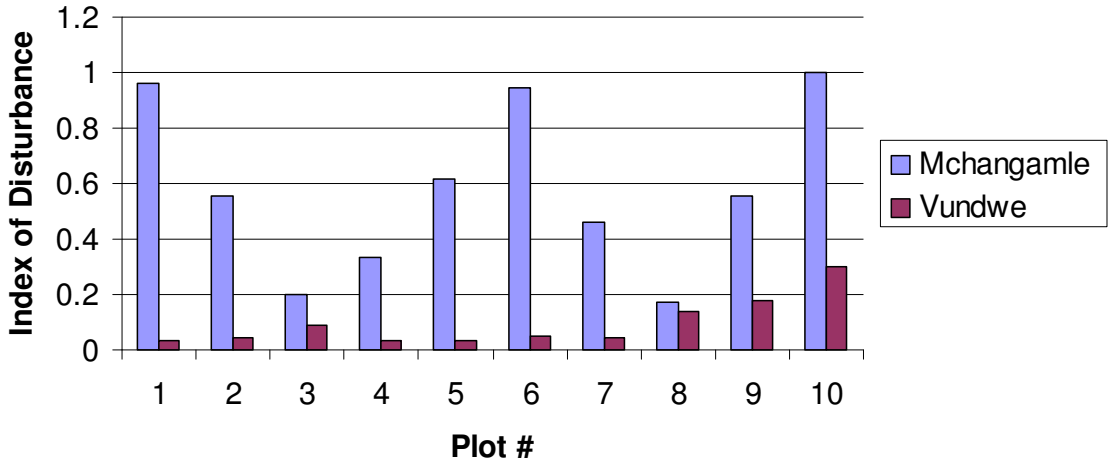


Figure 4: Index of Disturbance, the number of cut or burned stems over total number of stems, for Mchangamle and Vundwe.

A table of the Shannon-Wiener Index, total number of species, total number of individuals, and percentage of total stems cut, in comparison with Nowak's figures from 2005 can be found in Appendix 8.1. There were fewer individuals found on Mchangamle in 2009 (N = 955) than in 2005 (N = 2317) and on Vundwe in 2009 (N = 1566) than in 2005 (N = 2067). There were also fewer species found on Mchangamle in 2009 (N = 53) than in 2005 (N = 88) and on Vundwe in 2009 (N = 50) than in 2005 (N = 52).

The percentage of stems cut on Mchangamle in 2005 (12.13%) is less than 2009 (39.4%). When burned stems are included in this figure the percentage in 2009 increases to 58.3% for Mchangamle. Vundwe also shows an increase in the percentage of cut stems, which was lower in 2005 (5.56%) than in 2009 (9.7%). Number of cut stems per hectare has also increased significantly on Mchangamle from 2005 (N = 1992) to 2009 (N = 3116) and on Vundwe from 2005 (N = 928.9) to 2009 (N = 1532).

Regeneration was first assessed by summing the number of species in height class 1 (1.5-2.5 meters in height) in each plot of each transect. The species most commonly found in height class 1 on Mchangamle were *Ficus* spp., *Ozoroa obovata*, *Macphersonia gracilis*, and *Eugenia* spp. in that order. The species most commonly found in height class 1 on Vundwe were *Polysphaeria parvifolia*, *Macphersonia gracilis*, *Monothotaxis* spp., *Eugenia* spp., *Carpiodictera Africana*, *Sorindeia madagascarensis*, and *Aprodytes dimediata* in that order. These figures can be found in Appendix 9.0. Individuals in height class 1 were also totaled for each stratum (Appendix 9.3). The stratum with the most individuals was Low Coral Rag.

There were 60 regeneration and ground cover subplots in each transect. Totals for each subplot, for each vegetation plot, and for each species were enumerated. A table of these figures can be found in Appendix 10.1. The Mchangamle transect exhibits the highest level of regeneration shorter than 1.5 meters in plot 3, the only Low Coral Rag stratum on the transect. The Vundwe transects shows less regeneration towards the beginning of the transect, where vegetation is less disturbed. More individuals in regeneration subplots were found in plots with higher levels of human disturbance. The species most represented on Mchangamle were *Polysphaeria parvifolia*, *Macphersonia gracilis*, *Synaptolepsis kirkii*, *Monothotaxis* spp., and *Eugenia* spp. Sharing five of six main species in common, Vundwe also had high numbers of *Carpiodictera Africana* in subplots (Appendix 10.2).

5.2 Wildlife

Although formal population censuses of red colobus monkeys, blue duiker, and suni antelope were not conducted, species presence or absence was determined and dung encounters were quantified. A significant difference in dung encounter rates between Mchangamle and Vundwe ($p=0.01$) was found. Although weakly correlated, there was an inverse relationship between suni and blue duiker dung encounter rates and disturbance ($R^2 = 0.2$, $p=0.049$) but red colobus dung encounter rates and disturbance were not ($p=0.004$).

There were no encounters with red colobus monkeys, whether by sight, sound, or dung, on Mchangamle. Sykes monkeys were heard twice along the transect, on two

different days, at a distance of 80 to 100 meters West of the transect. Suni dung, categorized as old, was encountered five times along the transect. A table of wildlife encounters for Mchangamle can be found in Appendix 11.1.

On Vundwe Island red colobus monkeys were seen five times while on the transect and often observed when walking to the transect near the fishing village. Sykes were not seen on Vundwe. Both old and fresh dung from red colobus and duiker were found along the entire transect. Suni dung encounters were highest at the beginning of the transect, furthest away from the fishing village. Conversely, red colobus dung encounters were highest near the fishing village. A figure of dung encounters on Vundwe can be found in Appendix 11.2. A dema trap, a traditional method of fishing, was found near the fishing village adapted to catch monkeys.

Pengeleni was walked once to survey wildlife. The transect had three sections of distinctive vegetation structures and levels of disturbance. The first section, starting near Mchangamle peninsula and moving southward, was completely deforested with active fires burning through both shamba and forest. Heavy logging follows in the second section of the transect. The third section of the transect is still intact Low Coral Rag forest with relatively fewer incidences of human disturbance. Dung encounters were most frequent in the third section. A figure of dung encounters can be found in Appendix 11.3.

5.3 Interviews

All of those interviewed had lived on Uzi for their entire lives. Of the 23 interviewees, two individuals (8.7% of those surveyed) were not familiar with Mchangamle peninsula or Vundwe Island. When asked about conservation of the forest, 100% of those questioned believed that conservation was important. Women were verbally withdrawn during the interviews and offered fewer responses. Of the nine women interviewed, four (44% of women) did not know how to conserve the forests or how tourism would affect the community. Several individuals questioned had a comprehensive understanding of the impact that deforestation would have on the local community.

When asked how the Uzi community can protect and conserve the forest, villagers had varying responses. Four individuals (17%) did not know how Uzi could conserve the forests. Six individuals (26%) believed conservation was important but that the community should have unrestricted use of the forest. One man asserted that Uzi would go hungry if the forest was protected with a no-take policy. Four individuals (17%) thought that it would be a benefit to the environment and to the community if people were not permitted to harvest wood products from the study sites. One individual wanted complete forest protection in order to "save the monkeys and other animals". Another man interviewed believed there were alternatives to forest clearing and cutting such as installing electricity on Uzi for domestic use. Two of those questioned (9%) believed the forest could be managed and used sustainably by cutting areas of the forest and then planting tree species again.

Questions regarding tourism were met with mixed responses. The Sheha, or the Zanzibari equivalent of a mayor, of Uzi Uzi stated that most residents over 40 years old do not support tourism while those under 40 believe in its advantages. Thirteen villagers (57%) had never been exposed to tourism or its impacts and therefore could not comment on the potential effects it could have. The other ten interviewees (43%) had varying opinions of tourism with 40% believing tourism would be good for the Uzi community. Three of these supporters could not say how tourism would be beneficial and advantageous to the villages while one believed it would help education.

One male described how tourism would improve roads, bring in money to the local economy, provide a larger market for local products, and expand education. The same person also cited reasons why tourism would be detrimental to Uzi. Hotels block locals from using the sea, further degrade the environment, and do not uphold sustainable environmental practices. If tourism was to come to Uzi, he believed that private businesses along with their tourists should be completely separated from the people of Uzi. "Only if the two do not interact will they both win". A limited interface between parties would be the only way to ensure peace and mutual profit. Of the 60% that did not support tourism, 20% believed the primary negative impact would be on the poor. "Only the rich people benefit from tourism, the poor people lose." Others claimed it would lead

to further environmental degradation, threaten traditional habits, and bring investors that would hurt local culture.

6.0 DISCUSSION

Vegetation and wildlife on Mchangamle peninsula have been significantly disturbed by human activity in recent years. The fragmentation of Uzi's forests is devastating for both native wildlife and the ecosystem services they provide. Although Vundwe exhibits fewer incidences of total disturbance, its ecological resources are beginning to be exploited at higher rates in areas nearest to human settlement. Red colobus were not seen or heard on Mchangamle peninsula, suggesting a significant population decline since 2005. Dung encounter rates for suni were highest furthest from the Vundwe fishing camp indicating sensitivity to human activity. Discussions with local community members revealed limited understanding of conservation methods and potential social conflict with tourist development. The study has found extensive human disturbance in the remaining forests of Uzi and Vundwe Islands which is impacting local wildlife populations and ecology, but inadequate community motivation to initiate change. A conservation plan needs to be created to protect these forests while maximizing community education and benefits.

6.1 Vegetation

The high level of human disturbance in these plots introduces a number of factors that affect species richness and health. As habitats are fragmented, edge effects including unstable microclimates, species isolation, and altered organism composition extend inwards, harming the forest ecosystem (McClanahan and Young, 1996). Pioneer species, such as *Trema orientalis*, were found in four plots on Mchangamle, indicating high levels of disturbance.

The Shannon-Wiener diversity index was higher on Mchangamle for live stems in comparison to 2005 and lower for Vundwe. This could reflect greater species evenness among the live stems on Mchangamle. Persistent species evenness and genetic diversity in this ecosystem demonstrate the potential for healthy forest recovery if aided. A Sorensen's Index of 0.37 shows a similarity of 37% between the two sites. Mchangamle

and Vundwe are localized habitats, with enough variation to merit separate management plans. Distinguished species richness emphasizes the need to conserve both sites as unique habitats that support distinct resources and offer specialized ecosystem services.

Stratification of the plots showed Low Coral Rag to be the most common vegetation type. There were fewer Medium Coral Rag plots found on Vundwe and Mchangamle than in 2005. Shamba exhibited the highest Index of Disturbance, representing 30% of the plots on Mchangamle. The extent of negative human impact demonstrated by increased percentages of disturbed strata emphasizes the rapid degradation in these habitats.

Relative densities, relative frequencies, and relative dominance of each species showed *Eugenia* spp. and *Lanea bicolor* to be the principal species on Mchangamle and Vundwe respectively. Species most represented in regeneration subplots and in height class 1 of the vegetation plots were *Monothotaxis* spp., *Eugenia* spp., and *Macphersonia gracilis*. These species, as productive re-colonizers of disturbed and relatively undisturbed areas, could serve as useful successional species in reforestation projects. Although growth rate and nutrient needs of these species are unknown, planting programs run by NGOs such as Menai Bay Conservation should consider these species when implementing restoration initiatives.

An understanding of vulnerable and threatened species is essential for effective conservation plans. Species that were found to have a high percentage of cut stems but less regeneration included *Clausena anisata* and *Diospyros consolatae*. Such species should be targeted as trees of concern and incorporated into restoration strategies to ensure survival of these species and overall forest biological diversity.

Regeneration characterized by number of trees in height class 1 was highest in Low Coral Rag plots. The number of individuals in regeneration subplots was also highest in Low Coral Rag plots. High levels of regeneration in the stratum with a high level of human disturbance show the natural ability of these coastal forests to recover after widespread deforestation. Adaptations of native species to successive disasters are altering forest dynamics but increasing genetic resilience and resistance to negative anthropogenic impacts.

Wood cutting and charcoal making, both of which were witnessed during this study, are employed by fishermen for personal consumption on the island. Exportation of wood products from Vundwe Island for external market was also observed. The unsustainable exploitation of forest resources for commercial use stresses the need for immediate action. Vundwe cannot sustain commercial logging much longer before it is reduced to low forest only exploitable for domestic pole cutting. Without these forest resources or occupational alternatives, the people of Uzi will face great economic and social difficulties. Inhabitants rely almost entirely on the land and its associated habitats, thus the community must facilitate environmental conservation in order to ensure collective wellbeing and stability in the future.

There were a number of confounding variables that emerged during the vegetation surveys. The species list compiled is not representative of all the species at the study sites (Appendix 4.1 and 4.2). The species area curves showed that, if the area sampled had been expanded, additional species would likely have been encountered. Species identification was variable due to conflicting references, inconsistent local names, dioceous plants (differentiated male and female plants), and lack of high quality samples. Variability between localities, soil types, and microhabitats also made identification difficult. Local farmers would often use different names for the same species or use the same name for multiple species. Several species were unrecorded due to high undocumented, local endemism and these trees remain unidentified.

