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Who Else Would Plant The Trees? A Status Update on the Pemba Flying Fox

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Abstract

This study assesses the current population of Pemba Flying Fox, *Pteropusvoeltzkowi*, at four key locations on Pemba Island off the coast of Tanzania previously noted as highly populated roost sites: Ngezi National Forest, Wete, Kidike, and MsituwaMbiji. We evaluate local knowledge, perceptions, and practices of communities surrounding the Pemba Flying Fox. This study also documents roosting and migratory patterns of the bats. We hypothesize a growth in bat population, an overall positive community perception of the bats, and a greater amount of conflict between fruit farmers and *Pteropusvoeltzkowi*. Results showed a decrease in estimated population. Additionally, reverse correlation was found between mean roost tree height and colony size, and 50% of bats roosting in *Antiaristoxicaria*. MsituwaMbiji had the highest level of habitat disruption while Kidike showed the lowest. All informants had a positive opinion on bats. For all roost sites except Ngezi, all respondents claimed the nearby roost site had been in use for a "long time". All respondents mentioned that bats could be seen every day and every season, although about half of respondents reported seasonal variation. Little evidence of farmer-bat conflict was found, and most respondents claimed that no bat hunting was done in the area. However, physical evidence suggested that hunting was still ongoing. About half of all residents interviewed knew of no ongoing educational efforts concerning the bats.
Evidence suggests that colonies of bats are migrating to protected areas, forming larger colonies in smaller spatial areas with a consistent proportion of available tall trees, forcing bats to occupy smaller roosting trees. However, this could be due to the negligible hunting pressure found in the areas with larger colonies. Deforestation proves a considerable threat to continued conservation of the Pemba Flying Fox. Environmental education and community-based protection organizations based on economic, environmental and intrinsic appreciation of the bats is the key to this species' continued success.

Introduction

What is red, black, and not all over? Pemba Flying Foxes, *Pteropusvoelztkowi*, or "Popo wa Pemba," in Kiswahili, are a unique bat species with an incredible story. Pemba Flying Foxes are one species among the largest class of fruit-eating bats. Being the world's largest bat (with a 70 cm wingspan and weighing up to 600g), they can transport a maximum of 200g of fruit up to 40km in a night (Fitzpatrick 2007). This allows larger fruit stones to travel greater distances than those covered by birds. By pollinating and dispersing the seeds of many trees, Pemba Flying Foxes connect distant gene pools and help ensure the biological diversity of the island of Pemba off the coast of Tanzania, functioning as important players in the structuring of forest communities (Mohd-Azlan 2001). Many members of the scientific community believe fruit bat handling of seeds (both before and after digestion) increases the plants' germination rate by scoring the fruit and depositing the seeds with fertilizer (Djossa 2008). In fact, over 300 species of plants are dependent on the pollination and seed dispersal abilities of Old World fruit bats, like *Pteropusvoeltzkowi* (Djossa et al. 2008). The bats are colonial and highly gregarious, preferring to roost in great numbers in towering trees that support their free fall takeoff into flight (Leary 1998). Anthropogenic and natural habitat disturbance in additionto hunting can be devastating to Pemba Flying Fox populations, as they produce only one to two young each year with high parental investment (Leary 1998). Reports of subsistence hunting of the Pemba Flying Fox are prevalent throughout their history (Robinson et al. 2010, Fitzpatrick 2007, Entwistle 1995). In 1995, it was found that hunting still occurred in the vast majority of roost sites (Fitzpatrick 2007).

Pemba Flying Foxes are the lone endemic mammal species among the 27 mammalian and 13 bat species on the small sub-tropical West Indian Ocean island of Pemba, Zanzibar, Tanzania (Entwhistle 1997). The often island-based genus *Pteropus* tends to be highly endemic, faced with increasing vulnerability as keystone species in many island ecological and economic systems (Robinson et al. 2010). In fact, 27 of the 52 *Pteropus* species are currently listedas threatened populations by the International Union for the Conservation of Nature and Natural Resources(IUCN) (Breed et al. 2010).

The Pemba Flying Fox was first recognized by the scientific community in 1912 when Anderson recorded one roost site on the Western side of the Island (Entwistle 1997, Robinson et al. 2010). This study was followed by numerous reports in the 1940s and again in 1989 when the species was feared to be close to extinction, asfewer than 10 individuals were found (Entwistle 1997, Robinson et al. 2010). In 1992, population surveys suggested a less dire situation- an estimated 2,400-3,600 individuals- although the population had most likely severely declined since the 1980s (Entwistle 1997, Robinson et al 2010). Conservation efforts began on the Island the same year, focusing on school centered environmental education and emphasizing the Flying Foxes' key ecological role (Robinson et al. 2010). In 1994, the Phoenix Zoo in Arizona started a captive breeding program to help ensure the longevity of the species (Entwistle 1997). A refurbished Pemban educational campaign was launched in 1995 and by 1996 the IUCN had listed Pemba Flying Foxes as critically endangered (Robinson et al. 2010).In 1998, a student from School for International Training (SIT), distributed educational materials to schools surrounding some areas of high Flying Fox inhabitation (Leary 1998). Since 1997, the Pemba Department of Commercial Crops, Fruit, and Forestry has continued to raise public awareness about the endemic species through community seminars, educational promotions, and support for

community based environmental projects (Entwistle 2001). Indeed, it is often argued that the most successful outcome from Pemba Flying Fox conservation project was the establishment and support for grassroots environmental clubs in several villages surrounding roost sites, which now act as legal and social guardians against anthropogenic threats (Entwistle 2001).

A 2005 population survey yielded an estimated 6,900 bats and the Pemba Flying Fox was re-listed as a vulnerable species by the IUCN and CITIES Appendix II (Robinson et al. 2010). The latest population survey yielded a population of between 18,200 and 22,100- a 400% increase since the 1995 survey (Robinson et al. 2010).

In the face of the dramatic recovery these studies demonstrate for the Pemba Flying Fox, continued population monitoring and surveys of public perception are increasingly necessary. These studies provide the best information for government planning in continued support of conservation and show the species use of the landscape with respect to resource distribution among all island residents, including both people and bats (McClelland 2009). As the population of Pemba Flying Foxes continues to rise, sustained assessment allows conservation plans and viability analyses to evolve effectively with the changing condition of the species (Mohd-Azlan et al. 2001). This avoids the quandary of many threatened populations of Old World fruit bats, whose continued conservation is often thwarted by a lack of current data (Mohd-Azlan et al. 2001).

It is particularly important to understand changing public opinions on growing populations. For instance, the conservation efforts of the Australian Grey-Headed Flying Foxare currently hindered due to their public perception as an agricultural pest (McClelland 2009). Additionally, surveys monitoring roosting patterns and preferences, as well as human disturbance at roost sites, are integral to effective Flying Fox conservation. *Pteropus* depend

heavily on the benefits provided by roosting trees, such as "better mating opportunities; improved maternal care; increased social interactions and information transfer; cheaper thermoregulation; reduced commuting costs to foraging sites; and protection from adverse weather and predators" (Altringham 1996, Kunz 1982, Gosselin 1998). However, one of the greatest threats currently facing Old World fruit bats is deforestation and habitat loss due to agricultural development, which is especially pertinent considering Pemba's agriculturally based,high and rapidly increasing population**(**c. 501 km^{-2}) (Gumal 2003, Robinson et al. 2010). Few areas of primary forest remain on the island, and secondary forests are rapidly diminishing. Past studies suggest that human disturbance, especially hunting, in close proximity to roosts is a leading cause for colony site abandonment, further decreasing available bat habitat (Gumal 2003).

This study aims to assess the current population of Pemba Flying Fox at four key locations, which is then used to extrapolate the total population size based on previous studies. We would also like to add to the database of knowledge surrounding Pemba Flying Fox roosting habits and preferences, as well as to note evidence of human disturbance surrounding key roost sites. Additionally, this studywas done to evaluate local knowledge, perceptions, opinions, and practices of communities surrounding the Pemba Flying Fox, in addition to collecting anecdotal evidence of migratory roosting patterns. It is hypothesized that the bat population has continued to increase since the last survey performed on the island (Robinson et al. 2010), although roosting habitats may be increasingly subject to anthropogenic forest modification. It is predicted that overall positive community perception of the bats, although it is also foreseen that a greater amount of conflict between fruit farmers and *Pteropusvoeltzkowi*.

Study Area

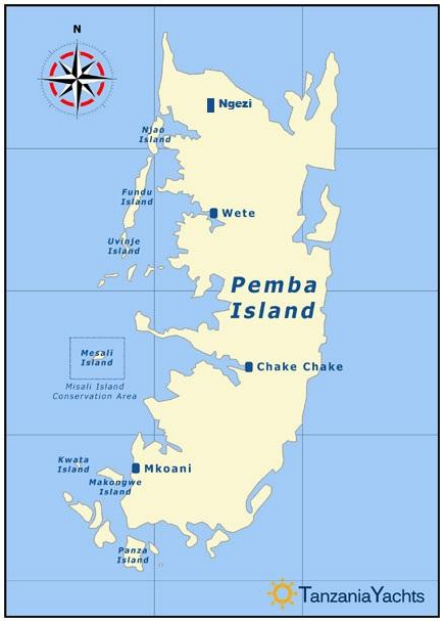
Pemba is a continental island 50km off the coast of mainland Tanzania, one of two major islands composing the Zanzibar Archipelago (Gosselin 1998). Its 980km^2 area is dominated by heavily vegetated ridges and valleys in the west and baobab, palm lands and coastal bush in the flatter west (Entwistle 1992). Two areas of primary forest still exist on the island (Negzi Forest Reserve and MsituMkuu community forest), though much of the Island features former clove plantations that have been overgrown by secondary forest. However, this regrowth is under severe threat from agricultural development, deforestation, and other anthropogenic pressures.

This study focuses on four sites throughout Pemba noted in previous studies as highly populated roost areas containing roughly 87% of Pemba Flying Fox population (figure 1, Robinson 2010). Ngezi National Forest Reserve is located in the far north-west of the Island. It is the largest conserved primary forest on Pemba and is cited as a biodiversity hotspot (Conservation International**)**. Although the reserve features a variety of vegetative types, roost site explorations were only conducted in the moist forest. This forest is composed of many large trees with heavy underbrush, situated in both flat and hilly areas. Interviews for this study site were held in the villages with the closest proximity to reported roost sites: KiuyuKibatini, KiuyuKipangani, and Mtondone.

Wete is one of the largest cities in Pemba (27,000 residents), located in the central north-west (zanzinet.org). It is also home to one of the island's largest and busiest ports. Immediately adjacent to this heavily trafficked area is the home to one of the largest reported permanent roosts on the island. Intermittent, isolated stands of trees exist throughout and around the city, although no major forests exist. These trees are primarily located on two steep ridges of a hill. Interviews were conducted in the space immediately surrounding the roost, and in outlying areas of Wete.

Kidike is located on the central east portion of the island, 10 km from ChakeChake, the unofficial capital of Pemba (zanzinet.org). However, the closest paved road is about 1 km away. The roost neighbors the village of Mjini Ole, with a population of about 2,000 (Fitzpatrick 2007). Kidike was established as a haven for the Pemba Flying Fox by the Kidike Environmental Conservation Club in 1992 (Clabby 2010). The Conservation Club is supported by and consists of 95 local community members (Clabby 2010). Reportedly the largest roost in Pemba, Kidike draws about 15 guests from all over the world for ecotourism events each month (Clabby 2010).The forest is flat, with isolated tall trees and thick underbrush, through which extends a cleared nature trail. Interviews were conducted in Mjini Ole.

Finally, MsituwaMbijiis located on the far southern coast of Pemba, 2.5km from the city of Mkoani. It is supported by the Shehia of Changaweni, which has a population of 1,882 residents (Muhammed 2012). The forest is part of a fledgling nature preserve started by the community in 2011 (Juma 2012). Villagers continue to farm cassava and clove cash crops, as well as process clove oil, in the area immediately surrounding the forest, but the nature preserve is a "no-take" zone, forbidding hunting and wood-harvesting at the risk of a cash fine (Juma 2012). The nature preserve area (about $4km^2$) is patrolled twice a week by a group of six community members (Juma 2012). The forest is primarily situated on many steep ridges, featuring many tall trees with thick underbrush. Interviews were conducted in the village of Changaweni.



http://www.tanzaniayachts.com/maps.shtml

Figure 1. This map shows the island of Pemba, located within the Zanzibar archipelago, off the coast of Tanzania and the four focus study sites located therein.

Methods

This study's methodology focuses on semi-structured interviews of locals and first hand roost observations. Both knowledgeable local contacts and roost sites were secured by word of mouth and previous studies. Field data and interviews were conducted for four days at each study site, from November 5-24, 2012.

Selected local residents in areas surrounding roosts were asked about past and current roosts, migratory patterns, and human activity in the area, as well as the presence of other bats or fruit farms in the vicinity, farmer conflicts, hunting and education. Though researchers prepared questions, informants were encouraged to elaborate and share the history of nearby roosts. Questionnaires were prepared in English and translated into Kiswahili, which was then edited with the help of S.I.T. faculty and staff, and subsequently again in the field (See Appendix A). At

some of the roost sites, interpreters were used (Ngezi, Kidike, and MsituwaMbiji). Multi-response questions were compiled by percent response with respect to all responses.

Roost observations were carried out by two researchers over four days at each site. At some sites, researchers were accompanied by guides (Ngezi, Kidike, and MsituwaMbiji). Roost density was calculated following observation and bat counting methods described in previous studies (Gosselin 1998, Robinson 2010). In areas of high visibility, direct observation was used. Low visibility root density was calculated by counting one patch of bats, which was then used to estimate the total density based on relative area and visible distribution patterns. Both researchers counted each roost and the average of the two totals was used. . Where discrepancies arose, roosts were recounted. At Kidike, the first colony population count was multiplied by two, since only half the roost was shown to researchers on that count day.

The roost tree species and height estimates were noted where possible. When on-site identification was not possible, pictures and leaf samples were used to identify the tree at a later date.Habitat disruption was graded at each site based on physical habitat disturbance (distance from nearby human settlements and farming, evidence of hunting, woodcutting, and charcoal making) and level of bat agitation in response to human activity, both of which were later averaged together for total habitat disruption.Total population estimates were then extrapolated based on a previous population study of the Pemba Flying Foxes by Janine Robinson to estimate total population. Regression analysis was used to test correlation between colony size and habitat disturbance, as well as colony size and tree height.

Results

Roost Observation Results

The total estimate of *Pteropusvoelztkowi* found ranged from 8,143 to 9,248 bats. The counts at each location varied greatly between observation days. The greatest number of bats was found at the Kidike roost, followed by the Wete roost, and then MsituwaMbiji and Ngezi National Forest roost sites (figure 2). When extrapolated based on Robinson et al. (2010) data, we estimate the total population of Pemba Flying Fox to be between 9,360 and10,630.