6.2 Wildlife

Quantitative assessment of the presence or absence of red colobus, blue duiker, and suni antelope indicated a decline in the number and range of these animals, potentially due to human activity and increasingly restricted habitat due to deforestation. Vundwe had higher red colobus dung encounter rates nearer to the fishing village. Conversely, duiker dung encounter rates were higher at the beginning of the transect. This discrepancy could indicate differences in forest type or behavioral variation. The inverse correlation between duiker and antelope dung encounter rates and forest disturbance indicates behavioral sensitivity to human presence. Additional human encroachment on Vundwe will constrict the ungulates' territories further and threaten

their survival. The absence of Ader's duiker from study results suggests that this endemic species has been overhunted or can no longer be sustained by the deteriorating forest.

The complete absence of red colobus from Mchangamle during days in the field is a concerning finding. A habitat that harbored a number of red colobus troops in 2005 (N = 66) is now completely degraded (Nowak, 2007). Watering containers for red colobus monkeys in the mangroves adjacent to Pengeleni that were the source of the poisoning of over a hundred monkeys in Kichanga Dowe mangroves still persist. The removal of these containers is pertinent for the future safety of the red colobus. In addition, the presence of the red colobus dema trap on Vundwe confirms the continued human hostility towards monkeys in the Uzi community. Ingrained antipathy toward these primates is a custom that can be addressed through education and the creation of a protected area on Vundwe (Struhsaker, 2004).

Wildlife surveys were not conducted at consistent times of day, presenting an uncontrolled variable that could affect rate of wildlife encounters. The second survey of Vundwe was paused for 20 minutes during a short rain, also potentially skewing results for wildlife sightings. Surveys were only conducted in the season of short rains, dung encounter rates could change considerably during the long rains or dry season due to changes in rate of dung decay. Blue duiker and suni antelope dung were not distinguished in this study owing to lack of trained observers. Furthermore, although all surveys were completed with a local guide who has had training in these fields, sampling could be biased initially as a result of poorly conditioned observation skills.

6.3 Interviews

Some Uzi inhabitants have a strong grasp on the complexities, barriers, and potentials of conservation on Uzi. Electricity as an alternative to firewood and charcoal use is more economically efficient and would reduce dependence on the forest. Reducing the local community's dependence on its coastal forests is the first step towards sustainable solutions to deforestation. Providing timber alternatives such as *Cassuarina* plantations is not optimal because it excludes native species and creates monocultures unwelcoming to some native fauna. Nevertheless, *Cassuarina* is a fast growing tree

species that can reduce pressure on native forests for fuelwood. Subsequently, providing occupational alternatives is vital for farmers and charcoal and lime producers. Financial aid would need to come from the government or non-governmental organizations to create livelihoods that do not deplete forest resources. Alternatives include employing rangers for protected areas, compensating locals for conserving ecosystem services such as forest patches for carbon sequestration, and educating farmers about sustainable marine employment. Eco-tourism could create employment opportunities and provide land use compensation but would need to be implemented cautiously.

Regions of Zanzibar have suffered due to tourism disrupting local culture and economy, and these mistakes could be avoided as Uzi considers tourism development. Appropriately managed tourism could be a positive asset to the community. Building relationships between foreigners and villagers can improve local facilities and education. Tourism can also improve the relationship villagers have with their natural ecosystem by giving it alternative economic importance. By putting monetary value on intact native environments, tourism can instill newfound pride in locals for their environment (Makame and Boon, 2008). Shifting forests from having consumptive use value, directly using natural resources, to non-consumptive use value, viewing the forests for their aesthetic and spiritual worth, can inspire villagers to implement their own conservation projects.

Though eco-tourism could offer advantages to the community and to its forests, interviews show a resistance and ignorance towards such change. Tourism can only be sustainable if supported by the people of Uzi. Lack of information on the carrying capacity of Uzi Island, especially for developed establishments, creates challenges for planning and assessment. Given the negative perspective some villagers have towards development and an insufficient understanding of Uzi's ability to sustain visitors with higher resource demands, further groundwork must be laid before Uzi can welcome tourism.

Through education, farmers can be taught how to integrate traditional farming and modern conservation strategies. Agroforestry is an example of such a synergy between forest and human interests. Introducing shade crops and concentrating pressure on recourses can help alleviate human disturbance on surrounding fragile forests (Bhagwat,

2008). By understanding practices that satisfy cultivation needs yet still retain a semi-forest structure that can harbor a biologically diverse habitat for wildlife, humans can continue to benefit from the ecosystem services forests provide.

There were a number of variables during interviews that represented significant confounds. Interviews were conducted in Swahili and later translated into English. The interviewer was not fluent in Swahili and could have more adequately stimulated conversation and opinions on the subject with improved comprehension. Interviews, although conducted with a single individual, were also often attended by multiple villagers, usually children. The presence of casual onlookers could have affected both content and comprehensiveness of responses. Additionally, results could be skewed due to a young sampling demographic with an average age of 32.2 years old.

7.0 CONCLUSION

The natural ecology of Mchangamle peninsula on Uzi Island and Vundwe Island is being seriously compromised by human resource use. A vegetation survey demonstrated significant deforestation due to slash and burn practices, conversion of the land to agriculture, and wood cutting. Two representative wildlife species, the red colobus monkey and suni antelope were qualitatively assessed and showed concerning signs of population decline. Interviews with villagers on Uzi demonstrated a wide variety of attitudes and beliefs about environmental issues, their impact on the health of the community, and potential approaches to improving environmental and community sustainability. Ongoing formal assessment of forest and wildlife degradation is recommended, as well as focus groups and education to determine the optimal approaches to environmental and economic sustainability, which are closely intertwined.

8.0 RECOMMENDATIONS

Gazettement of an area on Uzi or Vundwe for a Forest Reserve would be the most valuable conservation method for both the forests and the services these ecosystems provide. Community-based management of such an area to complement local expertise and enhance awareness would make a reserve sustainable. By engaging the people of Uzi and giving them an opportunity to invest socially in the forest, conservation initiatives can self-perpetuate proper resource use and strengthen responsible management. Evaluation of local perspectives found resistance to foreign investment but through appropriate benefit-sharing mechanisms this could be reconciled to maximize potential environmental services to both visitors and villagers. A potential first step toward gazettement of Vundwe as a Forest Reserve is to conduct focus groups and discussions with local villagers to asses their acceptance of such a proposal. The Wildlife Conservation Society and the DCCFF are working on such discussion but the process is moving slowly. This study has shown the need for immediate action on Vundwe in order to preserve existing species richness.

A more comprehensive study of ecosystem health and regeneration capacity could be used for future management plans. Current red colobus monkey census surveys would also be helpful for targeting remaining habitats for conservation. Biodiversity surveys evaluating bird, insect, and amphibian populations would be helpful for future monitoring of the health of these coastal forests.

Recovering the corridor of vegetation from Pengeleni to Jozani National Park is imperative for ecosystem health and wildlife habitat. Surveying vegetation plots along Pengeleni transect would be beneficial for further understanding human disturbance on Uzi. The extent of destruction observed on this transect poses serious concerns for the wildlife communities in this area. Data demonstrating the increase in deforestation and environmental degradation on Pengeleni peninsula could fuel conservation action.

Empowerment through education, protection with sustainable use plans, and local control of the forests are all important steps toward healthy people and healthy forests. Poverty alleviation can begin through involvement of the local community in profitable alternatives to deforestation and capitalization on non-consumptive ecosystem services. The forests of Uzi and their associated species richness are being rapidly degraded as

evidenced in this vegetation and wildlife survey. In order to save remaining populations of red colobus, duiker, and endemic trees, action plans need to be formulated immediately in conjunction with local villagers to protect these centers of endemism.

Tourism, especially appropriately managed ecotourism, can potentially be beneficial to the local populace as a source of economic stability and conversion to a more environmentally sensitive approach to the fragile ecology of this island complex. However, it is acknowledged that inappropriately managed tourism and development can be destructive to the community fabric, so again, involvement of the community from the ground level through education, focus groups, and group decision-making, is critical in this process.

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Asante sana Issak kwa kila kitu. Siku moja utakuwa mtu mkubwa mwenye kutambua majani mengi. Nitamkumbuka muda wangu kuwa nawe mwituni daima! Asante sana Namna Hassan na watu wote wa Uzi kwa ukarimu wenu na kunikaribisha katika msitu wa Uzi na kujifunza mambo mengi.

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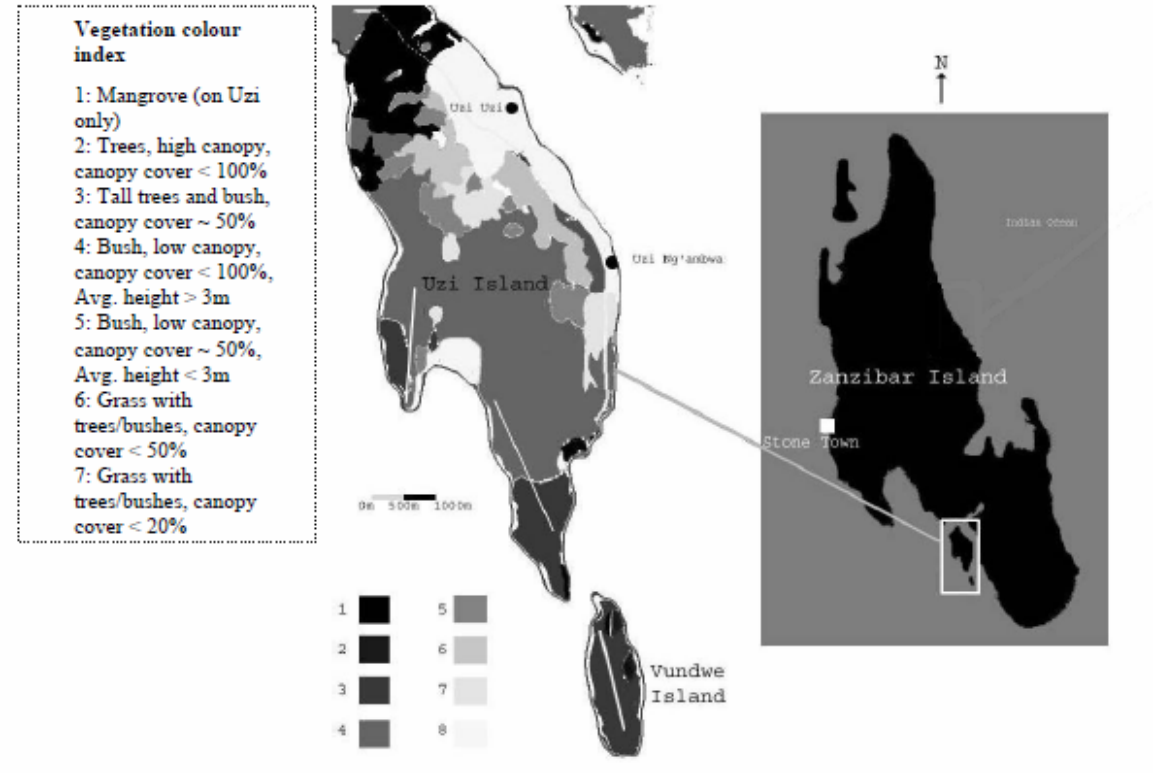
Appendix 1.0



1.1 Map adapted from Nowak, 2007. Originally adapted from the Department of Land and Environment (1989).

1.2 GIS Map of Uzi and Vundwe Islands with transects. Mchangamle is furthest North, Vundwe Island is the furthest South. Aerial photo courtesy of Sustainable Management of Land and Environment (SMOLE) 2005.

Appendix 2.0

Basal Area is used to measure the total quantity of certain trees or all trees.

$$\text{Basal Area} = 2\pi R$$

The Shannon-Weiner Diversity Index is used to measure biodiversity by taking into account number of species and distribution within an area. The resulting index will be higher with each additional species and with greater species evenness.
N_i = Number of individuals of species i, S = number of species, N = total number of all individuals, p_i = relative abundance of each species (proportion of individuals of a given species to the total number of individuals in the community = n_i / N)

$$H^1 = -\Sigma\, p_i \ln p_i$$

Simpson's Index of Diversity is the probability of two random species chosen being the same. Expresses species evenness within a population.

$$D = 1 - \Sigma\, (p_i^2)$$

Sorensen's Index, or Sorensen's Similarity Coefficient, measures the similarity between two ecosystems.

$$QS = \frac{2C}{A + B}$$

Appendix 3.0

Name	Age	Village	Occupation
Hamad Ramadan Mdura		Uzi Uzi	Sheha of Uzi Uzi
Mwalimu Hamadi Solomon		Uzi Uzi	Secondary School teacher
Mrisho Yussouf		Uzi Uzi	Health nurse
Mohamdi Hamada Hamadi	24	Uzi Uzi	Carpenter
Hassan Abdulla	40	Uzi Uzi	Seaweed farmer
Manakambu Hassan	25	Uzi Uzi	Seaweed farmer
Ali Yussouf	38	Uzi Uzi	Fisherman
Ashad Mohammed	40	Uzi Uzi	Fisherman
Asia Hamisi Ali	40	Uzi Uzi	Farmer
Semeni Solomon Mohammed	32	Uzi Uzi	Housewife
Shukrani Malimoudi	28	Uzi Uzi	School teacher
Isa Salim	16	Ng'ambwa	Farmer
Zainabu Salim	15	Ng'ambwa	Seaweed farmer
Idrisa Ahmed	24	Ng'ambwa	Squid supplier
Yecha Hamadi	28	Ng'ambwa	Fisherman
Ahmed Ali	30	Ng'ambwa	Fisherman
Zatuni Hamisi	17	Ng'ambwa	Housewife
Manisha Said	30	Ng'ambwa	Housewife
Juma Hamisi	38	Ng'ambwa	Fisherman
Mustafa Hamisi	45	Ng'ambwa	Farmer
Fatima Isa	39	Ng'ambwa	Farmer
Ramadan Hija	65	Ng'ambwa	Farmer/Fisherman
Rahia Mohamed	30	Ng'ambwa	Seaweed Farmer

3.1 List of all interviewees with ages and occupations.

Interview Questions

Sex: M / F Village: _____

Jina lako ni nani?
What is your name?

Una miaka ngapi?
How old are you?

Umeishi hapa Uzi miaka ngapi?
How long have you been a resident of Uzi Island?

Unafanya kazi gani?
What is your occupation?

Unajua peninsula ya Mchangamle? Unajua kisiwa ya Vundwe?
Do you know the Mchangamle peninsula and Vundwe Island?

Unaamini kwamba ulinzi ya Mchangamle ni muhimu? Na Vundwe? Kwa nini?
Do you believe it is important to protect these areas? Why?

Ikihifadhi Mchangamle, ni nzuri kwa wewe au mbaya? Kwa nini?
If these areas are protected, will this affect you negatively? Positively? How?

Kama watu hawawezi kutumia msitu, ni nzuri au mbaya?
If people could not use the forest, would it be good or bad?

Nge unachukua utalii Uzi?
What do you think of tourism on Uzi Island?

Unafikiri utalii inakupa faidika gani Uzi? Upungufu gani? Vipi?
What benefits do you think tourism would offer Uzi? What disadvantages? Why?

3.2 List of interview questions used.

Family	Genus species	Swahili Name
Anacardiaceae	*Ozoroa obovata*	Mn'gombe
Anacardius	*Lanea bicolor**	Mgongo
Annonaceae	*Monothotaxis* spp.*	Mchofu dume
Annonaceae	*Monothotaxis* spp.*	Mchofu mke
Asclepiadaceae	*Mondia ecornuta*	Mtugwi
Capparidaceae	*Capparis erythrocarpus**	Mnywa
Casuarinaceae	*Cassuarina equisetifolia*	Mvinje
Celastraceae	*Mystrigxylon aethiopicum*	Kifugu
Combretaceae	*Terminalia boivinii**	Mkunguni
Compositae	*Vernonia zanzibarensis**	Mtukutu
Ebenaceae	*Euclea shimperi*	Mdaa
Ebenaceae	*Diospyros consolatae**	Mkururu
Ebenaceae	*Euclea racsomosa**	Msiliza
Embryophyta	*Rhoicissus revolii**	Mtongo
Euphorbiaceae	*Suregada zanzibarensis**	Mdimu msitu
Euphorbiaceae	*Flueggea virosa*	Mkwamba
Euphorbiaceae	*Drypetes natalensis*	Mrimba
Euphorbiaceae	*Mollutus celitus*	Mtundutundu
Fabaceae	*Senna* spp.*	Mumbuzi
Fabaceae	*Senna* spp.	Senna
Flacourceae	*Flacourtia indica*	Mgo
Leguminosae		Mkenge
Malphigiaceae	*Acridocarpus zanzibaricus*	Unknown 1
Meliaceae	*Turraea nilotica*	Mtamagoa
Mimosaceae	*Albizia glaberima*	Mgerenge
Moracae	*Ficus* spp.	Mla ndege
Moracae	*Ficus* spp.	Mwambua 1
Moracae	*Ficus* spp.	Mwambua 2
Mrytaceae	*Eugenia* spp.*	Mkaraga
Musaceae	*Musa acuminata*	Mndizi
Rubiaceae	*Psychotria bibracteatum**	Mkonge
Rubiaceae	*Tarenna pavetoides*	Mla shore
Rubiaceae	*Polysphaeria* spp. *	Mlapaa #3
Rubiaceae	*Tricalysia microphylla**	Mlapaa dume
Rubiaceae	*Psychotria goetzei*	Mti mafuta
Rutaceae	*Citrus reticulata*	Mchenza mwitu
Rutaceae	*Clausena anisata*	Mfusho
Sapindaceae	*Macphersonia gracilis**	Mjoma
Sapindaceae	*Dodonaea viscosa*	Mkeng'eta
Sapindaceae	*Dalbergia vaccinifolia*	Mringozi
Sapindaceae	*Allophylus* spp.	Mchonjo
Sapotaceae	*Mimusops fruticosa**	Mnyumvyu
Tiliaceae	*Grewia bicolor**	Mkole
Tiliaceae	*Carpiodictera africana**	Muanga
Ulmaceae	*Trema orientalis*	Mpesu

	Mondia spp.	Mkenge mpaka
		Mkaati
		Mpwipwi
		Mwamba
		Unknown 3
		Unknown 4
		Unknown 5
*Also found on Vundwe Island		Unknown 7

3.1 Mchangamle Species List

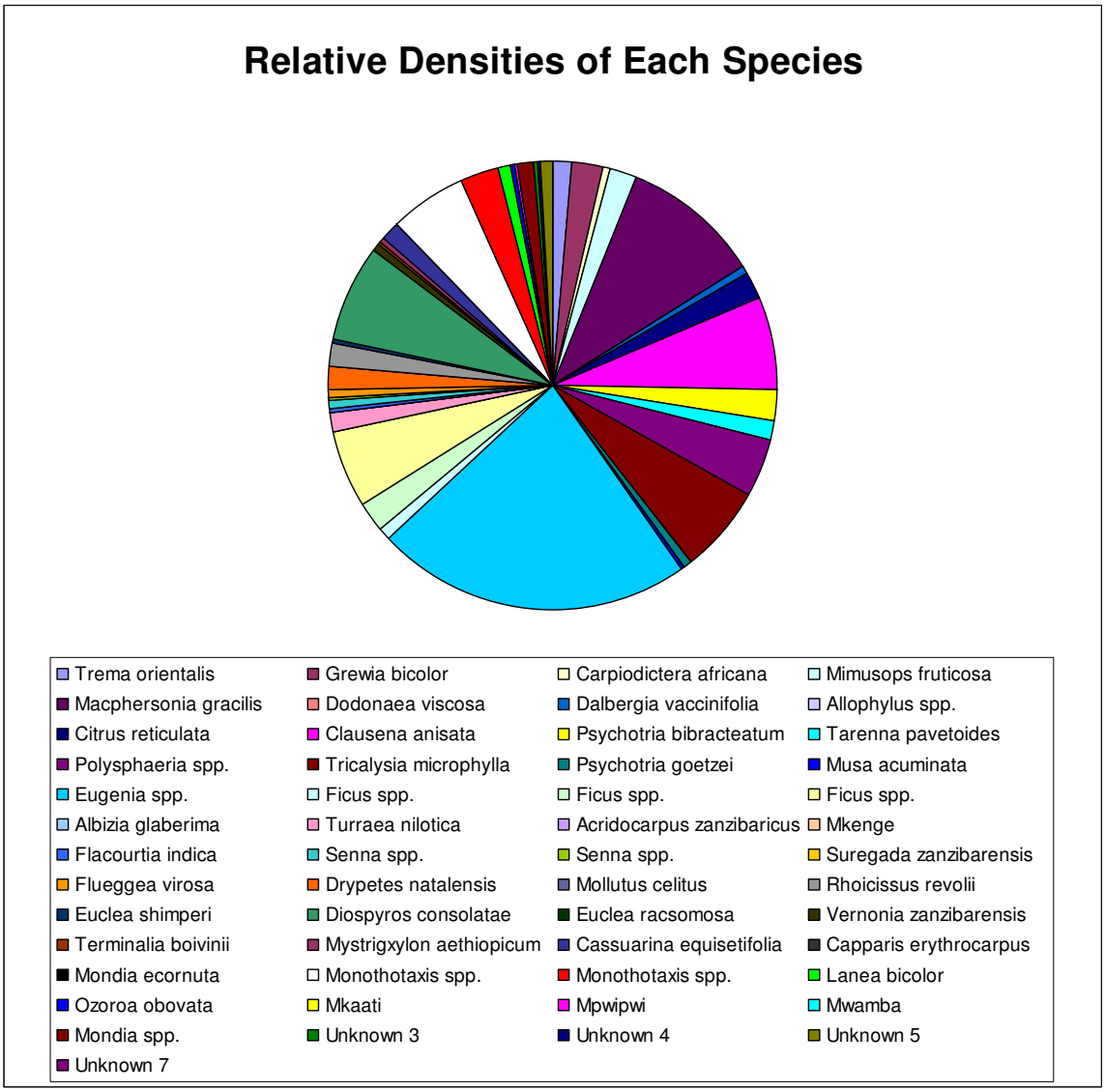
Family	**Genus species**	**Swahili Name**
Anacardiaceae	*Sorindeia madagascarensis*	Mpilipili doria
Anacardiaceae	*Ozoroa obovata**	Mn'gombe
Anacardius	*Lanea bicolor**	Mgongo
Annonaceae	*Monothotaxis* spp.*	Mchofu dume
Annonaceae	*Monothotaxis* spp.*	Mchofu mke
Annonaceae	*Monodora grandidieri*	Mchofu mkubwa
Annonaceae	*Zizigum comunii*	Mzambarau
Caesalpiniaceae	*Cassia abraviata*	Mumbuzi (2)
Capparidaceae	*Capparis erythrocarpus**	Mnywa
Celastraceae	*Maytenus mossambicensis*	Mnusi
Combretaceae	*Terminalia boivinii**	Mkunguni
Compositae	*Vernonia zanzibarensis**	Mtukutu
Ebenaceae	*Diospyros consolatae**	Mkururu
Ebenaceae	*Euclea racsomosa**	Msiliza
Embryophyta	*Rhoicissus revolii**	Mtongo
Euphorbiaceae	*Suregada zanzibariensis**	Mdimu msitu
Euphorbiaceae	*Mallotus opposifolius*	Mtumbika
Fabaceae	*Senna petacienna**	Mumbuzi
Flacourtiaceae	*Rawsonia lucida*	Mpera mwitu
Mrytaceae	*Eugenia capensis**	Mkaraga
		Mkangara
Myrsinaceae	*Rapanea* spp.	shamba
Myrtaceae	*Psidium guajava*	Mpera
Myrtaceae	*Capellobia spp.*	Kikoko
Ochnaceae	*Ochna thomasiana*	Kifugu mrambo
Rubiaceae	*Psychotria bibracteatum**	Mkonge
Rubiaceae	*Polysphaeria* spp.*	Mlapaa #3
Rubiaceae	*Polysphaeria parvifolia**	Mlapaa dume
Rubiaceae	*Leptactina platyphylla*	Mbuni mwitu
Sapindaceae	*Macphersonia gracilis**	Mjoma
Sapindaceae	*Dalbergia vaccinifolia*	Mringozi
Sapindaceae	*Paulinia pinnata*	Mzabibu mwitu
Sapindaceae	*Dalbergia vaccinifolia*	Mrimgozi
Sapindaceae	*Pancovia golungensis*	Mmotomoto

Sapotaceae	*Mimusops fruticosa**	Mnyumvyu
Sapotaceae	*Pachystela* spp.	Mchocha
Thymelaeaceae	*Synaptolepsis kirkii*	Bibi Kiu
Tiliaceae	*Grewia bicolor**	Mkole
Tiliaceae	*Grewia mollus*	Mkole mpwa
Tiliaceae	*Grewia* spp.	Unknown 9
Tiliaceae	*Carpiodictera africana**	Muanga
	Aprodytes dimediata	Muangoti
		Mbundiki
		Mchokoo
		Mchenza mwitu
		Mkumba
		Unknown 3
		Unknown 10
		Unknown 12
		Unknown 15
		Unknown 19