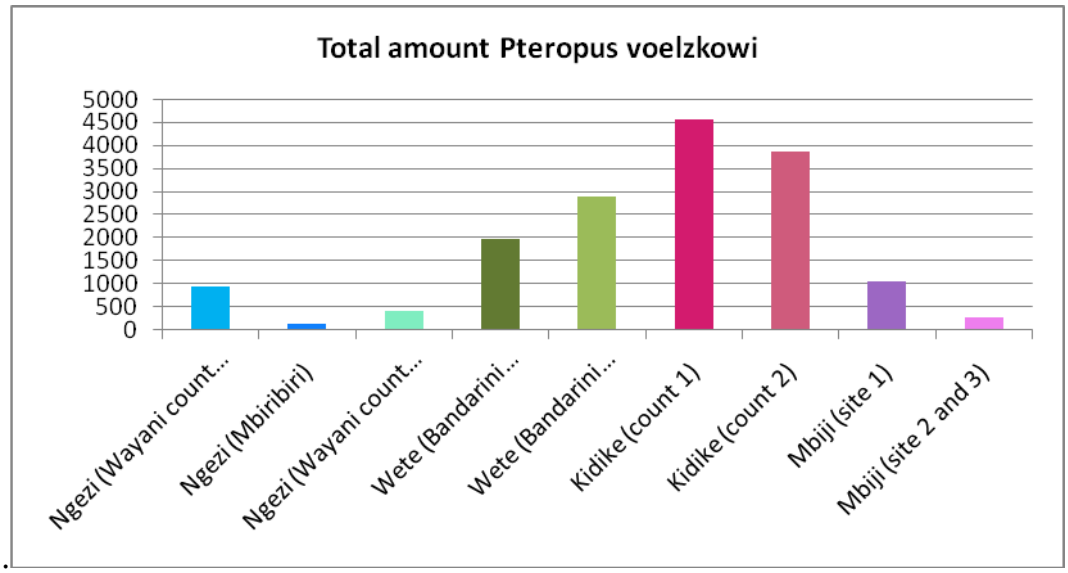


Figure 2. This graph shows the varying colony counts over all study sites and roosts during all counts. Data was collected on Pemba, Zanzibar, Tanzania November 5-24,2012.

The mean height of roost trees over all sites was 21.49m. Tree heights ranged from 8m to 30m. The Wete site had the lowest mean tree height (15.86m), while the second Mbiji site displayed the highest (27.23m). There was a fair correlation between roost site mean tree height and colony size (R^2= 0.38, figure 3), which showed larger congregations of bats associated with smaller roosting trees. Ngezi roost site tree heights were excluded from all calculations due to low visibility and on-site estimation bias.

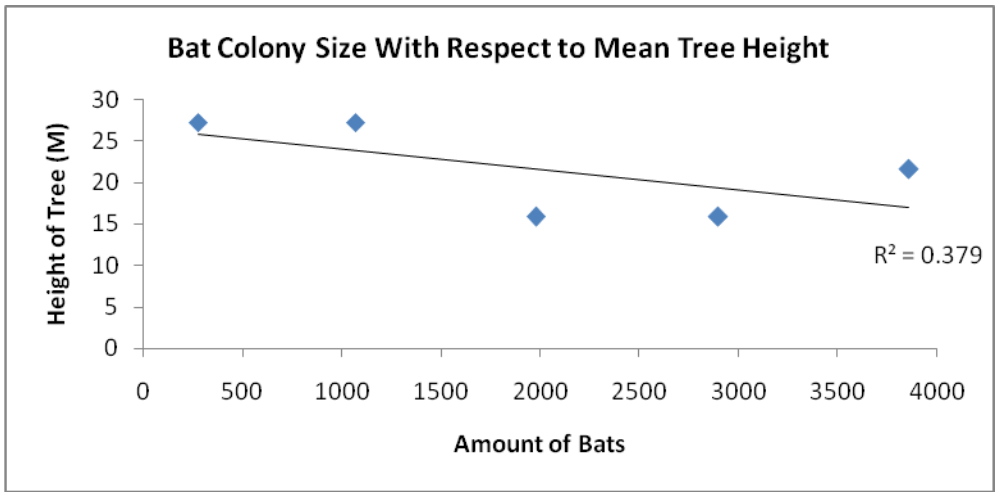


Figure 3.The graph shows the relationship between Pemba Flying Fox colony size and mean roosting tree height over all study sites, roosting areas and counts. This shows a fairly strong negative correlation between the two variables (R^2=0.3796). Data was collected on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

Antiaristoxicaria was, by far the most prevalent roost tree species (56%) when considering all study sites (figure 4). *Uapacaguineensis*and *Brideliamicrantha*were the next most common roost tree species (14% and 5%, respectively). *Antiaristoxicaria* was also the most common roost tree species at all Ngezi roost sites (50%, of 14 trees) and Kidike (98%, of 56 trees). At the Wete roosting site, *Mangiferindica*and *Terminaliacatappa*were the most utilized tree species (both 29% of 14 trees). In contrast, *Uapacaguineensis*and *Brideliamicrantha*was the most abundant roost tree species at all MsituwaMbiji roost sites (54%, of 30) (Appendix C, figures 13-16).

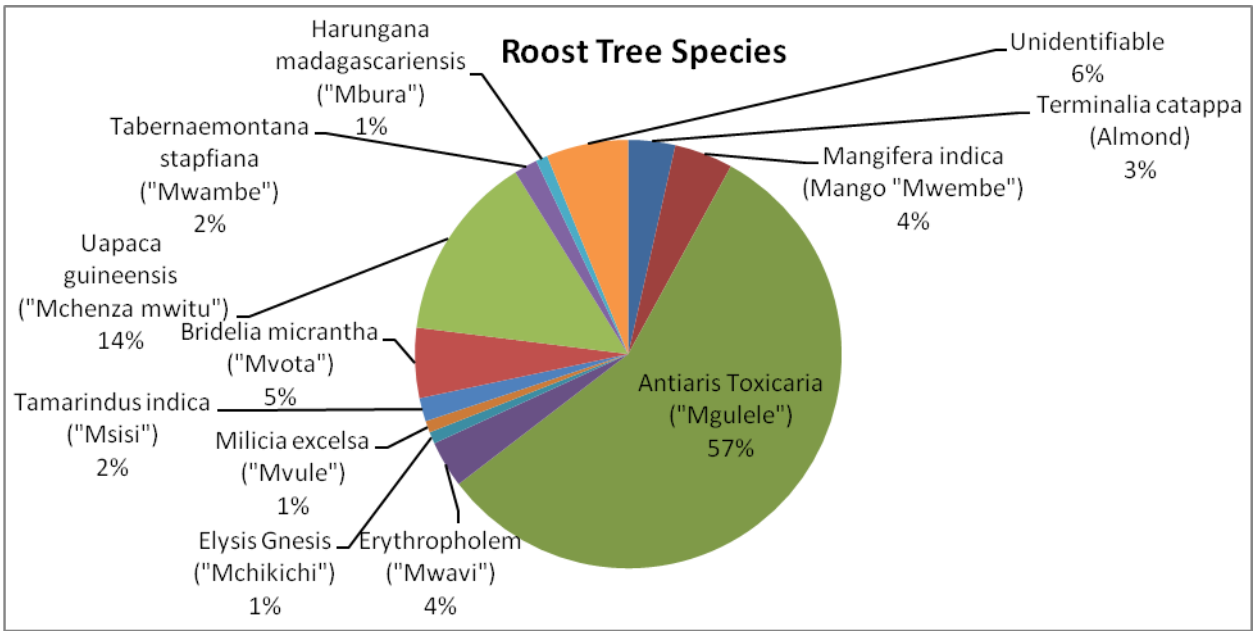


Figure 4. This figure shows the common roost tree species over all four study sites. Data was collected on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

The highest level of physical habitat disruption was at the Wete Port roost site. It is immediately adjacent to one of the main ports of Pemba and a large road bisects the roost. Both the port and road are subject to heavy traffic. Additionally, many people live close to the roost site and farm between the roost trees. However, no evidence of hunting was found at the roost. The Kidike roost showed the lowest level of physical habitat disruption, with no signs of hunting, woodcutting, or charcoal burning, although farming was practiced along the periphery of the roost. Wete and Kidike showed very little bat agitation. Ngezi bats were moderately flighty, whereas bats from Mbiji roosting sites took flight almost immediately upon approach. Mbiji roost sites were designated with the highest levels of habitat disruption, while Kidike was by far the lowest. Ngezi and Wete were moderately disrupted (figure 5). When colony population was graphed with respect to habitat disruption, little correlation was found (R^2=0.04, see figure 6).

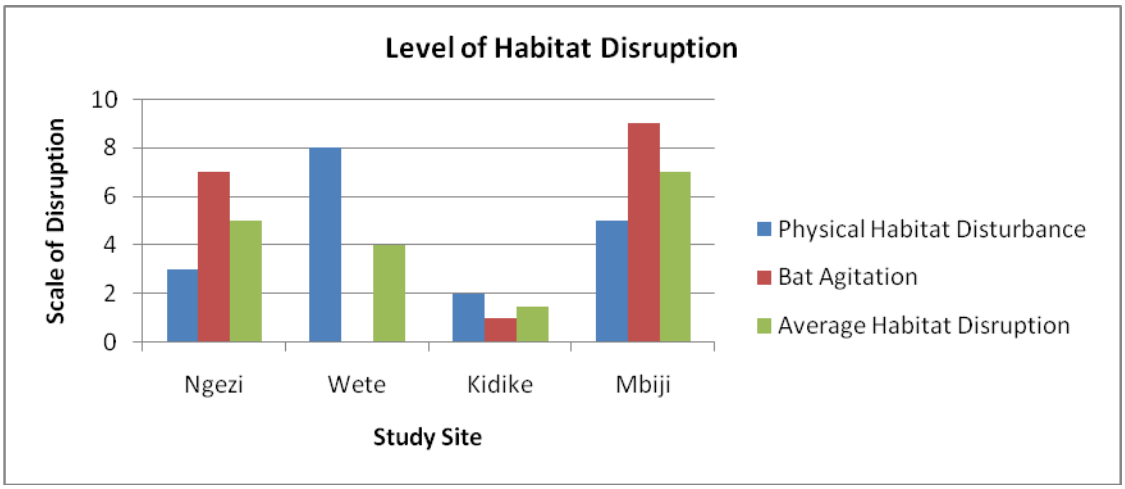


Figure 5.This figure shows the level of habitat disruption at each of the four study sites. Data was collected on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

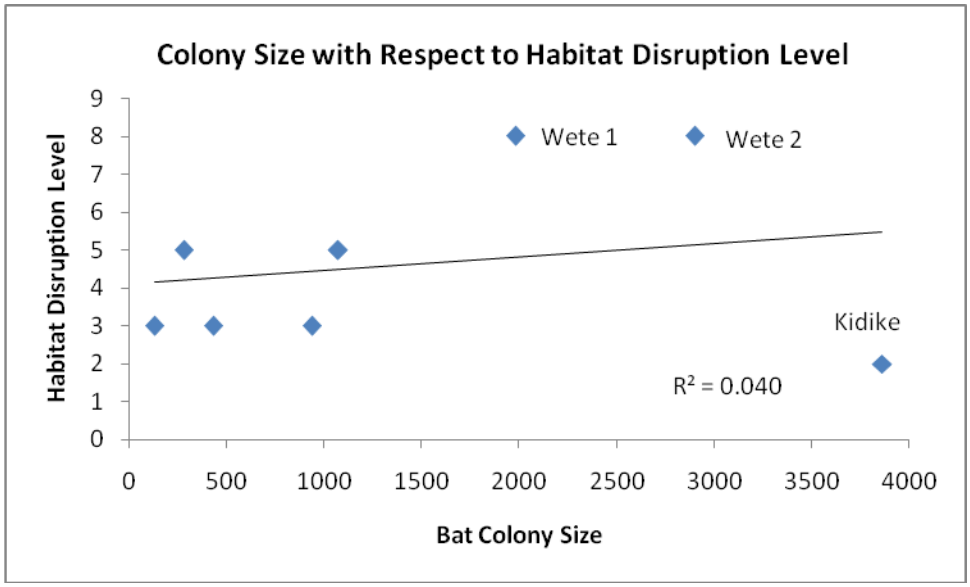


Figure 6. This figure shows the correlation between habitat disruption level and colony population size at each of the four study sites during each of the counts. Data was collected on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

Interview Results

For all roost sites except Ngezi, all respondents claimed the nearby roost site had been in use for a "long time," often adding that it had been occupied for "many years." One informant in Mtondone, nearby the Ngezi roosts, claimed that the bats had only been in residence for a short

amount of time. OneNgezirespondent, a ranger for the National Forest, mentioned that they were seen in different places around the same area because they moved roosts when disturbed. All other interviewees said that the bats could be seen at the specified roost sites every day and every season. However, seasonal variation was not noted by 47% of respondents: 22% said there were more bats in the heavy rains (*masika*) season and 15% claimed to see more bats during the light rain (*vuli*) season. Other interviewees mentioned seasonal population fluctuation based on hot and cold seasons, birthing times, and fruit abundance in the area (figure 7).

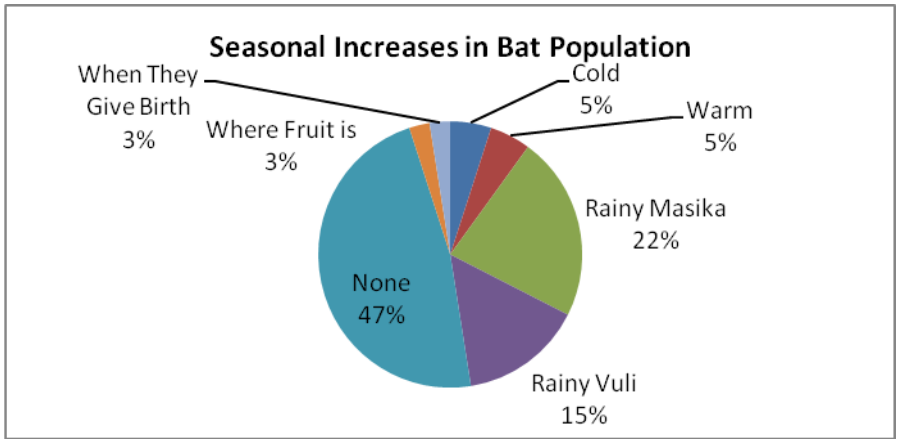


Figure 7. This figure shows the reported population increases of the Pemba Flying Fox at each of the four roost sites. Interviews were performed on Pemba island, Zanzibar, Tanzania, November 5-24, 2012.

However, these patterns varied drastically by geographical location. At Ngezi and Kidike, the majority (90% and 80%, respectively) saw no seasonal variation, while the dissenting minority (10%and 20%) saw an increase in bat population during the *masika* season. In Wete, 86% of respondents saw seasonal fluctuation in bat population, with an increase due to temperature (29% saw an increase in the cold season and 29% in hot season), local fruit abundance (14%) and "when they give birth" (14%). Similarly, 92% of Mbiji interviewees mentioned seasonal population variation. This percentage was evenly split between residents who saw an increase during the *masika*and *vuli*seasons (see Appendix D, figures 17-20).

All respondents at all sites stated an overall population increase of Pemba Flying Fox. When questioned about knowledge of local abandoned roosts, 54% of all respondents said they knew of one or more site(s) which were no longer inhabited. Reasons given by these interviewees for the movement included colonies moving to protected sites (23%), hunting (10%), and deforestation (5%). Thirty-one percent of all informants were sure that roosts in the area had not been abandoned (see figure 8).