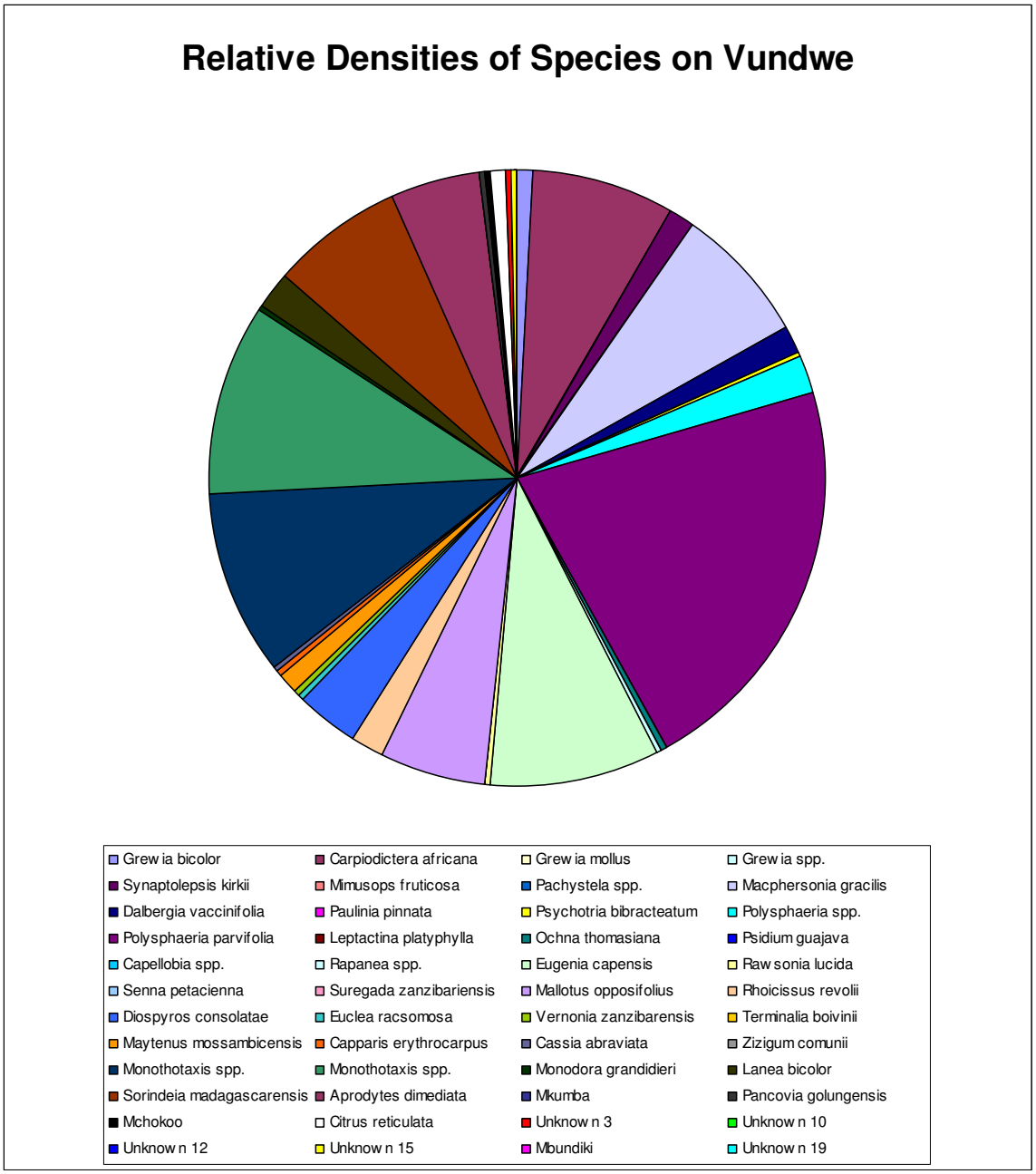
*Also found in Mchangamle

4.2 Vundwe Species List.

Appendix 5.0



4.1 Relative densities for all species in Mchangamle



4.2 Relative densities for all species in Vundwe

Genus species	Swahili Name	Tot. Indiv.	Rel. Dens.	Sum BA	Mean DBH	SD*	Height 1	Freq.	Rel. Freq.	Rel. Dom.	IVI
Trema orientalis	Mpesu	13	1.2732615	1.9334302	5.8202671	4.9581	2	3	1.7241379	0.0038841	300.13
Grewia bicolor	Mkole	23	2.2526934	7.2362341	5.3575236	6.3964	1	9	5.1724138	0.014537	743.96
Carpiodictera africana	Muanga	7	0.6856024	119.20467	4.6858004	3.8828	1	3	1.7241379	0.2394723	264.92
Mimusops fruticosa	Mnyumvyu	21	2.0568071	4.9502758	5.3335435	7.6483	2	5	2.8735632	0.0099447	494.03
Macphersonia gracilis	Mjoma	103	10.088149	16.477351	4.9251112	5.7669	8	10	5.7471264	0.0331016	1586.8
Dodonaea viscosa	Mkeng'eta	1	0.0979432	0.1042863	4.1811973	3.669	0	1	0.5747126	0.0002095	67.287
Dalbergia vaccinifolia	Mringozi	3	0.2938296	1.2124742	7.4053524	4.5024	0	1	0.5747126	0.0024358	87.098
Allophylus spp.	Mchonjo	2	0.1958864	747.0165	16.345719	27.956	0	2	1.1494253	1.5006946	284.6
Citrus reticulata	Mchenza mwitu	20	1.9588639	1.6808274	4.2257411	3.1306	2	7	4.0229885	0.0033766	598.52
Clausena anisata	Mfusho	69	6.7580803	8.8012524	5.2244021	4.8003	1	3	1.7241379	0.017681	849.99
Psychotria bibracteatum	Mkonge	22	2.1547502	2.4247813	3.8808322	3.1674	0	4	2.2988506	0.0048712	445.85
Tarenna pavetoides	Mla shore	14	1.3712047	1.4391745	3.2306505	2.5679	1	4	2.2988506	0.0028912	367.29
Polysphaeria spp.	Mlapaa #3	43	4.2115573	7.8343384	5.5373106	6.3376	3	8	4.5977011	0.0157385	882.5
Tricalysia microphylla	Mlapaa dume	68	6.6601371	9.9977077	5.2038837	5.2462	5	8	4.5977011	0.0200846	1127.8
Psychotria goetzei	Mti mafuta	6	0.5876592	0.3174107	3.5796349	2.2212	1	3	1.7241379	0.0006377	231.24
Musa acuminata	Mndizi	1	0.0979432	n/a	n/a		1	1	0.5747126		
Eugenia spp.	Mkaraga	236	23.114594	255.22071	6.6162557	18.178	8	10	5.7471264	0.5127174	2937.4
Ficus spp.	Mla ndege	9	0.8814887	19.946929	13.506988	22.371	2	3	1.7241379	0.0400717	264.57
Ficus spp.	Mwambua 1	24	2.3506366	6.7084047	5.6815618	6.6998	3	5	2.8735632	0.0134766	523.77
Ficus spp.	Mwambua 2	55	5.3868756	9.2159704	5.0744782	5.8938	11	4	2.2988506	0.0185141	770.42
Albizia glaberima	Mgerenge	2	0.1958864	1.4819474	10.554883	16.465	0	2	1.1494253	0.0029771	134.83
Turraea nilotica	Mtamagoa	12	1.1753183	0.984254	1.7188734	0	0	4	2.2988506	0.0019773	347.61
Acridocarpus zanzibaricus	Unknown 1	1	0.0979432				1	1	0.5747126	0	67.266
	Mkenge	1	0.0979432	0.0509296	2.5464791	0	0	1	0.5747126	0.0001023	67.276
Flacourtia indica	Mgo	3	0.2938296	0.1737335	2.1896339	1.532	0	1	0.5747126	0.000349	86.889
Senna spp.	Mumbuzi	5	0.489716	4.12871	8.1787797	4.8875	0	3	1.7241379	0.0082942	222.21
Senna spp.	Senna	2	0.1958864	0.0718187	3.0239439	0	1	2	1.1494253	0.0001443	134.55
Suregada zanzibarensis	Mdimu msitu	1	0.0979432	0.0602322	2.769296	0	0	1	0.5747126	0.000121	67.278
Flueggea virosa	Mkwamba	5	0.489716	0.1257881	2.640461	1.8279	2	2	1.1494253	0.0002527	163.94
Drypetes natalensis	Mrimba	17	1.6650343	11.865781	9.4289348	10.833	4	3	1.7241379	0.0238374	341.3
Mollutus celitus	Mtundutundu	1	0.0979432				1	1	0.5747126	0	67.266
Rhoicissus revolii	Mtongo	17	1.6650343	3.5352849	5.8975119	6.4065	2	5	2.8735632	0.0071021	454.57
Euclea shimperi	Mdaa	2	0.1958864	0.3346233	4.6154933	0	0	2	1.1494253	0.0006722	134.6
Diospyros consolatae	Mkururu	72	7.0519099	67.116014	9.0817321	18.617	6	9	5.1724138	0.1348305	1235.9
Euclea racsomosa	Msiliza	2	0.1958864	0.6824962	5.7454934	4.5691	0	2	1.1494253	0.0013711	134.67
Vernonia zanzibarensis	Mtukutu	5	0.489716	0.8027059	4.8557546	4.1377	0	3	1.7241379	0.0016126	221.55
Terminalia boivinii	Mkunguni	2	0.1958864	0.2034159	3.4336526	2.5263	0	2	1.1494253	0.0004086	134.57
Mystrigxylon aethiopicum	Kifugu	2	0.1958864	2.2194475	6.5583103	5.619	0	1	0.5747126	0.0044587	77.506
Cassuarina equisetifolia	Mvinje	15	1.4691479	1.4612254	3.5446079	0.8836	0	2	1.1494253	0.0029355	262.15
Capparis erythrocarpus	Mnywa	1	0.0979432	0.0175787	1.4960565	0	0	1	0.5747126	3.531E-05	67.269
Mondia ecornuta	Mtugwi	1	0.0979432	0.0097482	1.1140846	0	0	1	0.5747126	1.958E-05	67.268
Monothotaxis spp.	Mchofu dume	55	5.3868756	5.1050142	3.8935899	3.1365	2	8	4.5977011	0.0102556	999.48
Monothotaxis spp.	Mchofu mke	31	3.036239	2.7373536	3.8331854	3.1085	1	7	4.0229885	0.0054991	706.47
Lanea bicolor	Mgongo	7	0.6856024	13.714859	12.891485	23.99	1	4	2.2988506	0.027552	301.2
Ozoroa obovata	Mn'gombe	2	0.1958864	2.5050033	22.78216	17.722	1	2	1.1494253	0.0050323	135.03
Mondia spp.	Mkenge mpaka	12	1.1753183	0.8560069	3.9989985	3.5198	1	2	1.1494253	0.0017196	232.65
	Mkaati	1	0.0979432	0.0215177	1.6552114	0	0	1	0.5747126	4.323E-05	67.27
	Mpwipwi	3	0.2938296	0.2000418	3.6408964	2.8239	0	2	1.1494253	0.0004019	144.37
	Mwamba	1	0.0979432	0.03051	1.934817	1.1199	0	1	0.5747126	6.129E-05	67.272
	Unknown 3	1	0.0979432	0.0741662	3.1512679	1.6707	0	1	0.5747126	0.000149	67.28
	Unknown 4	2	0.1958864	7.1818668	3.0239439	0	1		0	0.0144278	21.031
	Unknown 5	9	0.8814887	1330.6889	10.950661	12.164	1		0	2.6732443	355.47
	Unknown 7	1	0.0979432	9.2357613	1.5278875	0.8984	0		0	0.0185539	11.65

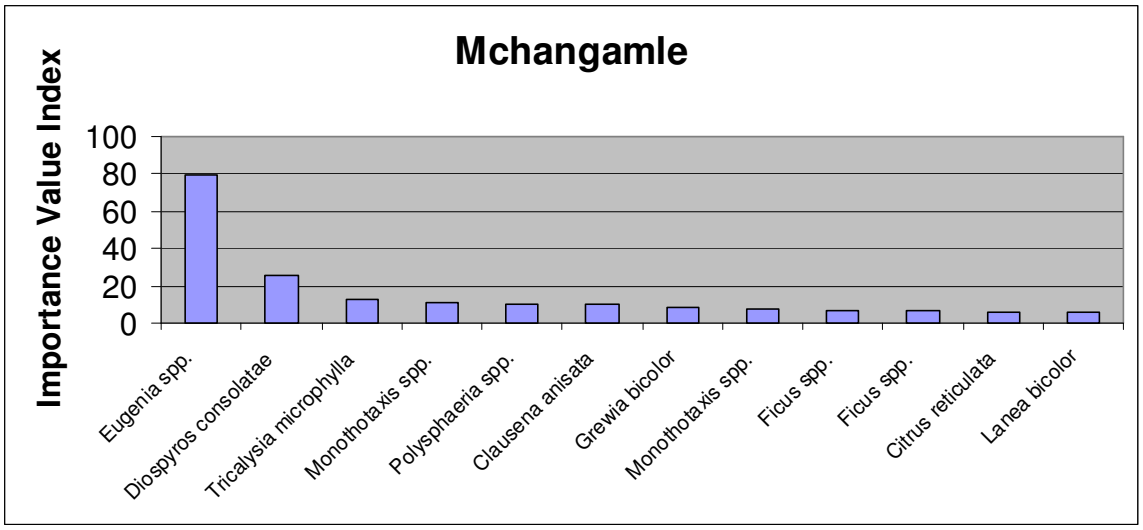
*Standard Deviation

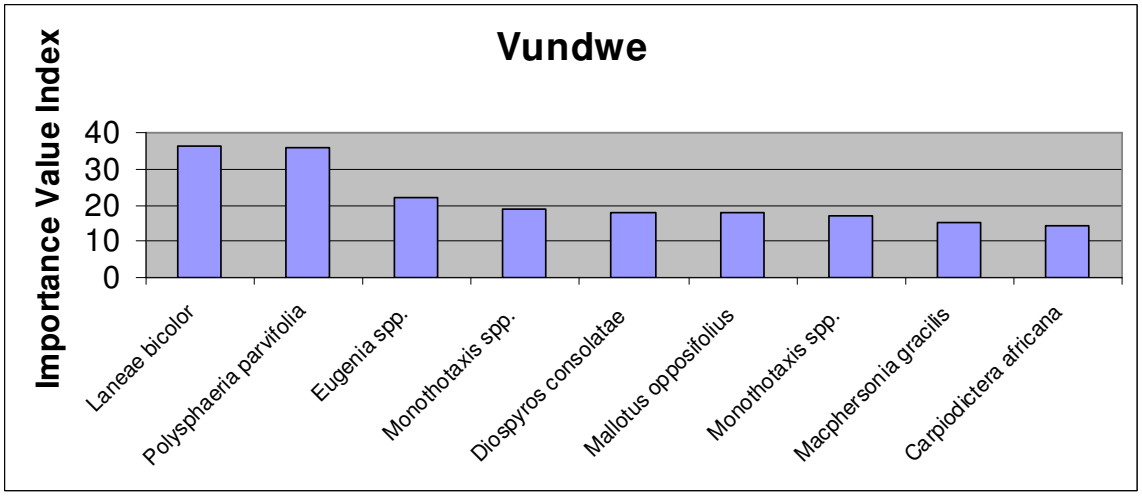
4.3 Table of relative densities, sum basal area, mean D.B.H., relative frequency of individuals in height class 1, relative frequency in height class 2, relative dominance, and Importance Value Index for each species in Mchangamle.

Genus species	Swahili Name	Total	Rel. Dens.	Sum BA	Mean DBH	SD*	Height 1	Freq.	Rel. Freq.	Rel. Dom.	IVI
Sorindeia madagascarensis	Mpilipili doria	107	6.832695	5354.72	6.313062	7.3	24	1	0.6289308	9.9199716	17.38
Ozoroa obovata	Mn'gombe		0				1				
Lanea bicolor	Mgongo	32	2.043423	16506.88	19.614019	15.3	1	6	3.7735849	30.580078	36.4
Monothotaxis spp.	Mchofu dume	152	9.706258	1495.773	3.4119388	2.87	23	10	6.2893082		
Monothotaxis spp.	Mchofu mke	158	10.0894	977.6971	2.9059129	2.4	52	8	5.0314465		
Monodora grandidieri	Mchofu mkubwa	2	0.127714	40.77629	4.7905638	2.45	0	2	1.2578616	0.0755408	1.461
Zizigum comunii	Mzambarau	1	0.063857	0.537944	0.8276057		0	1	0.6289308	0.0009966	0.694
Cassia abraviata	Mumbuzi 2	2	0.127714	152.1155	11.77993	8.42	0	2	1.2578616	0.281804	1.667
Capparis erythrocarpus	Mnywa	6	0.383142	25.59848	2.2620121	1.31	0	4	2.5157233	0.0474229	2.946
Maytenus mossambicensis	Mnusi	17	1.085568	612.207	8.4028513	7.88	1	5	3.1446541	1.1341537	5.364
Terminalia boivinii	Mkunguni	2	0.127714	1.204007	1.6501409	1.01	0	1	0.6289308	0.0022305	0.759
Vernonia zanzibarensis	Mtukutu	4	0.255428	198.2362	9.9359628	11	0	2	1.2578616	0.3672457	1.881
Diospyros consolatae	Mkururu	51	3.256705	6205.732	11.192288	14.1	4	5	3.1446541	11.496527	17.9
Euclea racsomosa	Msiliza	4	0.255428	352.233	14.346655	16.5	0	2	1.2578616	0.6525347	2.166
Rhoicissus revolii	Mtongo	27	1.724138	454.7916	4.4597599	3.56	2	7	4.4025157	0.8425314	6.969
Suregada zanzibariensis	Mdimu msitu	1	0.063857	88.13921	9.547284	6.46	0	1	0.6289308	0.1632837	0.856
Mallotus opposifolius	Mtumbika	86	5.491699	3584.181	6.5274302	6.67	8	9	5.6603774	6.6399315	17.79
Senna petacienna	Mumbuzi	2	0.127714	0	8.5466204	5.56	0	1	0.6289308	0	0.757
Rawsonia lucida	Mpera mwitu	1	0.063857	1.27324	1.2732395		0	1	0.6289308	0.0023588	0.695
Eugenia capensis	Mkaraga	142	9.067688	3854.497	5.0599145	5.43	46	9	5.6603774	7.1407095	21.87
Rapanea spp.	Mkangara shamba	1	0.063857	1.655211	1.6552114		0	1	0.6289308	0.0030664	0.696
Psidium guajava	Mpera	1	0.063857	2.06981	1.5321127	0.82	0	1	0.6289308	0.0038345	0.697
Capellobia spp.	Kikoko	2	0.127714	7.501409	1.2502348	0.68	0	2	1.2578616	0.0138969	1.399
Ochna thomasiana	Kifugu mrambo	1	0.063857	2.586268	2.3488264	1.87	1	1	0.6289308		
Psychotria bibracteatum	Mkonge	1	0.063857	4.567747	2.0587123	1.07	1	1	0.6289308	0.0084621	0.701
Polysphaeria spp.	Mlapaa #3	30	1.915709	339.3366	3.832811	2.94	5	5	3.1446541	0.6286434	5.689
Polysphaeria parvifolia	Mlapaa dume	335	21.39208	4384.549	4.1242964	3.31	98	10	6.2893082	8.1226658	35.8
Leptactina platyphylla	Mbuni mwitu	4	0.255428	272.6881	10.309891	7.57	1	1	0.6289308	0.5051727	1.39
Macphersonia gracilis	Mjoma	113	7.215837	1182.937	4.7306734	5.19	85	9	5.6603774	2.1914694	15.07
Dalbergia vaccinifolia	Mringozi (Mkamba)	20	1.277139	259.0836	4.0966762	2.93	1	6	3.7735849	0.4799693	5.531
Paulinia pinnata	Mzabibu mwitu	2	0.127714	128.6998	7.9468782	5.27	0	1	0.6289308	0.2384249	0.995
Dalbergia vaccinifolia	Mrimgozi		0				1				
Mimusops fruticosa	Mnyumvyu	2	0.127714	383.9494	19.657578	28.1	0	2	1.2578616	0.7112915	2.097
Pachystela spp.	Mchocha	1	0.063857	5.221078	2.5783101		1	1	0.6289308	0.0096724	0.702
Synaptolepsis kirkii	Bibi Kiu	20	1.277139	23.8064	1.1860095	0.54	2	6	3.7735849		
Grewia bicolor	Mkole	14	0.893997	1329.338	7.372421	6.99	2	5	3.1446541	2.462687	6.501
Carpiodictera africana	Muanga	115	7.34355	1391.679	3.9248691	3.63	25	7	4.4025157	2.5781763	14.32
Grewia mollus	Mkole mpwa	1	0.063857	2.236127	1.9110986	1.1	0	1	0.6289308	0.0041426	0.697
Grewia spp.	Unknown 9	1	0.063857	278.4901	6.3735778	7.17	0	1	0.6289308	0.5159213	1.209
Citrus reticulata	Mchenza mwitu	14	0.893997	309.6192	5.8625767	4.29	0	6	3.7735849	0.57359	5.241
Pancovia golungensis	Mkumba	1	0.063857	1.149099	1.2095776		1	1	0.6289308	0.0021288	0.695
Mondia spp.	Muangoti	74	4.725415	874.3861	3.9936108	3.33	20	3	1.8867925	1.6198578	8.232
	Mbundiki	1	0.063857	108.3535	11.745635		0	1	0.6289308	0.200732	0.894
	Mmotomoto	3	0.191571	15.30593	2.3130518	1.31	0	2	1.2578616	0.0283552	1.478
	Msoda	5	0.319285	1344.114	8.5246763	15.4	1	2	1.2578616	2.4900604	4.067
	Unknown 10	1	0.063857	2.320479	1.7188734		0	1	0.6289308	0.0042988	0.697
	Unknown 12	2	0.127714	1190.775	27.215495	5.9	0	2	1.2578616	2.205989	3.592
	Unknown 15	1	0.063857	86.13545	10.472395		0	1	0.6289308	0.1595716	0.852
	Unknown 19	1	0.063857	113.1027	12.000283		0	1	0.6289308	0.2095301	0.902
	Unknown 3	2	0.127714	26.93697	4.1380285	0.23	0	1	0.6289308	0.0499025	0.807

*Standard Deviation

4.4 Table of relative densities, sum basal area, mean D.B.H., relative frequency of individuals in height class 1, relative frequency in height class 2, relative dominance, and Importance Value Index for each species in Vundwe.





5.5 The species with the highest Importance Value Index for Mchangamle and Vundwe.

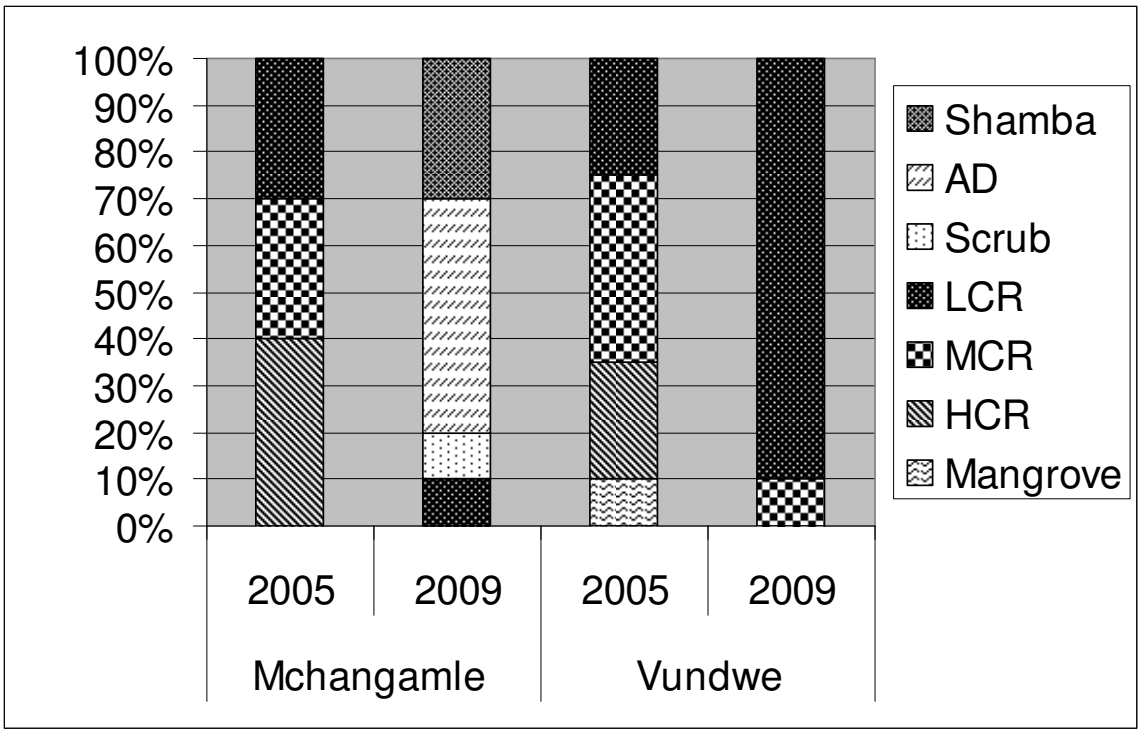
Appendix 6.0

Vegetation Type	Canopy Height (m)	Canopy Cover (%)	Description	Species
Medium Coral Rag	10-12	50-60	Denser understory but still impenetrable; many tree saplings, some emergent trees may be >15m in height.	*Terminalia boivinii*, *Ficus* spp., *Ozoroa obovata*, *Diospyros consolatae*, *Mystrozylon aethiopicum*. D.B.H <10 cm
Low Coral Rag	5-7	30-60	Vegetation low, understory often dense and impenetrable; many tree saplings. Few emergent trees. Mixed species.	*Eugenia* spp., *Eugenia capensis*, *Machphersonia gracilis*, *Strychnos angolensis*, *Psychotria* spp., *Polyshaeria* spp.
Scrub	5	<30	Low regenerating area with two vegetation types: one with bare ground and a second, succeeding state with spiny species growing thickly.	*Toddalia* spp., *Trema orientalis*, *Ficus sur*, *Tarenna pavettoides*, *Dichrostachys cinerea*, *Veronica zanzibarensis*
Shamba	5-7	0-10	Abandoned or overgrown farmland with grasses, fruit and pioneer (shrub) species; sometimes occurs adjacent to plantations of *Cassuarina equisetifolia*	*Citrus sinensis*, *Mangifera indica*, *Sorindeia madagascariensis*
Actively Disturbed	0-10	0-80	Low to medium coral rag with active disturbance including timber removal or	Any of above

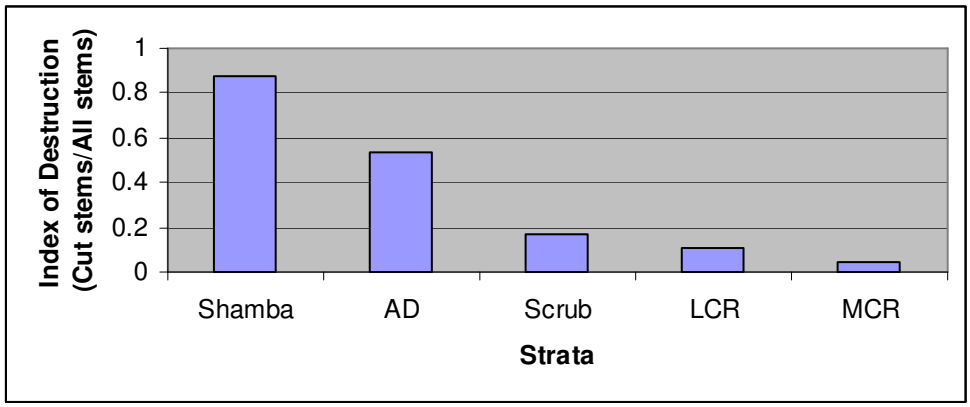
6.1 Strata adapted from Katarzyna Nowak's thesis work from 2003 to 2005. Actively Disturbed category added to characterize recent disturbance.