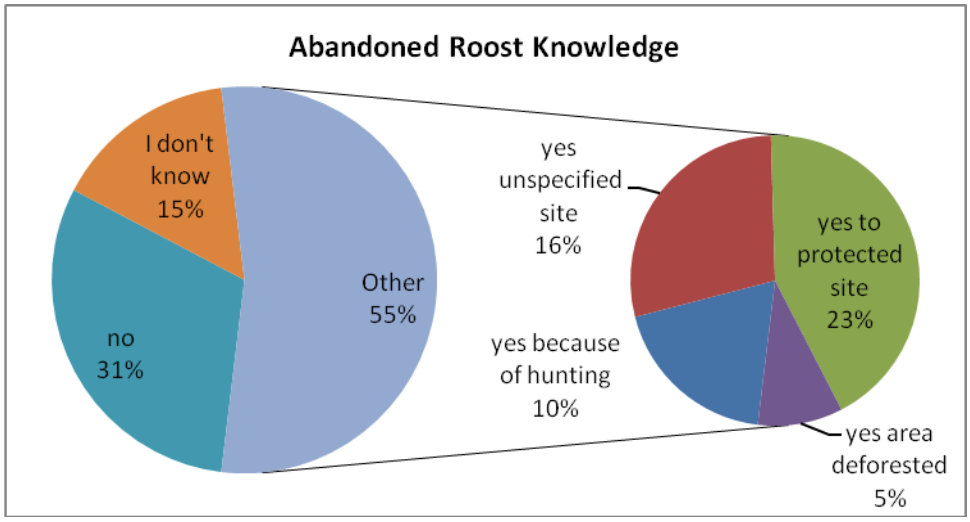


Figure 8. This figure shows the interviewees responses from all four roost sites when asked if they knew of any abandoned roosts in the area. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

At theWete and Mbiji sites, the vast majority of respondents mentioned frequent nearby roost abandonment (83% and 90%, respectively). However, at Kidike, 77% of interviewees claimed that there was no evidence of roost movement in the area. Most Ngezi informants had no opinion on roost movements (60%, see Appendix E, figures 21-24).

Based on anecdotal evidence and observations, researchers found that there was a large amount of fruit farming in the area, but that most trees were inter-planted within forests and farms. No evidence of fruit cash crops or intensive farming was found. When asked if farmers chased bats away from their fruit trees or otherwise attempted to protect their crops, only 9% of

respondents said farmers attempted to, while 56% of interviewees said it was impossible (see figure 9). According to informants at theMbiji and Kidike roosts, no farmers in the area attempt to protect their fruit crops from bats. However, 20% of Wete respondents claimed farmers often used lethal methods to chase bats away, and 18% of Ngezi respondents said area farmers protected their crops (9% using lethal methods and 9% using non-lethal methods, see Appendix F, figures 25-28). Lethal protection measures were most often sling shots, shot guns and sharpened sticks, while various types of noise makers were used by local farmers as non-lethal crop defense.

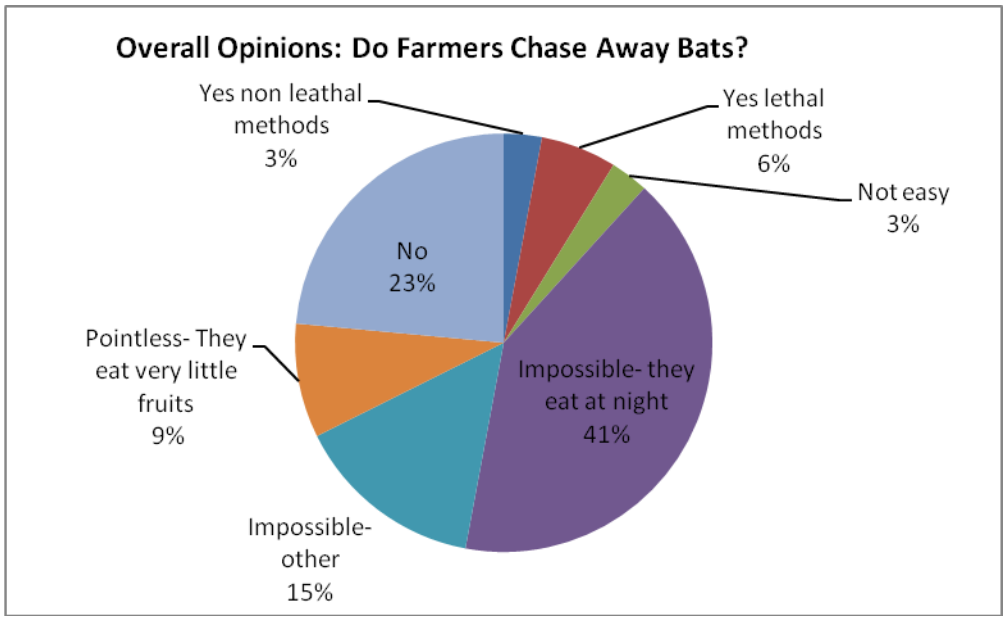


Figure 9. This figure shows the responses of interviewees from all four sites when asked whether or not fruit farmers chased away fruit eating bats. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

Most respondents (78%) claimed bats were not hunted. However, 69% mentioned that hunting was common in the past. Many said the change was due to the protection offered by bats' roosting areas (community forests, nature preserves and close proximity to government offices). Of the remaining respondents, 13% said that they were still hunted (see figure 10). In Mbiji and Kidike, the two community protected areas, the majority of interviewees said that bats

were no longer hunted, although they had been in the past (100% and 80%, respectively, see Appendix G, figures 29-31). However, there was much anecdotal evidence given by passers-by at study sites and at other points during interviews that bats were still eaten. Often, subjects made allusions to how delicious the bats are, or having hunted bats when they were younger.

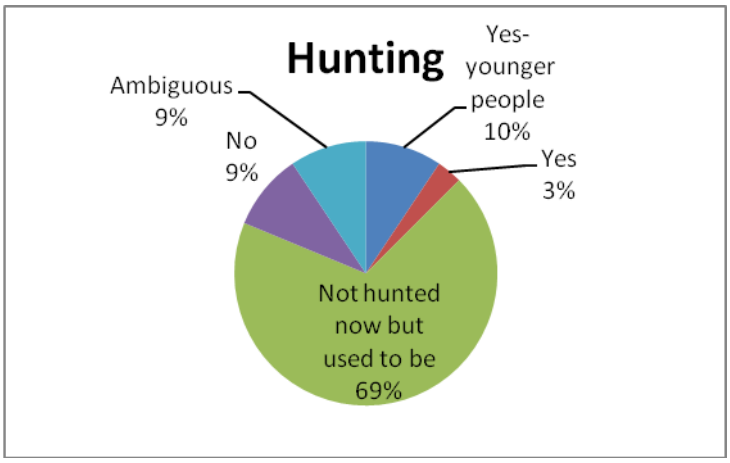


Figure 10. This figure shows the interviewees from all four sites responses when questioned about the presence or absence of hunting in the area. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

When asked their opinion on Flying Foxes, all respondents answered positively. The most common reason given was seed dispersal, including both economic benefits reaped by the community (22%) and forest regeneration (48%). Other explanations behind favorable outlooks were tourism (13%), a sense of pride felt for an endemic species (9%), and edibility (4%) (seeAppendix H, figure 32-35). Seed dispersal for environmental benefits was the most prevalent response in all study sites (34-67%). Kidike was the only site at which economic benefits of seed dispersal were not mentioned. Additionally, Mbiji was the only site at which tourism was not a factor, while all areas mentioned it at a frequency of 17% or higher (figure 11).

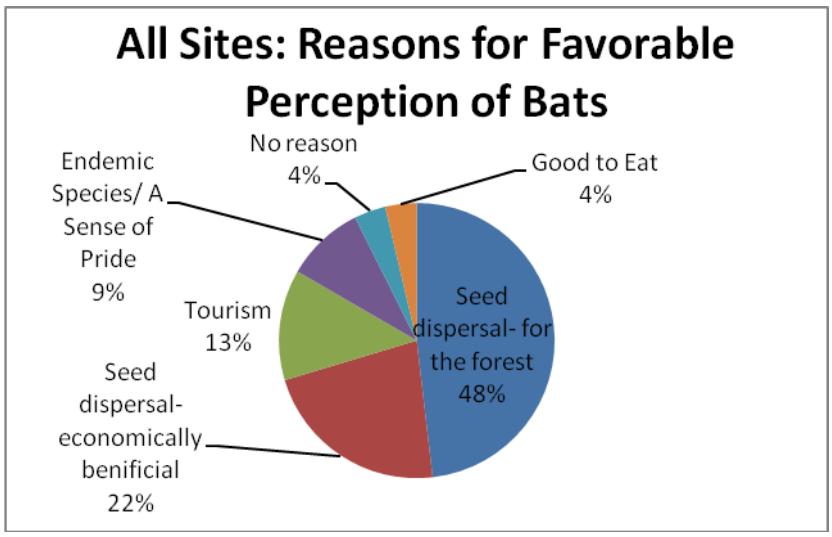


Figure 11. This figure shows the interviewees from all four sites responses when asked about the reasons behind their favorable opinion of the bats. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

Considering all study sites, 52% of respondents knew of no conservation education concerning Pemba Flying Foxes. About half of both Ngezi and Wete respondents knew of community education about the bats (50% and 60%). However, education around Ngezi depended largely on word of mouth (33%), while Wete residents received information through the Department of Forestry (40%). At Kidike, all informants mentioned some form of education, typically administered by the Kidike Environmental Conservation Club (87%). In contrast, no Mbiji interviewees knew of any Pemba Flying Fox conservation education in the area.

Discussion

It was interesting to note that larger bat colonies were associated with a smaller mean roost tree height. Many respondents noted that colonies from the area had abandoned historic roost sites and joined together in the protected, large roost sites in which thesurveys took place. The topic of deforestation and the rapidly diminishing number of large trees was also brought up repeatedly in interviews. These factors supported the theorythat the bats are congregating to form

larger colonies in smaller spatial areas with a consistent proportion of available tall trees, forcing bats to occupy smaller roosting trees.

One informant, a local Pemba Flying Fox conservation activist, emphatically stated that deforestation is currently the biggest threat to the Flying Foxes, due to the recent introduction of chainsaws to the island. Another contributor mentioned that chainsaw permits were currently required by the local government, although he questioned the effectiveness of their monitoring and enforcement program. This is especially pertinent considering that *Antiaristoxicaria, Uapacaguineensis,*and *Brideliamicrantha*,the three of the most prominent roost tree species, are used for timber, poles, and fuel wood (United Republic of Tanzania Ministry of Natural Resources and Tourism 2010).

The most recent study including roosting tree height of Pemba Flying Foxes found a similar but slightly larger mean roosting tree height (32.53m±0.85), which may suggest an overall decrease in available tall trees with a growing number of bats (Robinson et al. 2010). This trend may be detrimental to the continued recovery of this species, as favorable roosting conditions are crucial for bat population well-being.

Past behavioral research suggests that, among other advantages, larger roosting trees provide protection from predators (Gumal 2003). This lead to a second possible conclusion: perhaps this resource is not as vital for the "short tree colonies." Perhaps the same factor encouraging roost growth negates the need for tall roost trees: a lack of predators. The Wete and Kidike colonies are under negligible hunting pressure. Little evidence of hunting was found in these areas, compared to Ngezi and MsituwaMbiji. Roost-site hunting techniques typically favor slingshots and sharpened sticks, used to knock down and injure sleeping bats. This would enforce a small, flighty colony, tall-tree roosting pattern under hunting pressure.

Additionally, the Weteand Kidike colonies showed little response to nearby human activity, while the Ngezi and MsituwaMbiji colonies were far flightier. The Wete colony in particular, is subject to human traffic and habitat disruption, but the bats are nearly impossible to disturb. Almost all Wete respondents mentioned the difficulty of hunting in such close proximity to a police building, government ministries, and a naval station.

At Ngezi and MsituwaMbiji, bats were particularly alarmed by the smell of cigarette smoke and the presence of dogs, both of which may be associated with hunting. While half of Ngezi respondents acknowledged the presence of hunting, it is interesting to note that no MsituwaMbiji respondents recognized its practice in the area. However, a sharpened stick was found at an abandoned Ngezi roost and children bearing sling shots and sharpened sticks were seen walking toward the MsituwaMbiji community forest during interviews. A monkey hunting party was also encountered on community forest land during data collection.

The latter two colonies were far more likely to have moved roost location when revisited at a later date. At Ngezi, although guides and locals knew of four or five colonies within the forests, only two could be located. Out of the seven known roosting areas visited in Ngezi, only two had not been abandoned. At MsituwaMbiji, guides and locals knew of one large colony that moved roost locations and split and rejoined daily.Respondents most often cited hunting as the primary reason for roost abandonment and roosting pattern unpredictability.

Additionally, instead of the expected strong correlation to overall habitat disruption, colony population size seems to be much more dependent on “flightiness” and evidence of hunting pressure than physical habitat destruction. This leads to a secondary conclusion to a lower mean roost tree height. Although the Wete roost has very high average habitat disruption, the colony is one of the largest counted. In contrast, Ngezi and MsituwaMbiji have relatively low

habitat disruption and small colony counts. Though their physical habitat remains more intact, with more available tall trees, these colonies do not have nearly the numbers of those with high levels of environmental changes and low reactivity to human prescence.

It is striking that while Ngezi and MsituwaMbiji bats shared so many behavioral and habitat characteristics that point toward hunting pressure, informants from both Kidike and MsituwaMbiji(the two community protected areas) overwhelmingly responded negatively when asked about hunting. The perception of the forest by the surrounding communities is at the roost of eachof these inconsistencies. At Ngezi, residents may feel that they have minimal power over the management of a forest which was historically available for resource extraction. There is little engagement of the community and few, if any benefits are reaped by its preservation. Instead, the incentives to continue forest usage are strongly felt, and little enforcement is feared.

In contrast, MsituwaMbiji and Kidike are both community originated and managed. Both of these initiatives obviously carry a great amount of pride for their respective communities. However, while the impetus to conserve exists in both MsituwaMbiji and Kidike, it does not yet live up to its full potential at former. It should not be ignored that MsituwaMbiji is a very new community protected area, and Kidike has been operating for twenty years. Nonetheless, intrinsic value for the bats' conservation is not enough to initially commit a group of people to their protection. MsituwaMbiji lacks the incentive for conservation found at Kidike: ecotourism.

MsituwaMbiji was the only study site at which ecotourism and the revenue created by guests was not mentioned in support of the bats' positive image. In fact, residents in the community surrounding the nature preserve mentioned that the researchers were the first foreign visitors to come to the forest. However, at Mjini Ole, funds from Kidike are used in community development projects, such as installing electricity in the town mosque. As a result, "the

conservation of this bat instills a sense of pride and progress in the people […T]hey understand the soci-economic and natural importance to the bat and the surrounding mangrove forest" (Clabby 2010). Tourism provides economic incentive for bat conservation; preserving bats to preserve revenue. When community members are able to see the benefits from the bats through tourism, they begin to feel like stakeholders in the bats' protection. This may explain the discrepancies between the evidence for hunting found at MsituwaMbiji and the responses given by community members. Although there is a sense of pride felt by some members at the existence of the nature preserve, not all residents are completely engaged in the bats' protection.

A secondary effect of the presence of ecotourism is an elevated awareness of the bats and increased conservation and environmental education. To this extent, it is significant that 100% of Kidike respondents replied affirmatively when asked about the presence of conservation education. In contrast, Changaweni residents all answered negatively to the same question. The vast majority of the education within Mjini Ole seems to come from Kidike and the KECC. Residents in areas surrounding the Wete and Ngezi roosts received moderate amounts of education through word of mouth, community meetings, and information disseminated by the government. Both of these locations also seemed moderately aware of the bats' ability to being in revenue through tourism.

While community-centric conservation efforts and ecotourism ventures do encourage community members to actively engage in a more united front of conservation, it does not yield an intrinsic appreciation for the bats' singular ecological niche. This comes as a corollary to increased environmental education, as residents begin to fully understand the Pemba Flying Foxes' unique and undeniably crucial role in their environment. We can see the effects of this education beginning to take hold in Ngezi and Wete. However, Kidike's longevity makes it

possible to understand long-term effects of established bat conservation education programs. Respondents were able to explain their favorable opinions of the bats in terms of ecological benefits in a far more detailed manner and were obviously very proud of their bats.