Plot	Mchangamle	Vundwe
0 meters (Plot 1)	Shamba (few small banana plants, papayas and yams, young Cassuarina stands)	Low Coral Rag
200 meters (Plot 2)	Actively Disturbed (burned forest still standing, few small fires)	Medium Coral Rag
400 meters (Plot 3)	Low Coral Rag (very low, canopy average 0-3 meters)	Low Coral Rag
600 meters (Plot 4)	Actively Disturbed (active fires, approximately 40% of vegetation dead, previously burned standing trees)	Low Coral Rag
800 meters (Plot 5)	Actively Disturbed (active fires, 50% of vegetation dead, previously burned standing trees)	Low Coral Rag
1000 meters (Plot 6)	Actively Disturbed (active fires, 95% of vegetation dead, previously burned standing trees)	Low Coral Rag
1200 meters (Plot 7)	Actively Disturbed (active fires, 50% of vegetation dead, previously burned standing trees)	Low Coral Rag
1400 meters (Plot 8)	Scrub (Mostly bare coral rag with some regeneration)	Low Coral Rag
1600 meters (Plot 9)	Shamba (Few banana plants and yams, some regeneration)	Low Coral Rag
1800 meters (Plot 10)	Shamba (Completely burned shamba, very little regeneration)	Low Coral Rag

6.2 Plots divided into strata for each transect with brief descriptions of distinctive characteristics. Example pictures of shamba and low coral rag strata can be found on page 60.



6.3 Percentage of each transect in each strata between 2005 and 2009.



6.4 Index of disturbance (cut stems and dead burned stems over live and dead stems) across strata

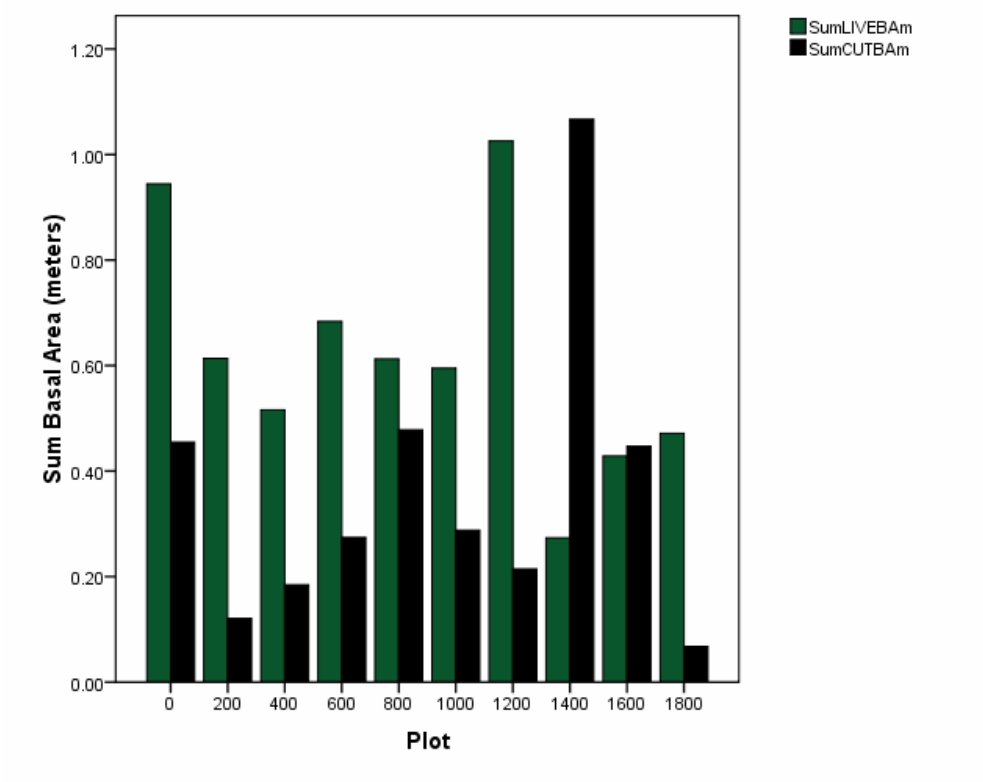
Appendix 7.0

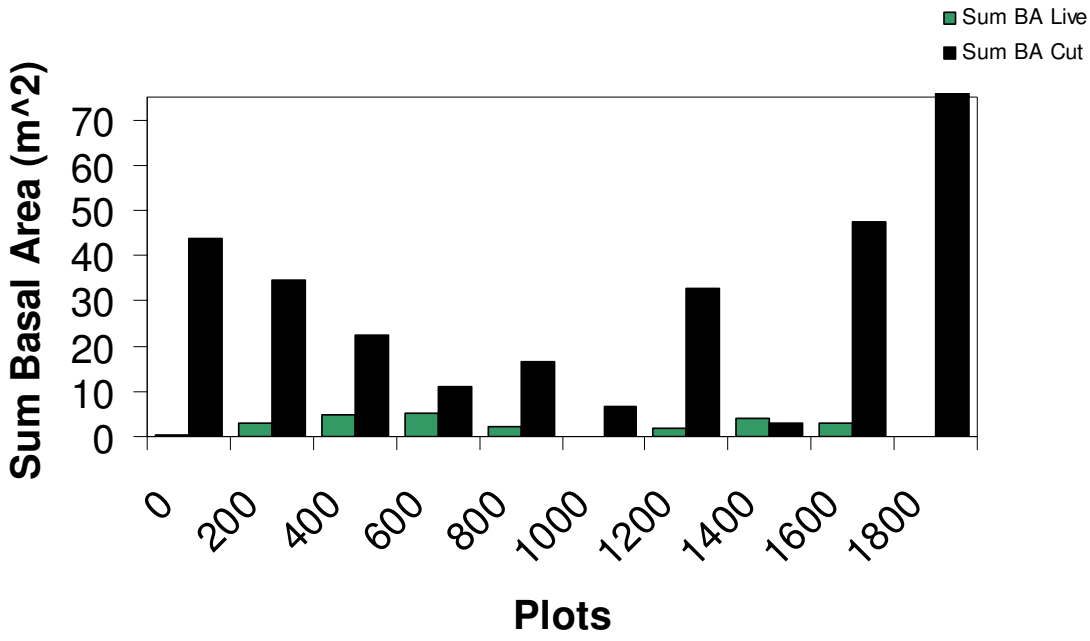
Genus species	Swahili Name	Live Stems	Cut Stems	Dead Stems	# Coppicing	Total	# of Cut/ Burned	%Cop. of Cut Stumps
Ozoroa obovata	Mn'gombe	1	2			3	66.66666667	0
Lanea bicolor	Mgongo	3	6	1		10	70	0
Monothotaxis spp.	Mchofu mke	33	41	5	1	80	57.5	2.43902439
Monothotaxis spp.	Mchofu dume	59	63	20	2	144	57.63888889	3.174603175
Mondia ecomuta	Mtugwi	1				1	0	
Capparis erythrocarpus	Mnywa	0	1			1	100	0
Cassuarina equisetifolia	Mvinje	15				15	0	
Mystrigxylon aethiopicum	Kifugu		2	1		3	100	0
Terminalia boivinii	Mkunguni	4	1	1		6	33.33333333	0
Vernonia zanzibarensis	Mtukutu	0	2	7	1	10	90	50
Diospyros consolatae	Mkururu	28	39	24	2	93	67.74193548	5.128205128
Euclea racsomosa	Msiliza	1	1		1	3	33.33333333	100
Euclea shimperi	Mdaa	0	2		1	3	66.66666667	50
Rhoicissus revolii	Mtongo	16	12			28	42.85714286	0
Drypetes natalensis	Mrimba	17	17	10		44	61.36363636	0
Flueggea virosa	Mkwamba	10				10	0	
Mollutus celitus	Mtundutundu	4				4	0	
Suregada zanzibarensis	Mdimu msitu			1		1	100	
Senna spp.	Senna	3	1			4	25	0
Senna spp.	Mumbuzi		5	3	1	9	88.88888889	20
Flacourtia indica	Mgo	2		1		3	33.33333333	
	Mkenge	1				1	0	
Acridocarpus zanzibaricus	Unknown 1	1				1	0	
Turraea nilotica	Mtamagoa	11	7		1	19	36.84210526	14.28571429
Ficus spp.	Mwambua 2	34	23	36		93	63.44086022	0
Ficus spp.	Mwambua 1	11	8	39.6		58.6	81.22866894	0
Ficus spp.	Mla ndege	16	8			24	33.33333333	0
Eugenia spp.	Mkaraga	143	234	42	23	442	62.44343891	9.829059829
Musa acuminata	Mndizi	1				1	0	
Polysphaeria spp.	Mlapaa #3	32	32	10	8	82	51.2195122	25
Psychotria bibracteatum	Mkonge	29	10	20	1	60	50	10
Psychotria goetzei	Mti mafuta	13		7		20	35	
Tarenna pavetoides	Mla shore	76	9	4		89	14.60674157	0
Tricalysia microphylla	Mlapaa dume	22	64	14	10	110	70.90909091	15.625
Citrus reticulata	Mchenza mwitu	27	4	34		65	58.46153846	0
Clausena anisata	Mfusho	14	62	17	1	94	84.04255319	1.612903226
Dalbergia vaccinifolia	Mringozi		5			5	100	0
Dodonaea viscosa	Mkeng'eta	2				2	0	
Macphersonia gracilis	Mjoma	75	60	60	15	210	57.14285714	25
Mimusops fruticosa	Mnyumvyu	15	19		2	36	52.77777778	10.52631579
Grewia bicolor	Mkole	45	13	5	1	64	28.125	7.692307692
Trema orientalis	Mpesu	14	2		1	17	11.76470588	50
Albizia glaberima	Mgerenge	2	1		1	4	25	100
Allophylus spp.	Mchonjo	3		1		4	25	
Carpiodictera africana	Muanga	1	18		2	21	85.71428571	11.11111111
Mondia spp.	Mkenge mpaka	6	1	10		17	64.70588235	0
	Mpwipwi	3	2		1	6	33.33333333	50
	Mwamba	3				3	0	
	Unknown 7	4				4	0	
	Unknown 5	13	2			15	13.33333333	0
	Unknown 3			7		7	100	

7.1 Number of live stems, cut stems, dead stems, cut stumps coppicing, and percentage cut and coppicing of total stems for each species on Mchangamle.

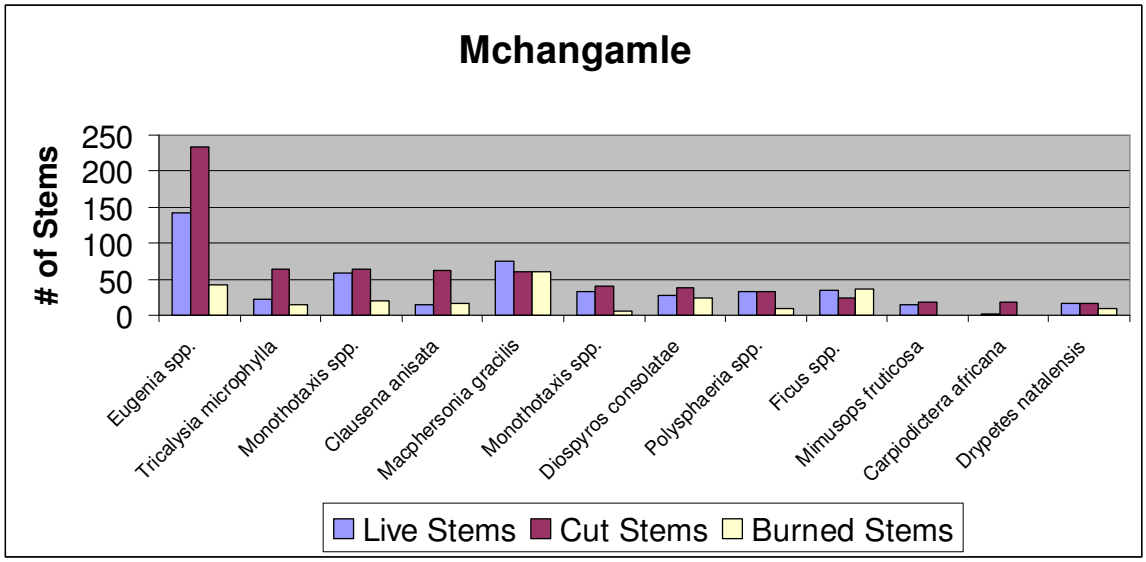
Genus species	Swahili Name	Live Stems	Cut Stems	Dead Stems	# Coppicing	Total	% Cut	% Cop of Cut
Sorindeia madagascarensis	Mpilipili doria	196	88	2	20	286	30.7692308	22.72727273
Lanea bicolor	Mgongo	34		5		39	0	
Monothotaxis spp.	Mchofu mke	545	30	8	1	583	5.1457976	3.333333333
Monothotaxis spp.	Mchofu dume	483	28	3	1	514	5.44747082	3.571428571
Monodora grandidieri	Mchofu mkubwa	2				2	0	
Zizigum comuni	Mzambarau	1				1	0	
Cassia abraviata	Mumbuzi 2	6				6	0	
Capparis erythrocarpus	Mnywa	23				23	0	
Maytenus mossambicensis	Mnusi	65	8	8		81	9.87654321	0
Terminalia boivinii	Mkunguni	1	1		1	2	50	100
Vernonia zanzibarensis	Mtukutu	3	1			4	25	0
Diospyros consolatae	Mkururu	60	8	9	2	77	10.3896104	25
Euclea racsomosa	Msiliza	3		1		4	0	
Rhoicissus revolii	Mtongo	46	1			47	2.12765957	0
Mallotus opposifolius	Mtumbika	191	19	5		215	8.8372093	0
Suregada zanzibariensis	Mdimu msitu	4				4	0	
Senna petacienna	Mumbuzi			2		2	0	
Rawsonia lucida	Mpera mwitu	1				1	0	
Carpilodia africana	Muanga	294	30	1	1	325	9.23076923	3.333333333
Eugenia spp.	Mkaraga	280	20	1	6	301	6.64451827	30
Psidium guajava	Mpera	2				2	0	
Ochna spp.	Kifugu mrambo	4				4	0	
Polysphaeria parvifolia	Mlapaa dume	672	61	21	8	754	8.09018568	13.1147541
Polysphaeria spp.	Mlapaa #3	58	17	1	3	76	22.3684211	17.64705882
Psychotria bibracteatum	Mkonge	5				5	0	
Leptactina platyphylla	Mbuni mwitu	7		1		8	0	
Macphersonia gracilis	Mjoma	241	16	17	2	274	5.83941606	12.5
Pancovia golungensis	Mmotomoto	3				3	0	
Mimusops fruticosa	Mnyumvyu	1	1			2	50	0
Pachystela spp.	Mchocha	2				2	0	
Synaptolepsis kirkii	Bibi Kiu	25				25	0	
Grewia bicolor	Mkole	31	7	2		40	17.5	0
Grewia mollus	Mkole mpwa	1	1			2	50	0
Grewia spp.	Unknown 9	3				3	0	
Cyphostemma spp.	Mzabibu mwitu	11				11	0	
Carpilodia ginesis	Kikoko	4				4	0	
Aprodytes dimediata	Muangoti	144	26	1	2	171	15.2046784	7.692307692
Rapenaeae malanofloem	Mkangarashamba		1			1	100	0
Citrus reticulata	Mchenza mwitu	28	7	5		40	17.5	0
	Mbundiki	1				1	0	
	Mchokoo	18	5	2		25	20	0
	Mkamba ya kuni	65	1			66	1.51515152	0
	Mkumba	1				1	0	
	Unknown 10		1		1	1	100	100
	Unknown 12	2				2	0	
	Unknown 15	1				1	0	
	Unknown 19	1				1	0	
	Unknown 3	2				2	0	

7.2 Number of live stems, cut stems, dead stems, cut stumps coppicing, and percentage cut and coppicing of total stems for each species on Vundwe.

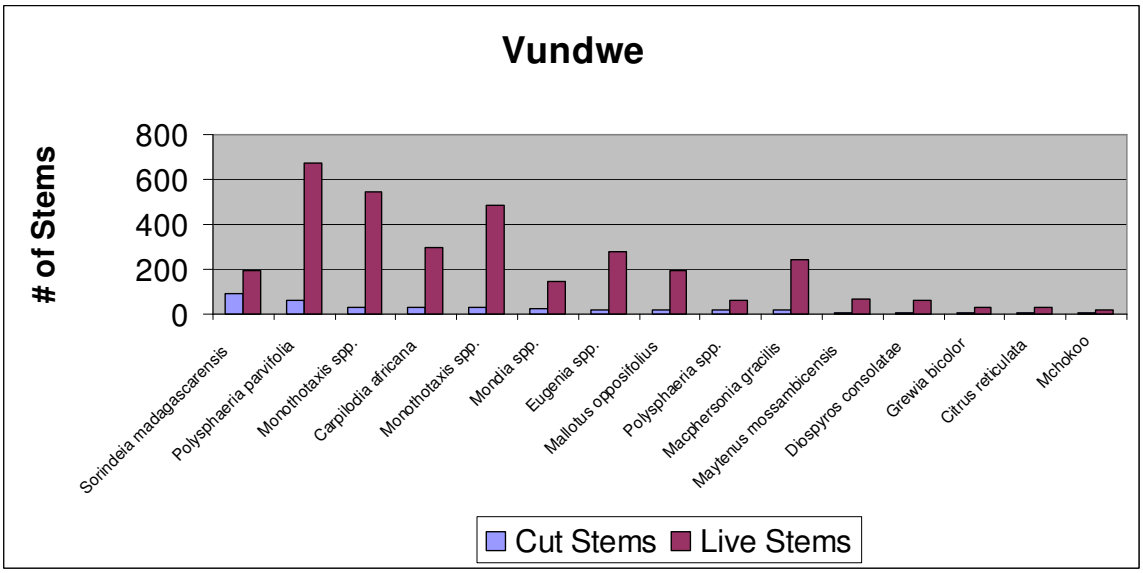




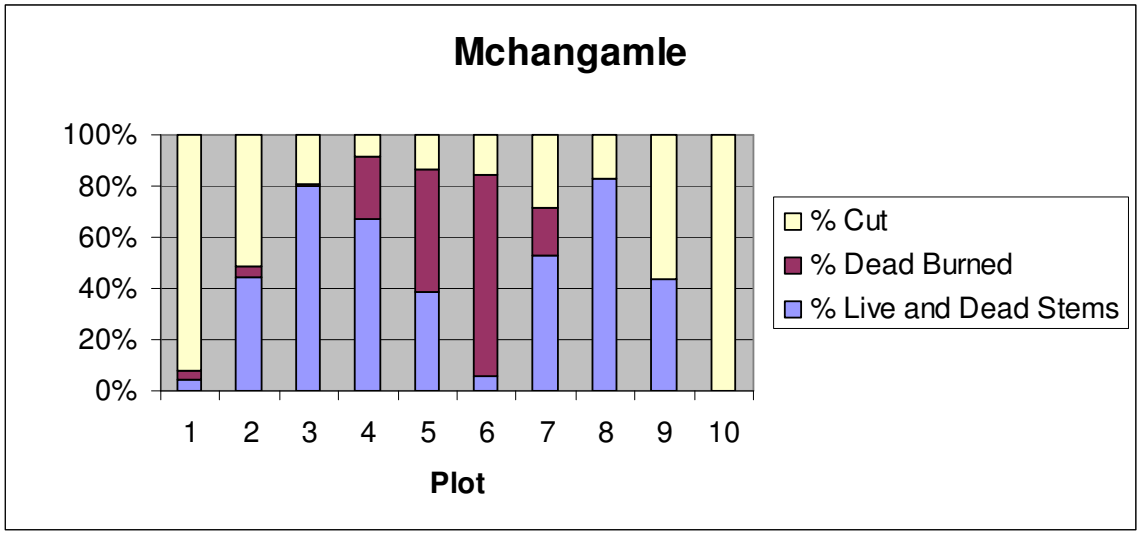
7.3 Graphs of sum basal area for each plot in Mchangamle between 2005 and 2009.



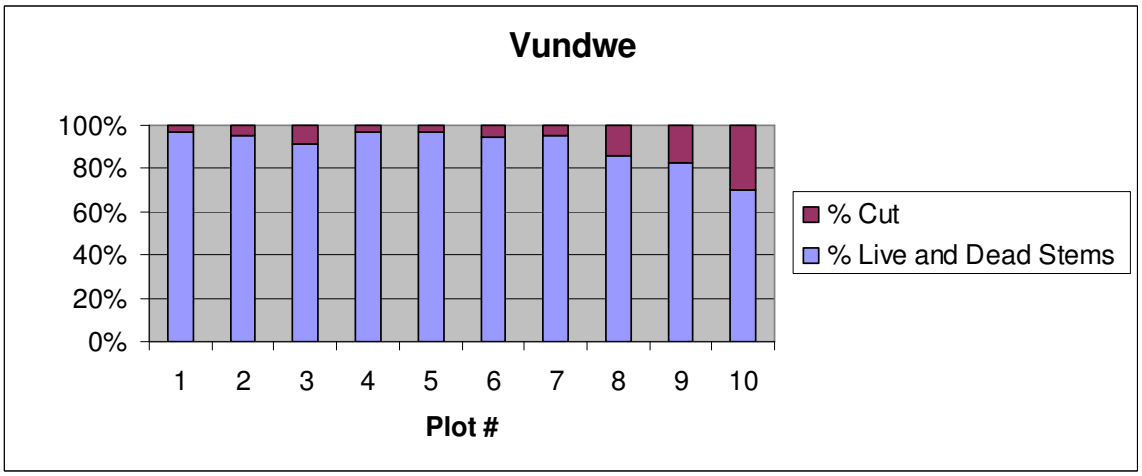
7.4 Graph of most disturbed species with number of live, cut, and burned stems from Mchangamle



7.5 Graph of most disturbed species with number of live, cut, and burned stems from Vundwe



7.6 Percentage of cut, live, and burned stems for each plot in Mchangamle.



7.7 Percentage of cut and live stems for each plot on Vundwe.

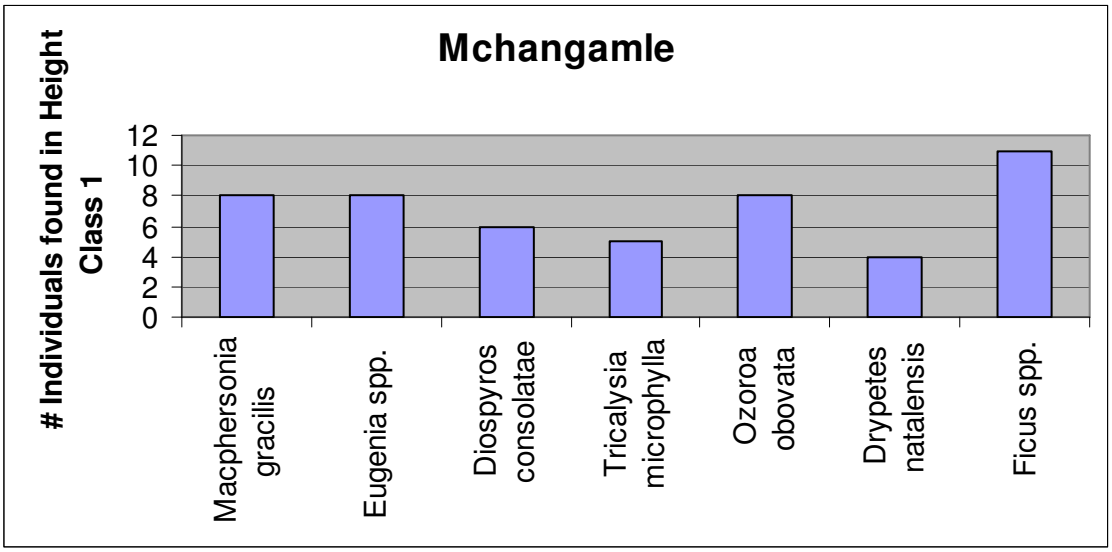
Appendix 8.0

	Mchangamle		Vundwe	
	2005	2009	2005	2009
Shannon-Wiener Diversity Index for Live Stems	2.97	3.13	2.73	2.66
Number of Individuals	2317	955	2067	1566
Number of Species	88	54	52	50
% Cut of Total Stems	12.13%	39.4%*	5.56%	9.70%
# Cut Stems/ha	1992	3116**	928.9	1532