Such knowledge of the bats' environmental niche helped to produce a positive public image of the species. This, in tandem with the manner of fruit farming on Pemba, led to a negligible amount of conflict between Pemba Flying Foxes and farmers. Respondents seemed to be well educated on the subject of the foxes' role as seed dispersers and see them as benefactors rather than pests and claimed that farmers did not attempt to dissuade the bats from eating their crops. One interviewee asked, "Who else would plant the trees in the forest?" In addition to gratefully acknowledging the fruit trees that were "planted" by the bats, many respondents noted that bats only eat fruit that is too ripe for human consumption or sale, that they only eat small amounts from each place, and that the bats' feeding pattern is migratory, depending on food availability. This information is corroborated by Parry-Jones et al., who conclude that Old World fruit bats migrate primarily due to fruit seasonality and display frugal eating habits in large colonies (2001). This is especially interesting considering that many respondents reported no seasonal variation of roost occupation, which may be due to the large feeding range of the bats on the small island of Pemba. Many bats most likely do not need to change roosts in order to follow fresh fruit. The respondents reporting more bats during the rainy season may be observing smaller scale feeding migration or colony roost movements.

Past studies (Robinson 2010, Entwistle 1997, Fitzpatrick 2007) have expressed concern about the rising number of Pemba Flying Fox on a small island with a consistent number of farms and the possibility of ensuing conflict. However, a decreased proportion of respondents saw conflict between bats and growers (Robinson found 52% of growers dissuaded bats from

crop trees) even though a continued increase in the Flying Fox population is supported by all responses from interviewees in this study (Robinson et al 2010).

However, the population estimates determined from the counts do not support this claim. The latest study of the same nature found a 440% increase in population in the past 15 years, with an estimated 2010 population of about 22,100 (Robinson 2010).This study shows a population decrease by more than half. These discrepancies are most likely due to researcher inexperience, low visibility, methodology limitations, and the duration of our study.Additionally, the estimates of colony population counts made on subsequent days could be due to smaller colonies joining and breaking away from larger colonies in the roosting sites. Anecdotal evidence strongly supports an increase in bat population on the island. All respondents noted that the focus roost sites had been in residence for a long time and had shown an increase in perceived roost size. Continued monitoring and revised population surveys are necessary in the near future.

The perils of increased numbers and its effect on public opinion should not be taken lightly. The Australian Grey Headed Flying Fox's image with Australians has proven a significant stumbling block to its conservation efforts. In addition to perception as an agricultural pest, the Australian Gray Headed Fox is unwelcome in urban centers as well because of its stench and noise (McClelland 2009). In further contrast, even Pemba Flying Foxes in urban centers (such as Wete) still retain an overwhelmingly positive image in the eyes of their human neighbors. The Australian bats' negative public image and popular misinformation further challenges conservation and education efforts. Luckily, this is not a hurdle that the Pemba Flying Fox will have to overcome before effective conservation efforts are realized. In Pemba,

education is a simple step that can be used to jumpstart the community's active engagement in their endemic bats' future.

While community-based education is integral to successful conservation of the bats, a school-based curriculum would most likely increase these benefits greatly.The education efforts of the early and mid-nineties have effectively been abandoned in schools, according to all respondents. The education campaign of 1992 was centered on seed dispersal and forest regeneration and attempted to encompass both formalized and community-based educational outlets (Robinson 2010). It is interesting that though this campaign began in schools, where it lingers now only in community resources and by word of mouth education.

Evidence of a truly successful educational effort extends far beyond the classroom, inspiring an environmental discourse within families and communities that extends into action, creating a sustainable loop of increased awareness. Studies show that students' "noble value," or intrinsic appreciation for environmental conservation is difficult but vital to cultivate in order to ensure the lasting impact of any environmental education program (Hassan et al. 2010).These values are challenging to instill in students, because they require children to create abstract relationships between morals, current practices, historic changes, and future possibilities (Hassan et al. 2010). However, the instillation of these "bioethics" enforces "common values in perspectives […] responsibility and internalization" of environmental problems (Urker et al. 2012). Conservation campaigns must rely on the awareness of children, as they are the leading agent of information flow into families and will become the instigators of future change.

This information path is crucial. Changing perspectives and ideas on Pemba Flying Fox conservation are most suited to begin in schools and clubs for children and youth; but without the support and willingness toward action within a community, it is impossible for them to be self-

sustainable and ultimately effective. School-based education campaigns have the potential to create a ripple effect, influencing community proactiveness and the creation of community-centric informational outlets with the power to continue into the future (Entwistle 1997). Additionally, a comprehensive and holistic method of education encompassing the bats role in a complex and evolving ecosystem would potentially increase understanding in a way that would also help to mitigate the threats faced by the Flying Fox due to deforestation.

A revitalization of a youth-centered conservation education program is even more crucial on Pemba now than ever. Nearly all of respondents who affirmed a hunting presence on the island specified that it was done primarily by children and youth. Several mentioned that this was because of the difficulty of and time-consuming nature of hunting, which did not lend itself easily to busy adults. Many informants alluded to the deliciousness of Pemba Flying Fox meat, and when further questioned, admitted that they had eaten it, though most said they had only done so in their youth. The manner of their responses and visual evidence of hunting, leads to more questions than answers. Regardless, it is clear that some form of hunting is still practiced. In fact, many people were surprised to learn that it was illegal.

Although theestamatedpopulation count does not support the hypothesis of a growing number of *Pteropusvoeltzkowi*, anecdotal evidence emphatically does. The researcher's initial presupposition of a positive public image was overwhelmingly corroborated, as that of a generally knowledgeable public, However, our theory of increased farmer-bat conflict was, happily, not substantiated.

It should be noted that thisstudy is only an initial assessment of population, roosting and migratory patterns, and public attitudes and actions toward the bats. Limitations of this study include counting bias, low site visibility, colony movement, and interviewee bias. Due to

themethodology, bats may have been misestimated during estimation in low visibility sites. Continued monitoring of these animals and their human island co-inhabitants is vital to the bats' continued recovery.

Conclusion

Environmental education and community-based protection organizations based on economic, environmental and intrinsic appreciation of the bats is the key to this species' continued success. These initiatives would help to mitigate the current and potentially increasing threat of deforestation as well as to dispel the remnants of harmful hunting practices in these areas. The current positive public image of the Pemba Flying Fox and the general knowledge of its role as a seed disperser are an incredibly positive starting point for a refreshed conservation education campaign. Established community-based protected areas and conservation clubs are excellent role models for emerging movements to protect local resources and should be encouraged to share their stories of attempts and successes. Most importantly, it must be stressed that the conservation of an island-dwelling, endemic species is never over, and for one as integral to the people and land in which it dwells as is the Pemba Flying Fox, this initiative must be a sustainable one that is carried into the future with pride by its human neighbors.

Recommendations for Future Studies

- Establishing ecotourism and advertising with MsituwaMbiji would be an extremely fun and fulfilling project. The nature preserve is up for review in 2014, and both the community and forest would benefit from this greatly. The people are very nice and willing to help, and would love to work with researchers and students. As we were their first foreign visitors, this opportunity has not been explored at all, but the community is very receptive and eager to try it.

- Although not extremely feasible for SIT students, radio tracking of Pemba Flying Fox would potentially lead researchers to more fully understand the migratory patterns and seasonal movements of Popo wa Pemba, which would be extremely helpful in conservation efforts and population monitoring.
- Research into the seed dispersal activities of the Pemba Flying Foxes could help gauge the recovery of Popo wa Pemba by measuring their ecological functionality as their numbers grow.
- Mapping forests with substantially large trees and other potential roosting sites could help focus deforestation prevention in an effort to preserve the Flying Fox habitat. Another project to this same effect could include working with Pemba Community Forests, which sponsors reforestation projects in Wete and Chake districts.
- Determine the Pemba Flying Fox's influence on surrounding village culture. Ask about legends and stories of Popo wa Pemba and assess people's attitudes about the bats. It would be particularly interesting to focus on the role of religion and farming livelihoods in Flying Fox conservation.

Literature Cited

Breed, A.C., H.E. Field, C.G. Smith, J. Edmonston, J. Meers.2010. Bats without borders:Long-distance movements and implications for disease risk management. EcoHealth. 7:204-212.

This article examines the movement of flying foxes in Australia, Papua New Guinea, Indonesia, and Timor-Leste in the face of endemic virus spread. It is interesting that these flying foxes migrate across large bodies of water, when the Pemba flying foxes seem relatively sedentary and isolated to Pemba. This article provided helpful information regarding seasonal migrations of fruit bats, including study methods, general migratory patterns, and possible uses for migratory information, such as conservation challenges and disease risk management.

Clabby, P. 2010. Cultural Tourism in Mjini Ole, Pemba: A case study in its establishment and marketing. School for International Training. Tanzania: Zanzibar Coastal Ecology and Natural Resource Management. Fall Semester.

Peter Clabby's ISP focused on ecotourism ventures in Mjini Ole, the community immediately surrounding, supporting, and responsible for Kidike Environmental Conservation Club. This study provided integral background information on the history of Kidike, the culture of the community, and the importance of ecotourism to the conservation of the bats.

Bergren, M. 2009. A better future in Tanzania's forests.Conservation International.http://www.conservation.org/FMG/Articles/Pages/better_future_in_tanzania_forests.aspx (accessed 13 November 2012).

This website article provided helpful information about the biodiversity hotspots of Tanzania, including the Eastern Arc Mountains and Ngezi national forest, one of our four focus study sites. It is significant that the forest is one of the last remaining parcels of primary forests on Pemba and is host to a myriad of remarkable ad rare species, such as the endemic Pemba Flying Fox.

Djossa, B.A., J. Fahr, E.K.V. Kalko et al. 2008. Fruit selection and effects of seed handling by flying foxes on germination rates of shea trees, a key resource in northern Benin, West Africa.Ecotropica. 14:37-48.

This article provided useful information on the symbiotic relationship existing between large fruit bats and fruit trees. Their ecological role as seed dispersers is vital to their habitats, and because of this, flying foxes are often primary forest community engineers. The data provided by Djossa et al. was used in support of conservation for economic and environmental motivations.

Entwistle, A. 1997. Status and distribution of the Pemba flying fox *Pteropusvoeltzkowi*.

Cambridge University Press.

Entwistle's research locates large historical roost sites of the Flying fox on Pemba. This study is used by our study to determine known past roost sites for the Pemba Flying Fox. It also provides a historical context and baseline for our study. Additionally, it is a chief source of ecological information on the Pemba Flying Fox.

---- 2001. Community-based protection successful for Pemba Flying Fox.Oryx.4(35):355-356.

Abigail Entwistle's short article describes the relative successes of Pemba Flying Fox recovery after 9 years of conservation efforts. She focuses on the community-centered conservation clubs that emerged from the recovery energies, which are key to the Popo wa Pemba preservation by protecting the natural habitats of the bats, instilling a sense of pride in the community, and making the bats a viable source of income, due to ecotourism projects. One study site used in the survey was an established, Popo wa Pemba-centered, community-based protection area, while another was a community nature reserve that happened to host a large population of Pemba Flying Foxes and hopes to become a ecotourism destination.

Fitzpatrick, C. 2007. Conserving the Pemba Flying Fox, *PteropusVoeltzkow*, through

Ecotourism.School for International Training. Tanzania: Zanzibar Coastal Ecology and

Natural Resource Management. Fall Semester.

Fitzpatrick's ISP assesses the recoveryof the Pemba Flying Fox in 2007 and the possibility of ecotourism to aid in the conservation effort. This study concentrates on 4 main roost sights: NgeziVumawimbi, Mjini Ole, Kojani Island, and Misali Island. It is useful to this study because it gives specific locations of past roost sights, and estimates of the size of each colony. It also gives good background on the Popo wa Pemba, our study species. This ISP also provided helpful contacts for the study locations.

Gosselin, J.T. 1998. A study of comoran fruit bats (*Pteropus s. comorensis*) on Chloe

Island.School for International Training. Tanzania: Zanzibar Coastal Ecology and Natural

Resource Management. Fall semester.

This ISP investigates roosts of fruit bats in Mafia Island, Zanzibar. It provides helpful background information about fruit bats and Zanzibar, as well as a methodology for roost

inventory that is very similar to our proposed methodology. Although Gosselin investigates a different species of fruit bats, Comoran fruit bats and Popo wa Pemba share the same family and face many of the same environmental threats and challenges with respect to conservation.

Gumal, M.T. 2004. Diurnal home range and roosting trees of a maternity colony of Pteropusvampyrusnatunae (Chiroptera:Pteropodidae) in Sedilu, Sarawak. Journal of Tropical Ecology. 20(3):247-258.

This article contained useful information about the migratory and roosting patterns of other fruit bats. Gumal also writes very detailed information on roost tree types and sizes, as well as the many benefits gained from suitable roosts. This information was used in our study in choosing data to be gathered as well as in analyzing the meaning of our roost tree data with relation to the study sites.

Hassan, A., T.A. Noordin, and S. Sulaiman. 2010. The status on the level of environmental awareness in the concept of sustainable development amongst secondary school students. Procedia- Social and Behavior Sciences. 2:1276-1280.

This article discusses the challenges and rewards of secondary school-based environmental education in a developing country. We used it to further understand the implications of instilling intrinsic value for sustainability in students as well as the societal consequences of educating children. These citizens act as invaluable information paths to spread environmentally conscious attitudes and behaviors throughout families.

Juma, O. Committee member, MsituwaMbiji. Personal interview.Changaweni, Pemba, Tanzania. 21 November 2012.

This interview concerned the specifics of the community sponsored nature preserve of MsituwaMbiji, including its origins, how it is run and its size. This information was used with respect to the MsituwaMbiji study site.

Leary, J. 1998. Popo wa Pemba: Conservation of *Pteropusvoeltzkowi*. School for International Training. Tanzania: Zanzibar Coastal Ecology and Natural Resource Management. Fall Semester.

This ISP is an excellent source for informational on the fledgling conservation efforts of Popo wa Pemba, including the origins of Kidike, a community-based conservation club centered

around the bats. It also provides bat count estimates for relevant sites, and is evidence of an education effort in local schools.

"Map #4 -Map of Pemba" *Tanzania Yacht Charters*.Web. December 3, 2012. <http://www.tanzaniayachts.com/maps.shtml>

McClelland, K. 2009. Challenges and recovery actions for the widespread, threatened Grey-headed flying fox:A review from a New South Wales policy perspective. Ecological Restoration and Management.10:110-116.

This review assesses the recent steps taken by the government and research community surrounding the grey-headed flying fox since it was listed as a threatened species in 2001. It includes useful methodologies for roost distribution and counts, as well as community mitigation in the face of resource conflicts. This study provides helpful guidelines for conservation and allows for an interesting comparison between a threatened species with a large habitat range and an island dwelling, endemic bat.

Mohd-Azlan, J., A. Zubaid, T.H. Kunz. 2001. Distribution, relative abundance, and conservation status of the large flying fox, *Pteropusvampyrus*, in peninsular Malaysia: a preliminary assessment. ActaChiropterologica. 3(2):149-162.

This study identifies the abundance of the flying fox species in Malaysia. This bat has gone through many similar disturbances as the Pemba flying fox. The methods from this study were used as a basis for our methods in our study of the status of the Pemba flying fox. It was also used to gain insight into flying fox ecology, biology, and history.

Muhammed, R.A. Sheha of Changaweni. Personal Interview.Changaweni, Pemba, Tanzania. 21 November 2012.

This interview was conducted with the Sheha of the area surrounding MsituwaMbiji (ChangaweniShehia) and concerned the population of the area surrounding the community nature preserve, in addition to the same semi-structured interview used in the study for all other respondents.

Parry-Jones, K.A., and M.L. Augee. 2001. Factors affecting the occupation of a colony site in Sydney, New South Wales, by the Gray-Headed Flying Fox *Pteropuspoliocephalus* (Pteropodidae). Austral Ecology. 26:47-55.