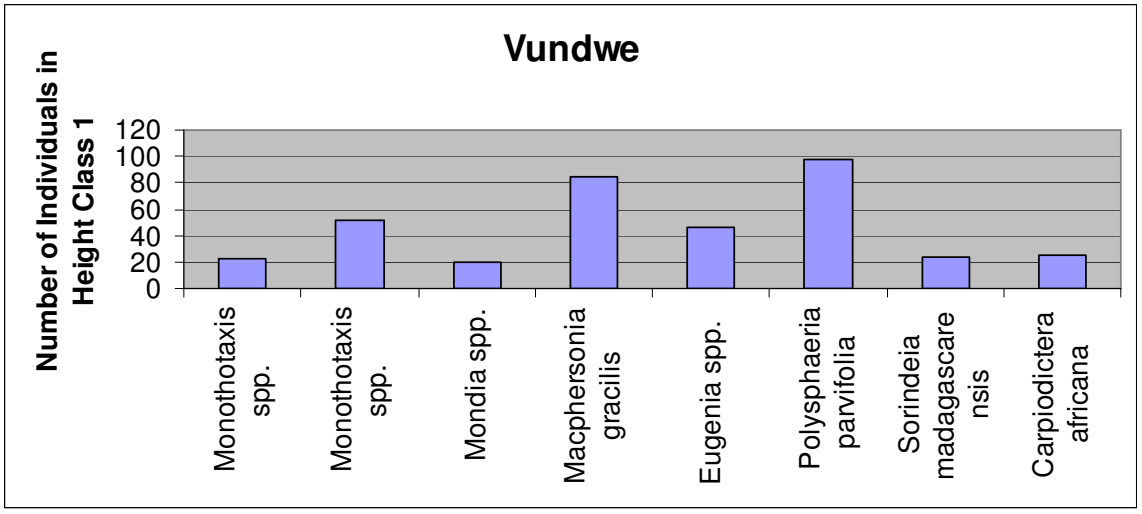
*% Cut/Burned Stems of Total Stems = 58.30%
**# Cut/Burned Stems/ha = 4456

8.1 Table of Shannon-Wiener Diversity Index, number of individuals, number of species, % of total stems cut, and number of cut stems per hectare for 2005 and 2009.

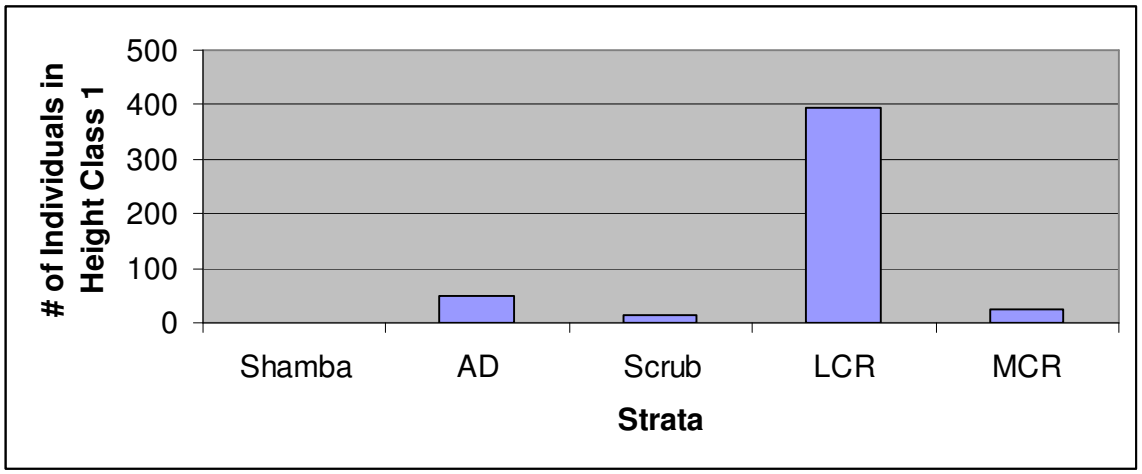
Appendix 9.0



9.1 The species with the highest number of individuals in height class 1 are shown for Mchangamle.

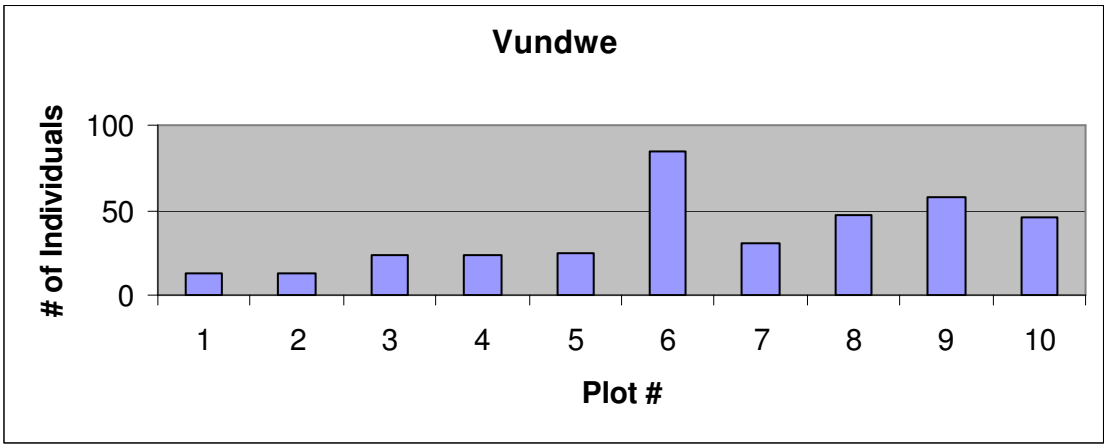


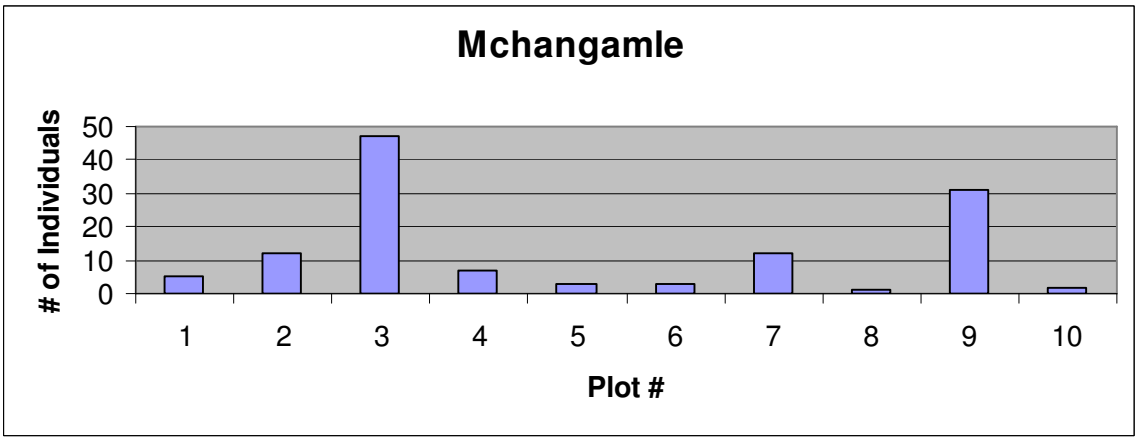
9.2 The species with the highest number of individuals in height class 1 are shown for Vundwe.



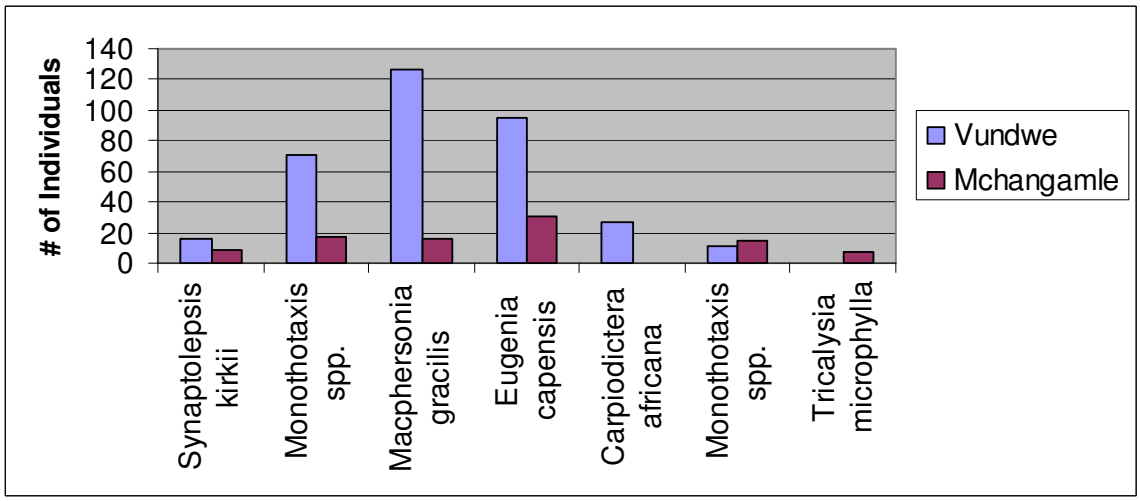
9.3 The total number of individuals found in height class 1 by strata.

Appendix 10.0





10.1 Regeneration subplots: Total number of individuals in 6 one square meter subplots in each plot.

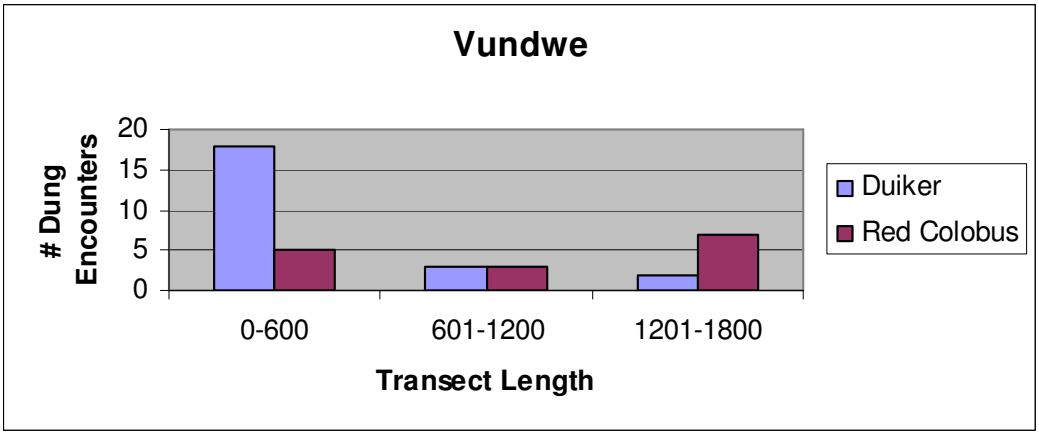


10.2 Regeneration Subplots: Species most represented in all of the subplots in each transect.

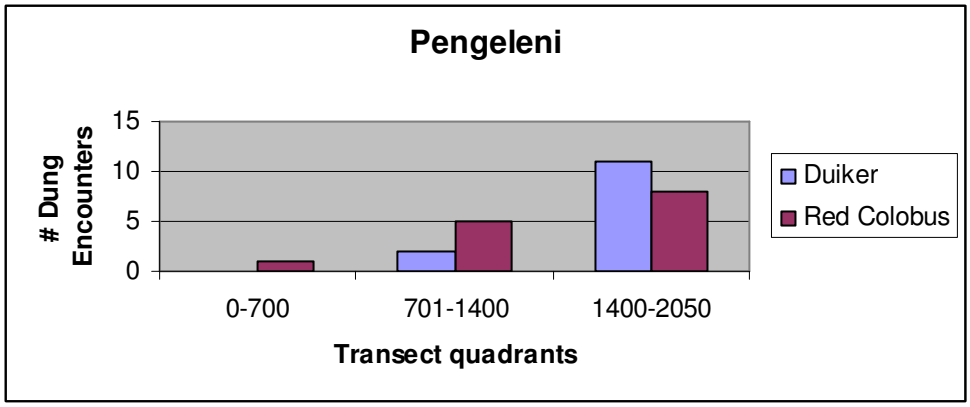
Appendix 11.0

Meters	Species	Dung		Distance from Transect (meters)	
		Fresh	Old	Sight	Sound
480	Ader's Duiker			20	
615	Ader's Duiker		1		
618	Ader's Duiker		1		
642	Ader's Duiker		1		
645	Ader's Duiker		1		
1400	Sykes				80
1620	Ader's Duiker		1		
1800	Sykes				100

10.1 Wildlife encounters in Mchangamle.



10.2 Number of dung encounters on Vundwe transect



10.3 Number of dung encounters on Pengeleni transect

Low Coral Rag

Shamba

Species	**Stems**	**Circumferences**	**Height**	**Status/Notes**

Sample datasheet