Parry-Jones and Augee's article provided useful information on a close cousin of the Pemba Flying Fox, the Australian Gray-Headed Flying Fox, which has faced conservation hurdles that are at times, very similar to those of Popo wa Pemba. However, the Australian bat conservation efforts cover a greater range and must also combat a negative public opinion, unlike the Pemban flying fox.

"Pemba Island."Zanzinet Forum. Zanzinet. http://www.zanzinet.org/zanzibar/pemba/pemba.html27 (accessed November 2012).

This website provided helpful information about the demographics and statistics of Pemba Island. It was used to understand population growth and distribution within the island, as well as historical changes of the island. Additionally, Zanzinet was used to gather more detailed information about our four focus study areas, including population, distances from other landmarks, and other helpful facts.

Roberts, B.J., C.P. Catterall, P. Eby, J. Kanowski. 2012. Long-distance and frequent movemements of the flying fox *Peropuspoliocephalus*: Implications for management. Plos ONE. 7(8):1-13.

The article focuses on the grey-headed flying fox in eastern Australia and how its periodic roost changes affect local conservation. If the Pemba flying foxes display seasonal migratory pattern, this could further complicate their conservation efforts. However, since the island of Pemba is such a small place, their movement is not as drastic as that of the Australian Flying Fox. Roberts, et al. conclude that local conservation efforts are practically ineffectual for the Australian grey headed flying fox due to the range of its roosting and movements.

Robinson, J.E., Bell, D.J., Saleh, F.M., Suleiman, A.A., Barr, I. 2010. Recovery of the Vulnerable Pemba flying fox *Pteropusvoeltzkowi*: population and conservation status. Oryx, 44, pp 416-423 doi:10.1017/S0030605310000463

This study identifies recent Pemba Flying Fox roost sites and gives an estimation of the population size as of 2010. Their methodologies also provided a foundation for the

methodology of our study. Additionally, this study provided useful contacts, resources, Pemban locations, and information about flying fox ecology and history within the local environment.

United Republic of Tanzania Ministry of Natural Resources and Tourism, Forestry and Beekeeping Division. December 2010. Species List Sorted by Vernacular Names.National Forest Resources Monitoring and Assessment of Tanzania.

This resource was used to identify trees using Kiswahili, common English, or scientific names when all three were not easily accessible in the field. It was also used to in-situ tree identification and to connect tree species with their common local uses. This information helped us to understand the significance of our results with respect to roosting tree species and heights utilized by the bats and the implications of and reasons behind continued deforestation.

Urker, O., M. Yildiz, N. Cobanoglu. 2012. The role of bioethics on sustainability of environmental education. Procedia- Social and Behavioral Sciences. 47: 1194-1198.

This article dealt with a comprehensive view of environmental education that asks students to draw abstract and ethical conclusions and connections between the complex ideas of sustainability with an eye toward a common human perspective. This form of education encourages students to understand environmentalism in terms of satisfying a world-wide need for resources felt by all earthly inhabitants. Environmental education of this manner encourages appreciation of intrinsic values and is extremely hard to cultivate in a school setting but provides the most radical and long lasting change in environmental attitude.

Appendix A

Semi-structured Interview Questionaires—

Kiswahili

1. Popo wa Pemba wanaonekanawapikwasiku? Kuna makaazinynginekaribuyahapa?
2. Mudaganiwamekuepohapa? Unajualiniwalifikahapa?
3. Waneonekanakilasiku? Kilamsimu? Baadhiyamsimuwaneonekanazaidikulikonyngineyamsimu?
4. Kablawakatihuu, walikuawameonekanawengizaidi?
5. Kuna popowaainanyinginewapatikanahapa? Kama wapo, ainagani?
6. Watuwanafanyakazi au shugulikaribuyamakaaziyapopo? Ainagani?
7. Unajuamakaaziyazamaniya Popo wa Pemba ambayohawaishitena? Ngapi? Z/ikowapi?
8. Je kunamashambayamatunda au mtikaribuyamakaaziya Popo wa Pemba? Popokulamatundayashambakule?
9. Watuwanafukuza Popo kulamatundayashamba? Vipi/kwanini?
10. Watuwanawinda Popo wa Pemba hapa? Watuwadogo au mzeezaidiwanawinda? Kablawakatihuu, watuwaliwinda? Naniwaliwinda?
11. Jamiikunaelimukuhusu Popo wa Pemba? Ainagani? Ikowapi? Nanianafundisha?
12. Unafikirininikuhusu Pop wa Pemba? Ni wazuri au mbaya? Kwanini?
13. Popo wa Pemba nikituganiambachowanafanyawakiwakatikamji, shamba, namsitu?
14. Utapendakutuambiakitukynginekuhusu Popowapemba?

English

1. Where can the Pemba Flying Foxes be seen in the afternoon? Is there another roost around here?
2. How long have they been here? A long time or a short time? Do you kow when they arrived?
3. Can they be seen every day? Every season? Can more be seen during some months than others?

4. Before now, you could see more than you can now?
5. Is there another type of bat that lives around here? What kind?
6. Do people work or have activities near the Flying Fox roost site? What kind?
7. Do you know of any abandoned roost sites?
8. Are there any tree or fruit farms near the Flying Fox roost site? Do the bats eat the fruit from the farms?
9. How do people keep the bats from eating the fruit from their farms?
10. Do people hunt the Flying Foxes? Young or older people? Before now, did people hunt?
11. What do you think about the Flying Foxes? Are they good or bad? Why?
12. How do the Flying Foxes influence the forest, farms and community?
13. Does the community have any education about the Flying Foxes? What kind/ Where? Who teaches?
14. Would you like to tell us anything else about the Pemba Flying Foxes?

Appendix B

-questions not included were not asked, due to circumstances or the edition of the questionnaire being used, or were not answered by the informant-

<u>Interviews from villages surrounding Ngezi roosts</u>

Age: 67 Sex: Male Village: KiuyuKibantini Occupation: Sheha
Questionnaire edition: 1
1.Ngezi Forest
2. A long time
3. Every day, every season
4. Now there are many more
5. Two, both live in the forest and are small
6. Yes, farming
7. Yes, some used to live outside the forest and now live inside of it
8. Yes, mango *mitondo*, *mikungu*. The bats eat the fruit
9. It is impossible because they eat at night
10. ----
11. ----
12. They are good because they help the forest and the seeds need them
13. ----
14. ----

Age: 32 Sex: Male Village: KiuyuKipangani Occupation: unknown
Questionnaire edition: 1
1.Ngezi Forest
2. A long time
3. Every day, every season
4. Now there are more
5. Yes, Popo wadogowadogo
6. Farming only
7. Yes, many
8. Yes, mango bread fruit. The bats eat it
9. It is impossible because they eat at night
10. ----
11. ----

12. They are big. They are good because they do good work for the forest.
13. ----
14. ----

Age: 37 Sex: Male Village: KiuyuKipangani Occupation: Duka Owner
Questionnaire edition: 1
1. The place they sleep- the forest
2. A long time
3. Every day, every season
4. There are more now
5. Yes, smaller ones. Doesn't know the names
6. They do, but outside the forest: farming cows and plants
7. Yes
8. Yes, mango, bread fruit, and tofah. The bats eat the fruit
9. It is impossible because the seeds and trees need them
10. Some do, mostly younger people
11. The community holds education meetings
12. They are good because there are trees living now that people didn't plant. They provide economic benefits
13. ----
14. There are more bats now and they are doing better, but more education is needed so people stop killing them.

Age: 70 Sex: Female Village: KiuyuKipangani Occupation: unknown
Questionnaire edition: 1
1. This forest [Ngezi]
2. A long time
3. Every day, every season
4. Now there are more
5. maybe. Doesn't know.
6. Farming
7. Doesn't know
8. Yes there are farms. Yes the bats eat the fruit but not a lot of from most farms
9. They can't
10. Yes. Doesn't know specifics
11. ----
12. They are very good. They provide "self-confidence." Who else will plant fruit trees in the forest?
13. They help many trees. They grow them.
14. ----

Age: 50 Sex: Male Village: KiuyuKipangani Occupation: unknown
Questionnaire edition: 1
1. This forest [Ngezi]
2. A long time
3. Every day, every season
4. Now there are more
5. Yes, wadogowadogo
6. Farming
7. Doesn't know
8. Yes. Mango, cashew, ficus, papaya, breadfruit
9. They can't because the bats eat at night
10. ----
11.----
12. They disperse seeds and help the community because everyone can use the fruit from the trees
13. They are good. They are "self-conserving" because they spread seeds from far away for everyone
14. ----

Age: 26 Sex: Male Village: KiuyuKwaManda Occupation: Ngezi Forest Ranger
Questionnaire edition: 1
1. In Ngezi (Wayani and Chokani) There are 4 colonies at Ngezi
2.They have been there a long time
3. Every day, every season. No seasonal movement, but they move day to day because of hunting. You can see traps, slingshots and sticks at abandoned roost sites sometimes.
4. There are fewer now because of hunting
5. Yes. There are other fox subspecies, but all are small

6. Yes. There is cultivation outside the forest and many people cut wood inside the forest.
7. Yes. Mkungwi near Chokani Beach was hunted out completely
8. Yes, but most fruit trees are interplanted on farms and the bats eat from them
9. Noise –making contraptions (buckets with rocks in the trees), traps
10. Yes. Not many people eat it, because it is illegal both in Islam and in taking from Ngezi. Younger people are more likely to try it.
11. Older people try to educate younger people not to eat it because it is forbidden by Islam.
12. They are very good. For the habitat and because they are endemic they bring in foreign visitors (and therefore money) and make people proud
13. See Above
14. ----

Age: 38 Sex: Male Village: Mitondone Occupation: unknown

1) Forest of Ngezi
2) A long time
3) Every day
4) Every season
5) More now
6) There are 5 species of bats. Other species live in coconut trees
7) They live in coconut and banana trees and in old houses and forests of Ngezi and in the caves.
8) People work beside the bats (farming, pastoralism and fishermen)
9) –
10) Yes
11) They eat fruit in the village
12) Mango, Cashew trees, “Maribo”, “Mesuffi”, “Mkuyu”, “Kunga” and Zambarau
13) They eat fruit but they are not easy to stop because they eat at night when farmers are resting.
14) Good because they are endemic species and help fertilize the area.
15) They are not hunted now, they used to hunt in the past.
16) People learn about the bats because they were here a long time, there is no education about conserving the bats or conservation. Old men know about bats and they know bats are helpful so they told people in the village and now they are conserved more.

Age: 21 Sex: Male Village: Mitondone Occupation: unknown

1) Forest
2) Short time
3) Every day
4) Every season
5) Small
6) Two – Popo wa Pemba and WadogoWadogo
7) No
8) –

9) I don't know

10) Yes

11) Fruit – mango, "konguanagula"

12) Yes

13) It is impossible to stop bats because they fly away immediately.

14) Good

15) Hunting is not good

16) It is necessary to educate people about the bats

Age: 18 Sex: Female Village: Mitondone Occupation: unknown

1) Forest

2) Long time

3) Every day

4) Every season

5) Now there are more

6) Three sepecies – Popo wapemba and small ones that live in trees

7) No

8) –

9) I don't know

10) No

11) "Zambarau", mango and "msufi"

12) Yes

13) Perhaps if you have a fruit tree you can wait at night and shoot them

14) They are good

15) It is not good to hunt them but people do hunt. There is no good reason to trap because they are an endemic species and money from hunting goes to tourists outside.

16) –

Age: 25 Sex: Female Village: Mitondone Occupation: unknown

1) Forest

2) Long time

3) Every day

4) Not every season- in the heavy rains you can see them

5) More now

6) Two- big and wadogowadogo

7) –

8) No

9) Cultivation

10) I don't know

11) Yes, fruit – I don't know what kinds

12) Yes

13) No specific ways to stop them from eating the fruit. Impossible.

14) They are good because they bring tourists and they move in the forest and come to disperse seeds but they eat farmers' fruits.

15) There is no good reason to hunt because then the number of bats will decrease and they avoid the area. They might make them go extinct. There is no hunting in the village

Education is important because it means preservation in the forest

<u>Interviews from people surrounding Wete roost</u>

Age: 52 Sex:Male Village: Bubujiko Occupation: Butcher in Wete

1) They sleep near the port. Other colonies outside of wete. The closest ones are in Ukungwi and Changani, but they are much smaller.
2) 25 year
3) You can see them every day and season, but they are more in the cold season. Doesn't know where they go.
4) There are many more now
5) There are, but now many and they live further away (popoeupe)
6) Port work, people live near there, schools
7) Before he was brn there were more roosts but they were hunted/eaten
8) Yes and Yes. Mango and "msufi" flowers
9) They don't stop them because the bats only eat a little fruit and they eat at night
10) -
11) It is now easy to hunt them. They live close to the government buildings in very tall trees. Before now people used to hunt.
12) –
13) Yes, but not much. Mostly researchers, some in school and seminars.

GROUP INTERVIEW

Age: 35&32 Sex: M& F Village: Utan (Wete) Occupations: unknown, runs a restaurant

1) The port, kisuanimchengwe, wetemzote
2) Close to 20 years
3) Every day and every season. More during – one says cold season and one says the hot season
4) More now
5) WadogoWadogo and Wang'ombe
6) Yes, my restaurant
7) Misali
8) Yes. Chungwa, passion, "mahindi" , "mabelong". Yes they eat
9) "Kibati", shooting -
10) -
11) Not now, because the bats are close to the police

12) Good

13) People from the forestry department hold education seminars

Age: 52 Sex: Male
Village: KiswaniKigumbani
Occupation: unknown

1) Long agothe forest around wete. Now at port

2) Long time maybe since 2006

3) Every day and every season, but move roosts if disturbed and most forests are.

14) There are fewer roosts and more bats congregating in places like wete.

15) Wadogowadogo and one that lives in banana trees

16) When people do work near the roosts, the bats usually move. Wete is exceptional. Maybe because they are tall trees.

17) Many

18) They travel very far for fruit, but eat from farms most likely

19) They can't because they eat at night. Also , the bats eat very ripe fruit, most likely wouldn't be used anyway. So not a problem.

20) The travel with the seeds and drop them where they germinate into new trees. Mangos and many other fruit trees grow because of them.

21) No many are hunted now. Two types of hunting: one uses hooks or sling shots or sharp sticks to bring sleeping bats down from roost trees, the other is to hunt at night. It is not easy, mostly done by boys age 8-30 yrs. More hunted before because of conservation efforts. Considered a success, generally well received but ongoing.

22) They conserve themselves by eating at night, but still vulnerable. Less so now because people no longer hunt using bird shot. Biggest threat now is deforestation. Almost all the big trees have been cut down. The bats at Wete are safe because the government conserves them but in 10-20 years the bats will have no home. Maybe they will move to the mangrove swamps. Chainsaws are a threat because they make cutting wood easy.

23) Mostly done by ministry of agriculture and word of mouth. None in schools now, but posters were distributed to all the schools in the 1990s (Ole Seehaveseu).

Age: 25 Sex: F Village: Mtumbe Occupation: Runs Wete fruit stand

1. They sleep in big roost trees. When there is no more fruit they will leave.

2. Long time
3. Every day
4. There used to be none here because there were more trees other places. They leave when the big trees go.
5. No
6. No work can be done around roosts, or they leave.
7. Yes, because people cut the trees down. Ngezi.
8. No, because people grow fruit trees one by one, but the bats eat from family trees.
9. Impossible, they fly away when approached.
10. They grow fruit trees that people can use in the forest. Good things.
11. No hunting, never has been.
12. -
13. No

Age: 61 Sex: Male
Village: Wete Occupation: Sheha

1. The big trees
2. Long time. He has always seen them.
3. Some days, every season. Sometimes there are more, maybe they birth more.
4. More now because more have been born
5. -
6. Navy post
7. Many, they change roosts because of hunting.
8. Yes. Cloves, jack fruit, they eat the fruit.
9. They can't because the bats eat at night.
10. -
11. Has not seen it happen recently, but many did it before.
12. They are good, big, and fat
13. No

Age: 36 Sex: Male
Village: Wete Occupation: works at a guest house

1. Big trees near the port, also in Raha.
2. Long time, doesn't know when they arrived.
3. Every day and season. More in the hot season.
4. There are more now
5. Wadogowadogo
6. Yes. Government offices, port work, and naval station
7. No
8. Yes, many. They eat the fruit
9. Slingshots

10. They only eat a little fruit at each place and eat fruit by season

11. Not many because its illegal. Younger people do , because they like it and have time

12. They are good because they are special to pemba and bring in foreign guests

13. A little, not enough is done by seminars by ministry of environment.

<u>Interviews from Mjini Ole, the community surrounding Kidike</u>

Age: 19 Sex: male
Village: Ole Occupation: Student
** father works at Kidike

1. Kidike forest, they attract many tourists from Germany, Australia, England and America.
2. A long time. They came to the natural forest. Doesn't know when.
3. Every day and season. No seasonal variation.
4. There were fewer when he was younger
5. Sometimes, but they are all small
6. Tourism
7. Yes. Mantani. Thinks they were hunted or woods were cut
8. Far away, maybe Makaani, some here.
9. They can't because they feed at night
10. They improve the forest, they expand it and fertilize it
11. No, because it's illegal
12. They are under control. They are very good because they stay quiet and will amuse anyone.
13. Yes, at school

Age: 40 Sex: Female
Village: Ole Occupation: None **
no family at Kidike

1. The Kidike trees
2. A long time, doesn't know
3. Every day and season, no seasonal changes
4. There are more now
5. No
6. Agriculture and animal husbandry
7. No
8. Yes, mango and papaya the bats eat.
9. They can't because the bats eat at night
10. They eat and spread seeds around
11. They did before, but not now
12. -
13. There is, it's held in the village by forestry people

Age: 62 Sex: Male
Village: Ole Occupation: Sheha **
no family at kidike

1. -
2. Long time
3. Every day/ season, no seasonal variation
4. Many more now
5. Yes, but they are small and you can't see them in the afternoon
6. Agriculture, but not intensive
7. Yes, at Makani, they left because there was no more forest
8. Yes, Mango, Mikuyu. The bats eat the fruit.
9. It is not easy to do, and there are many fruits, so most people don't try.
10. -
11. Not now, but they used to. Mostly young people.
12. They are good because they plant trees and are good to eat.
13. Yes, people from the forest teach in town.

Age: 38 Sex: Female Village: Ole Occupation: None ** No family at Kidike

1. Kidike
2. Long time
3. Every day and season. No variation
4. More bats now
5. No
6. Agriculture and animal husbandry
7. No
8. No, they travel far distances for food
9. They don't because the bats eat at night
10. They eat fruit
11. Not now, children used to.
12. Good because they grow trees (answer changed by bystander input)
13. Sometimes

Age: 35 Sex: F Village: Ole Occupation: Farmer **No family at Kidike

1. Kidike forest only
2. Long time
3. Every day and season. There are more during Masika (rainy season)
4. There are more now
5. None
6. Agriculture
7. No
8. Yes. Mango. Many bats eat from farms
9. They don't. There are many uneaten fruits.

10. They grow trees.
11. Not now, but people used to. Mostly big people
12. Very good! They help by planting trees.
13. Some people from the forest give seminars, but there needs to be more

Age: 30 Sex: F Village: Ole Occupation: None **has family at kidike

1. Kidike
2. Very long, doesn't know exactly when
3. Every day/ season, no variation
4. Now there are more
5. No
6. Farming, but not much, and tourism
7. No
8. No the bats eat in far away places
9. They don't. the bats don't eat much
10. They help the forest by spreading seeds
11. No (originally said Yes, but answer changed after bystander input)
12. They are good, many people like them
13. Yes. The village has some.

Age: 16 Sex: M Village: Ole Occupation: Student ** Family member works at Kidike

1. Kidike
2. A long time, he always remembers seeing them
3. All the time, no variation
4. Many more now
5. Yes, but you can't see them in the afternoon
6. Farming
7. No
8. Yes. Mango, banana, popo tree, jack fruit, the bats eat a lot.
9. They don't because they know "its nature"
10. They provide fertilizer for the forest, and plant trees all around. Bring in guests from far away.
11. No. People of all ages used to.
12. Good
13. Yes. At Kidike and in the community, taught by people from the forest.

GROUP INTERVIEW

Ages: 36, 40 Sex: F, F Village: Ole Occupation: Kidike steering committee, farming & beadwork

1. Kidike. They live in some other trees but not many.

2. Long time
3. Every day and season. No variation
4. Many more now
5. Have not seen any
6. Agriculture
7. (yes) (no)
8. Yes. Mango and mbungu, the bats eat a lot.
9. They don't because the bats eat at night
10. (they spread seeds and grow the forest) (no reason)
11. No. They used to but it is illegal and not easy.
12. They are good because they grow trees.
13. Yes. Kidike hosts seminars, also word of mouth from Kidike members.

Age: 22 Sex: M
Village: Ole Occupation: Student
**Stated that he had no family at kidike but his mother is on the steering committee

1. Some places in the forest, Kidike
2. Long time, don't know when they arrived
3. Every day/ season. There are more during Masika (rainy season)
4. No increase or decrease
5. No
6. Agriculture
7. No
8. Yes. Mango and Msufi. The bats don't eat the fruit from farms
9. Don't because they eat at night (answer changed by bystander input)
10. Doesn't know
11. Not now, but younger people used to
12. (answer changed by bystander input)
13. There is some in the community by Kidike people.

He added that it is good that they bring in foreign guests.

GROUP INTERVIEW

Ages: 59,56,52 Sexes: Male, Female, Male Village: Ole Occupations: Ministry of Agricultre, Kidike steering committee, kidike steering committee

1. Kidike
2. Long time (didn't know when)
3. All the time, no change
4. Now there are more
5. (no)(wadogo, mgomba) (wadogo, mgomba)
6. Agricultre
7. No
8. Yes. Mango. They eat a lot
9. They don't

10. They eat fruit and spread tree seeds

11. No. they used to. All people liked to eat them

12. They are good. They spread seeds and make farms bigger

13. Yes. Taught by people from the community

Interviews from Changaweni, the community surrounding MsituwaMbiji

Group interview
Ages: 51, 51, 36, 48, 52, 34 Sex: All male but one (48 year old) Village:Changaweni Occupation: Farmers, Sheha
Questionnaire edition: 1
1. Big forests, Mbiji and other, smaller roosts
2. Along time, since before 1960
3. Every day and season. There are more during *masika* and *vuli* seasons
4. Now there are more
5. No
6. No, not very close. If people work too close to them, they will leave
7. Yes, there are many that moved from the surrounding area into Mbiji
8. Not close to the roost sites, there are fruit farms farther away
9. They don't
10. Not now. Children and teenagers used to, but now it is illegal
11. No, but the department of environment has education about the environment, not about the bats. Community awareness is low
12. They are very good because they are delicious and they are impressive and amazing to see hanging by day and when they fly at night
13. They help grow the forest by supplying seeds for trees used by the community
14. ----

Age: 58 Sex: Male Village: Changaweni Occupation: Farmer
Questionnaire edition: 1
1. MsituwaMbiji, Kichunjuu Forest
2. A long time, thirty years or more
3. Every day and season. There are more during *vuli* because there is more food
4. There are more now
5. Yes, they are small
6. Yes. People farm, but not very close to the roost sites, below the ridges the bats sleep on
7. Yes.
8. Yes. There are trees grown close to the roosts (cloves) and fruit farther away that the bats eat
9. They don't because the bats eat at night
10. No, but children used to
11. No
12. They are good
13. They strengthen the farms and forest because they grow trees that grow fruit
14. The bats need bigger trees that grow quickly,Mbiji needs advertisement and ecotourism for bats

Age: 53 Sex: Female Village: Changaweni Occupation: Farming
Questionnaire edition: 1
1. MsituwaMbiji
2. Many years, more than 70
3. Every day, every season. There are more during the rainy seasons
4. There are more now
5. Doesn't know
6. Farming
7. Yes. Two moved from nearby forests (gestured to same areas as previous informant) into Mbiji
8. No fruit farms, but many trees (cloves)
9. They don't because the bats eat at night
10. No, but young people used to
11. No.
12. They are good because they spread seeds to new places when they eat

13. They help to strengthen the forest because they spread seeds and fertilizer
14. -

Age: 60 Sex: Female Village: Changaweni Occupation: Doesn't work
Questionnaire edition: 1
1. MsituwaMbiji in the trees
2.They have been there a long time
3. Every day, every season. There are more during this season (*vuli*)
4. Before now there were fewer. There are more now because more were born.
5. No
6. People farm, but far away from the bats
7. Yes. The bats that lived in nearby forests (same ones as mentioned by previous informants) now live in MsituwaMbiji
8. There are mango trees and they are eaten by the bats
9. They don't because they come at night
10. Children used to, but they don't now because the forest is protected
11. No
12. They are good because they look impressive when they sleep
13. They help strengthen the forest
14. ----

Age: 45 Sex: Male Village: Changaweni Occupation: unknown
Questionnaire edition: 1
1. Mbiji
2. They have been there a long time, since before he was born
3. Every day, every season. No seasonal movement.
4. There are more now because new ones ran away to Mbiji
5. No.
6. Not close to the bats
7. No.
8. Yes. The bats eat a lot of the fruit
9. They don't because the bats eat at night
10. They used to, but not now. Little kids liked to eat it more, but adults hunted sometimes too. It is very delicious.
11. No.
12. They are good because the spread seeds and help the forest.
13. They help farms and farmers grow trees
14. -

GROUP INTERVIEW WITH 6 VILLAGERS FROM CHANGAWENI

Age: 51, 52, 36, 48, 52, 34 Sexes: Male, Male, Female, Male, Female, Male
Village: Changaweni Occupations: unknown

1. Big forests, mbiji, others are smaller in the area
2. Long time before 1960
3. More during Masika and Vuli
4. Now there are more, more in the rains
5. No
6. No, not very close because they will leave
7. Many moved here because of disturbance
8. No (there are but they are far)
9. They don't
10. They help grow the forest by supplying seeds (mkungu, mtondo, mawbe) that are later used by the community

11. Not now, they used to be hunted by children and teenagers. Now it is illegal.
12. Very good. They are delicious, amazing to see and impressive.

Age: 58 Sex: Male
Village: Changaweni Occupation: Farmer

1. Mbiji
2. Long time, thirty or more years.
3. Every day and every season. More during Vuli (more food)
4. There are more now
5. Yes, but they are small
6. Farming, but not close. Below the roost site ridges.
7. Yes
8. Yes. Tree farms are close, fruit farms are further away. The bats eat the fruit
9. No, because they eat at night
10. They grow trees that grow fruit for the community
11. Not now. Children used to.
12. Good
13. No

Age: 53 Sex: M
Village: Changaweni Occupation: Farmer

1. Mbiji
2. Many years, more than 70
3. Every day, every season. Rainy seasons there are more.
4. Yes
5. Doesn't know
6. Farming
7. Two, mantindio moved to mbiji
8. Only the forest, many trees
9. No because they eat at night
10. -
11. Not now, children used to
12. Good, they take seeds to new places
13. No
14. Yes, spreading seeds, fertilizer

Age: 60 Sex: F
Village: Changaweni Occupation: none

1. Mbiji, in the trees
2. Long time
3. Every day and season. This season (mvuli) there are more
4. Before there were few, because more have been born
5. No
6. Far away, they farm
7. Here, now live in mbiji
8. Mango, yes they eat

9. No, because they come at night
10. -
11. Kids used to. Don't know because they live in the forest.
12. Good, they look good when they sleep
13. No
14. They help the forest

Age: 45 Sex: M
Village:Changaweni
Occupation: unknown

1. Mbiji
2. Long time, before he was born
3. Every day and season, no seasonal variation
4. –
5. No
6. Not very close
7. There aren't any
8. Yes, they eat a lot of it
9. No, because they eat at night
10. Before but not now. More little kids than adults like to eat the bats, but some adults do hunt.
11. –
12. Good. They spread seeds, help the forest
13. No
14. They help farms

He also added that if you cut the forest they leave.

Appendix C-Site-Specific Graphs: Common Roost Tree Species

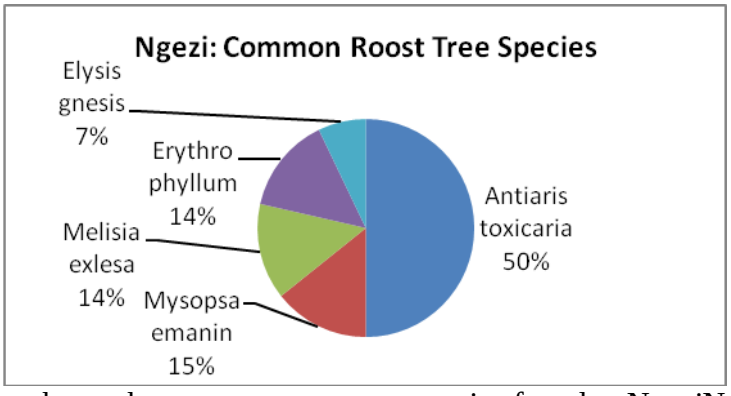


Figure 14. This figure shows the common roost tree species found at NgeziNational Forest. Data was collected on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

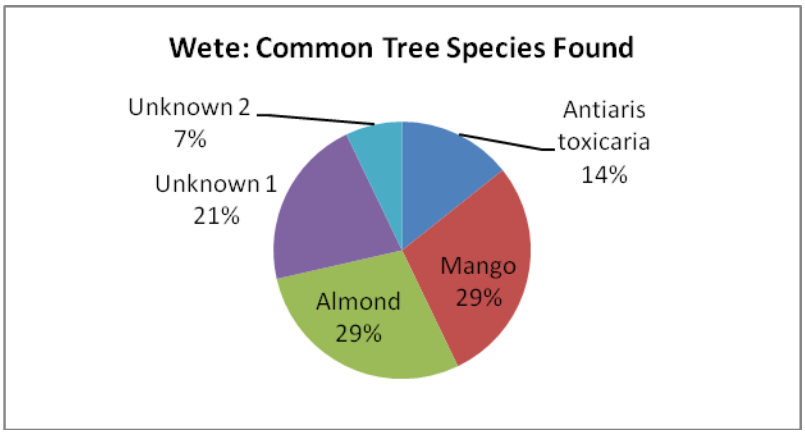


Figure 15. This figure shows the common roost tree species found at the Wete roost site. Data was collected on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

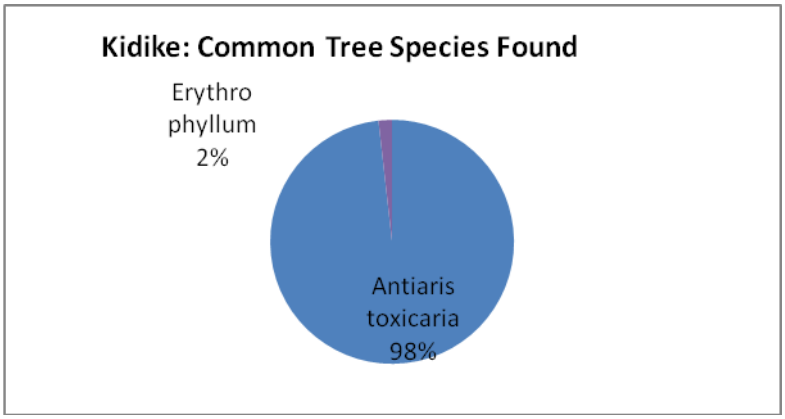


Figure 16. This figure shows the common roost tree species found at the Kidike roost site. Data was collected on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

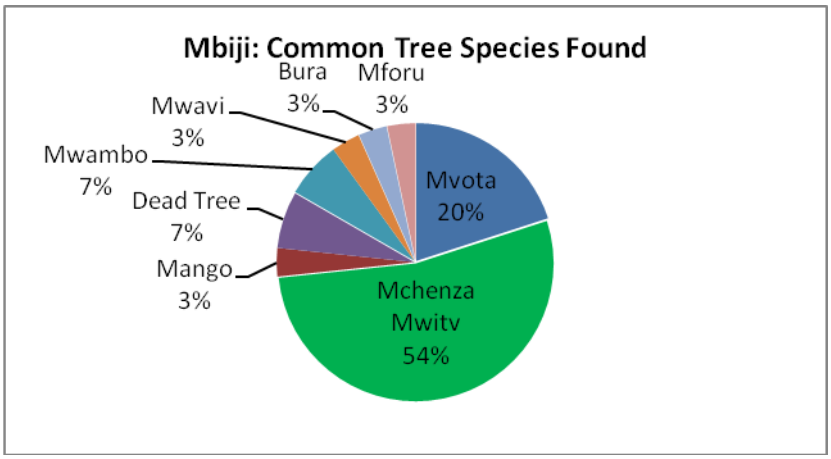


Figure 17.This figure shows the common roost tree species found at the Mbiji roost sites. Data was collected on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

Appendix D-Site-Specific Interview Response Graphs: Seasonal Fluctuation in Population

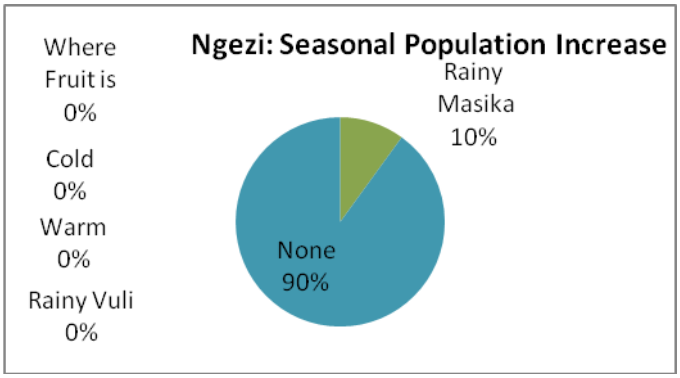


Figure 18. This figure shows the reported seasonal population increases of the Pemba Flying Fox at the Ngezi roost sites. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

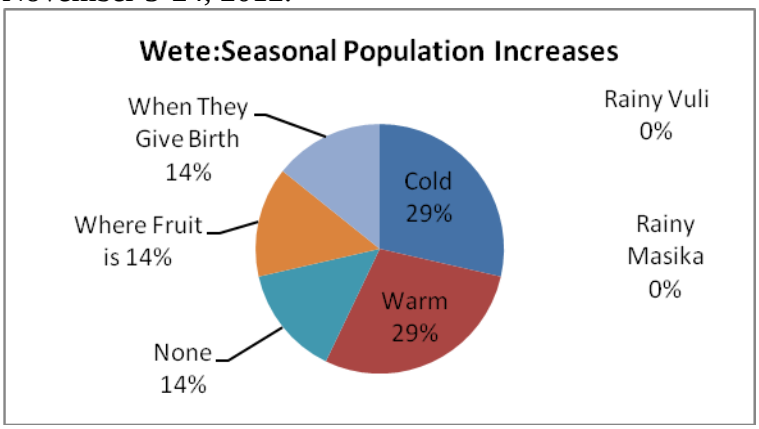


Figure 19. This figure shows the reported seasonal population increases of the Pemba Flying Fox at the Wete roost site. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

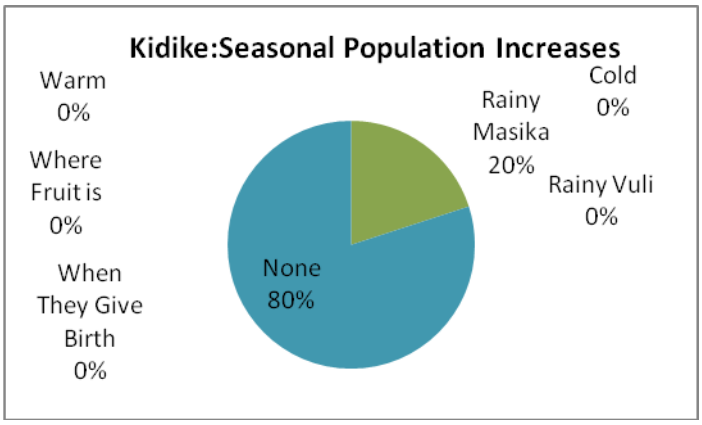


Figure 20. This figure shows the reported seasonal population increases of the Pemba Flying Fox at the Kidike roost site. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

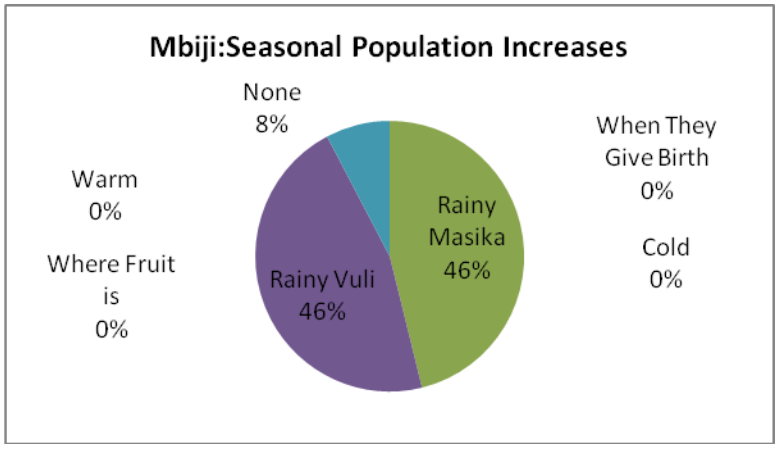


Figure 21. This figure shows the reported seasonal population increases of the Pemba Flying Fox at the Mbiji roost sites. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

Appendix E-Site-Specific Interview Response Graphs: Local Knowledge of Abandoned Roosts

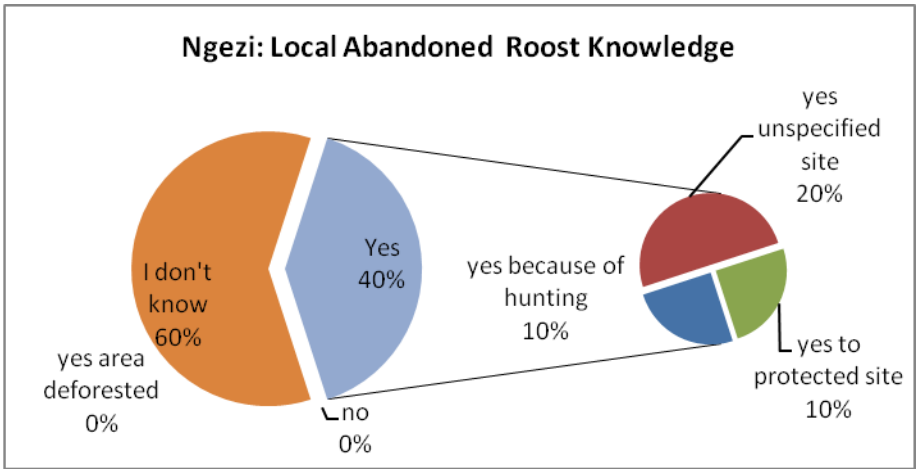


Figure 22. This figure shows the interviewees responses when asked if they knew of any abandoned roosts in the Ngezi forest area. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

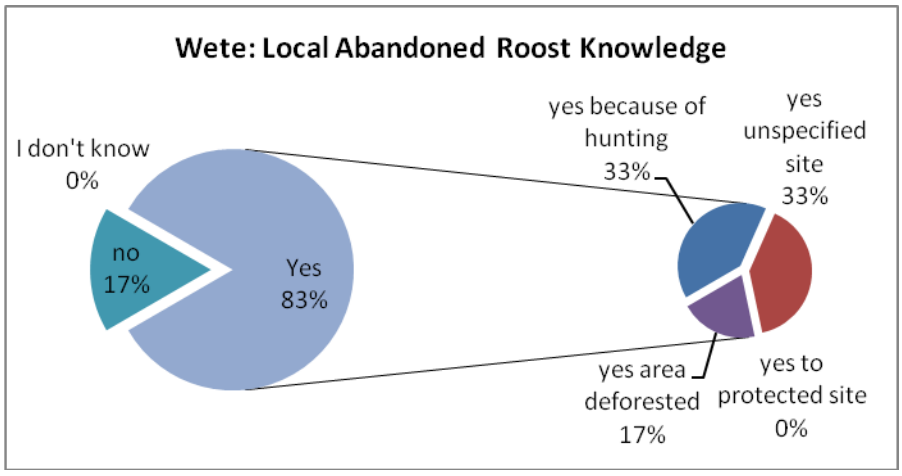


Figure 23. This figure shows the interviewees responses when asked if they knew of any abandoned roosts in the Wete roost area. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

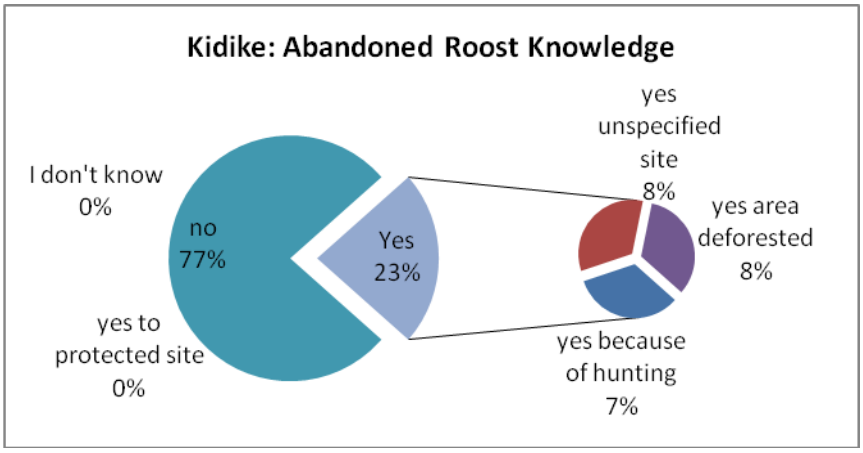


Figure 24. This figure shows the interviewees responses when asked if they knew of any abandoned roosts in the Kidike roost area. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

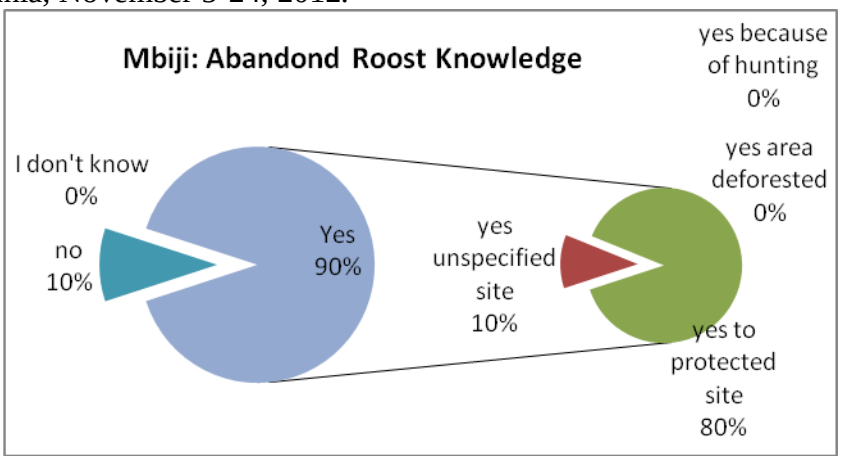


Figure 25. This figure shows the interviewees responses when asked if they knew of any abandoned roosts in the Mbiji roost area. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

Appendix F-Site-Specific Interview Response Graphs: Farmer-Bat Conflict

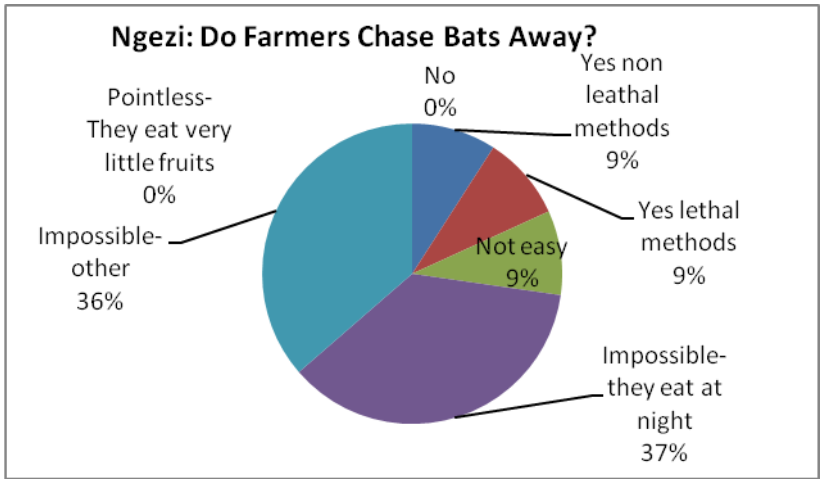


Figure 26. This figure shows the responses of interviewees from Ngezi when asked whether or not fruit farmers chased away the bats. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

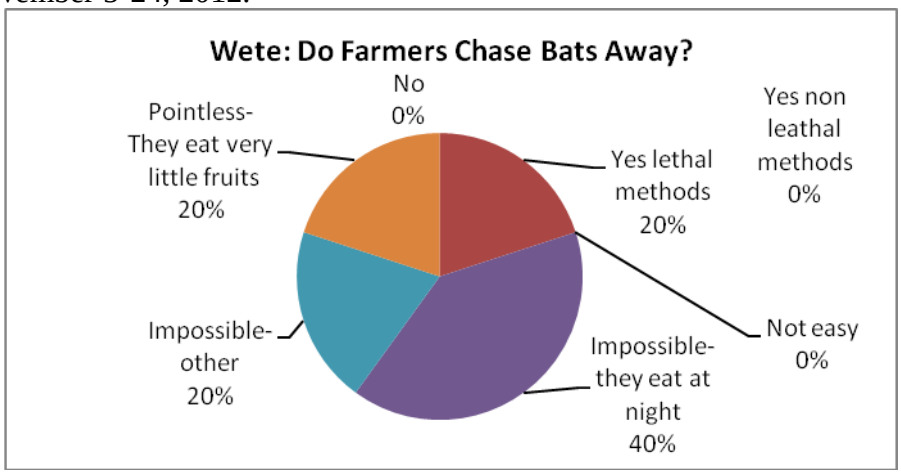


Figure 27. This figure shows the responses of interviewees from the Wete roost site when asked whether or not fruit farmers chased away the bats. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

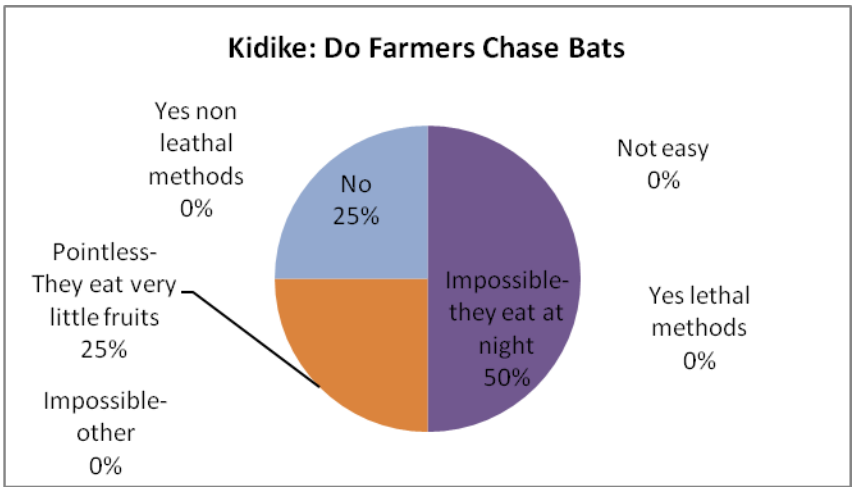


Figure 28. This figure shows the responses of interviewees from the Kidike roost site when asked whether or not fruit farmers chased away the bats. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

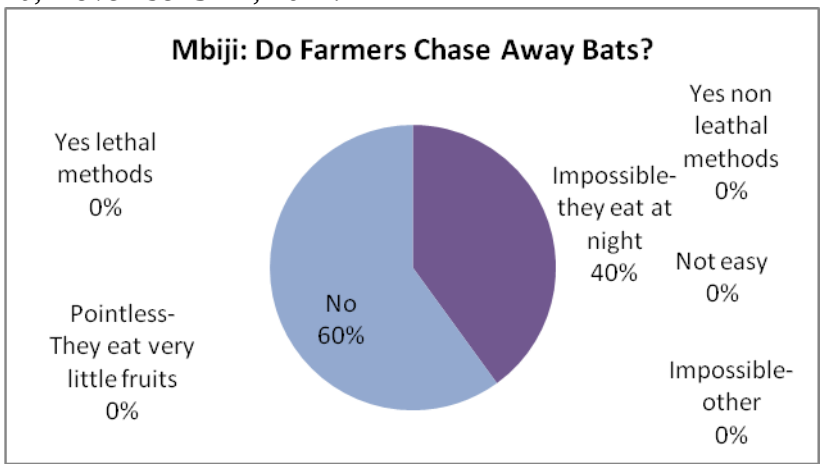


Figure 29. This figure shows the responses of interviewees from the Mbiji roost sites when asked whether or not fruit farmers chased away the bats. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

Appendix G-Site-Specific Interview Response Graphs: Hunting Presence

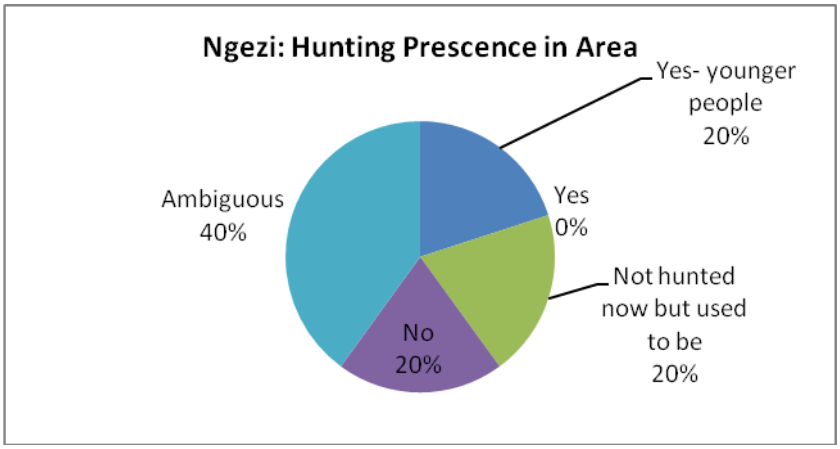


Figure 30.This figure shows the responses of interviewees from communities surrounding Ngezi when questioned about the presence or absence of hunting of the Pemba Flying Foxes in the Ngezi area. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

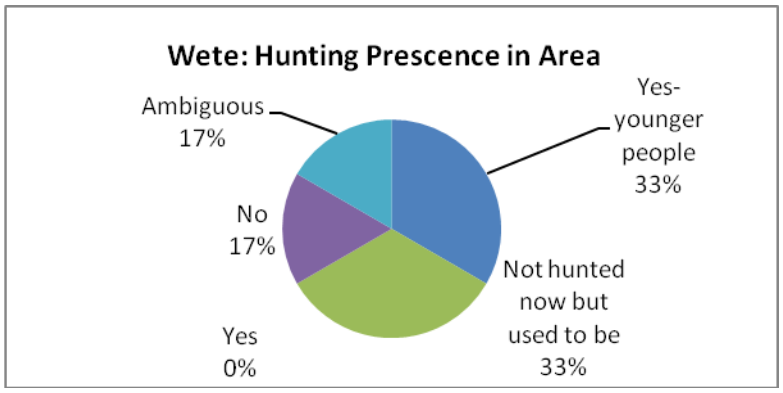


Figure 31.This figure shows the responses of Wete interviewees when questioned about the presence or absence of hunting of the Pemba Flying Foxes in the Wete area. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

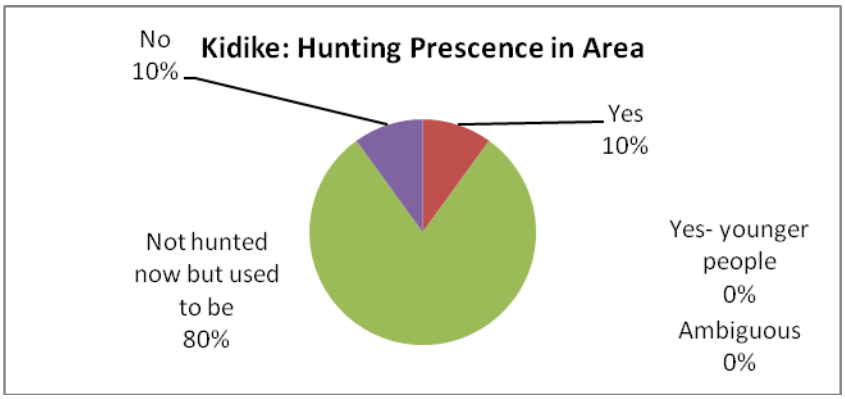


Figure 32.This figure shows responses of Mjini Ole respondents when questioned about the presence or absence of hunting of the Pemba Flying Foxes in the Kidike area. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

Appendix H-Site-Specific Interview Response Graphs: Reasons for Pemba Flying Foxes' Positive Public Image

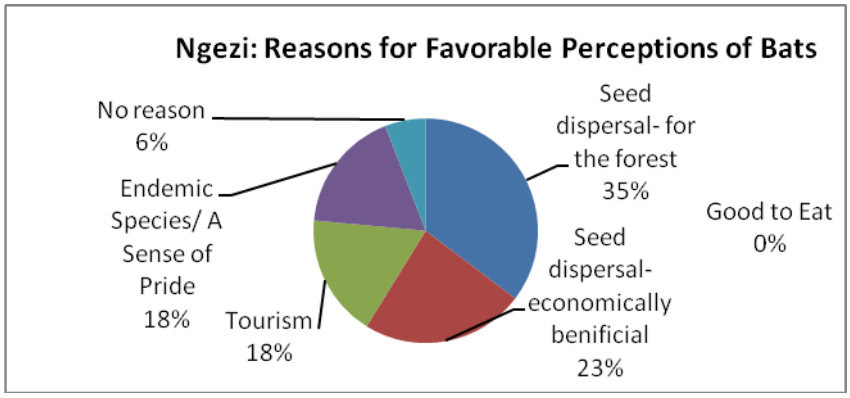


Figure 32. This figure shows the interviewees from Ngezi responses when asked about the reasons behind their favorable opinion of the bats. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

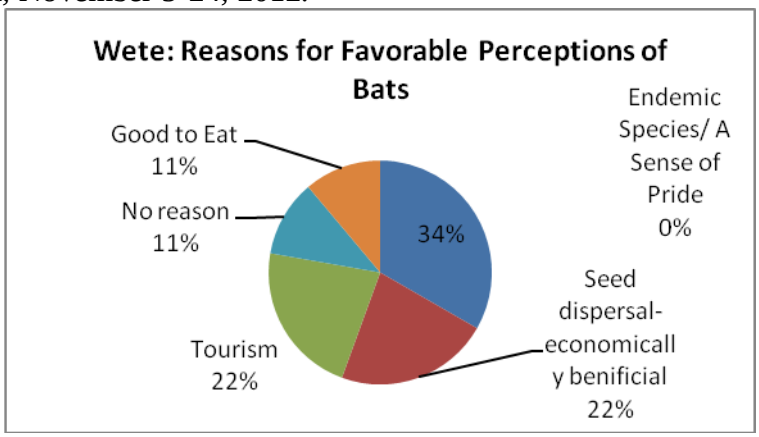


Figure 33. This figure shows the interviewees from Wete responses when asked about the reasons behind their favorable opinion of the bats. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

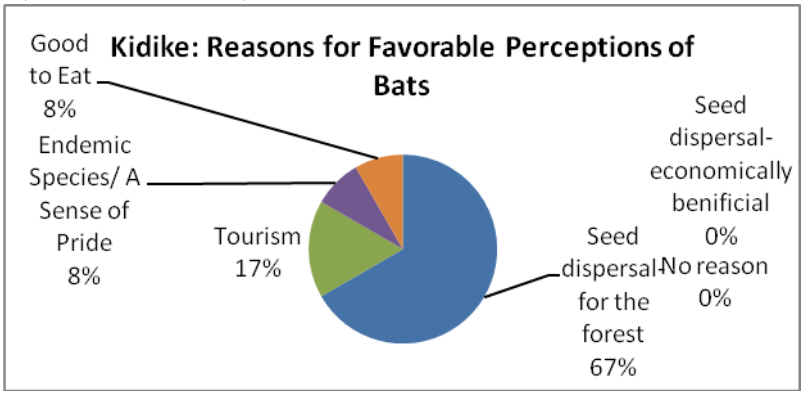


Figure 35. This figure shows the interviewees from Kidike responses when asked about the reasons behind their favorable opinion of the bats. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

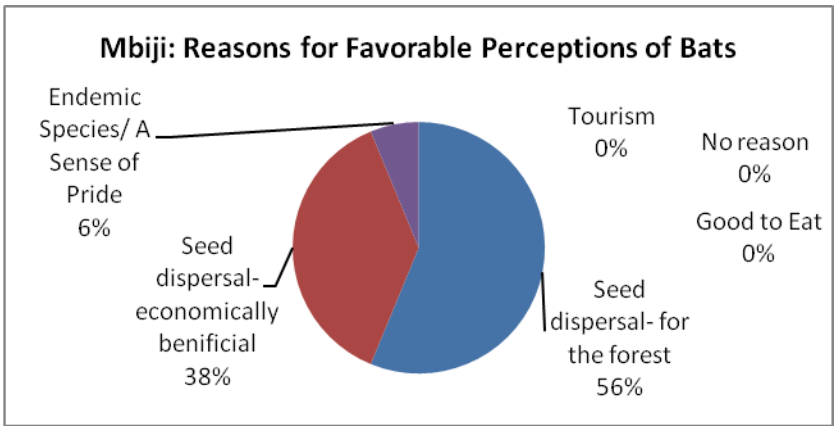


Figure 36. This figure shows the interviewees from Mbiji responses when asked about the reasons behind their favorable opinion of the bats. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

Appendix I-Site-Specific Interview Response Graphs: Presence of Pemba Flying Fox Conservation Education

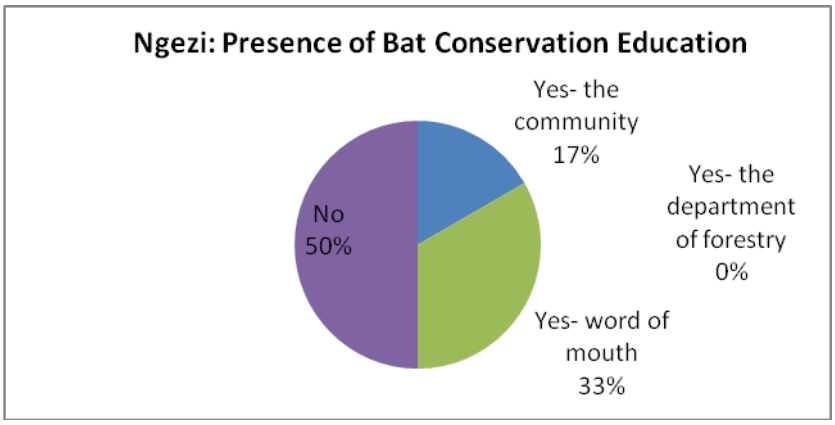


Figure 37. This figure shows the interviewees responses from Ngezi when questioned about conservation education of the Pemba Flying Fox. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

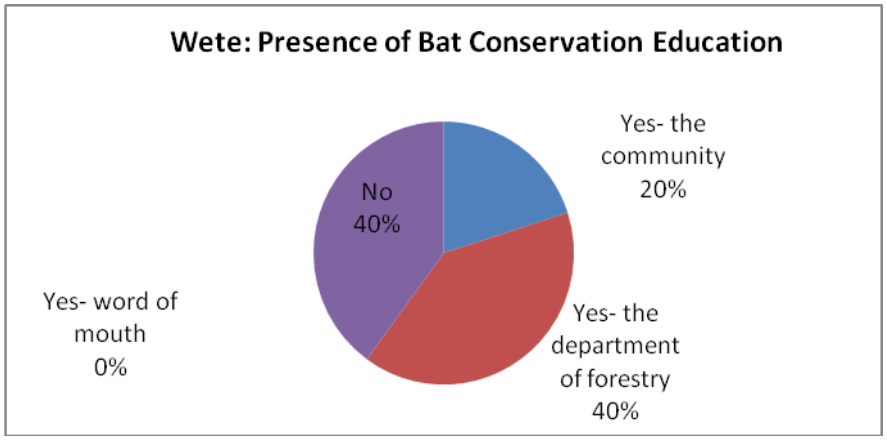


Figure 38. This figure shows the Wete interviewees responses when questioned about conservation education of the Pemba Flying Fox. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.

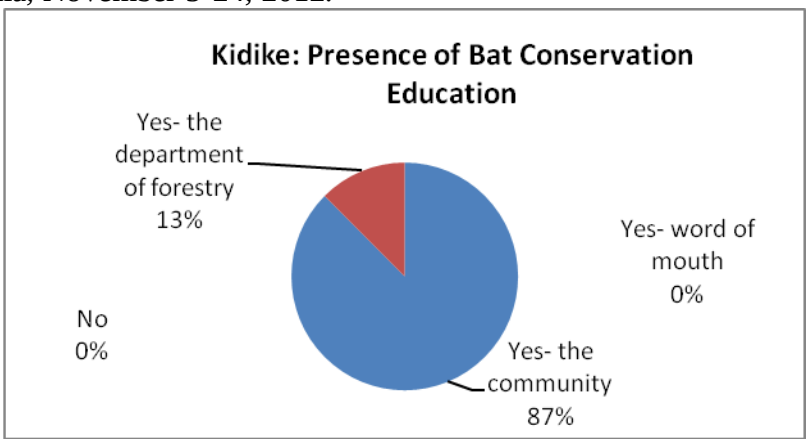


Figure 39. This figure shows the Kidike interviewees responses when questioned about conservation education of the Pemba Flying Fox. Interviews were performed on Pemba Island, Zanzibar, Tanzania, November 5-24, 2012.