Anthropogenic Disturbance in Nocturnal Primates & Conservation Perception in Zaraninge Forest, Tanzania

Adam Murphy
Master Thesis, 45 Credits, Ecology: Conservation Biology
Supervisor: Ola Olsson, Department of Biology: Biodiversity, Lund University

Galagos are an understudied family of primates which inhabit much of Sub-Saharan Africa, some of which are potentially at risk. The coastal forests of East Africa are home to many galagos, however this habitat is under threat from an increasing human population seeking timber, charcoal and land for agriculture, amongst other pressures. This study used repeated transect methods when estimating the density of both the Zanzibar galago (*Galagoides zanzibaricus*) and Garnett's galago (*Otolemur garnetti*) in a human influenced forest and a relatively undisturbed forest which were otherwise similar. Densities of Zanzibar galagos were not significantly influenced by human activities. Garnett's galago numbers showed a statistically significant though slight increase when their environment displayed signs of modification by human activities. Results also indicate that the future use of territory mapping style methods may give reliable estimates of species that have been difficult to monitor in the past, as well as providing a more comprehensive view of social structure in surveyed populations. A survey of 60 households in close proximity to these forests found that 56.7% of household heads thought that conservation of the forests and their resources were worth conserving. It also identified that problems need to be addressed in the management of the park to prevent loss of crops for farmers and that many of them resent stringent restrictions they must abide by when living in proximity to this protected forest. This study shows that proposed agroecosytems to be used to help the conservation of primates will only aid certain species and that further study is necessary of the Galago family to determine how they will fare in rapidly changing coastal forest environments.

Key Words: galago density, coastal forest, conservation perception, territory mapping

Introduction

Galagos *(Galagidae)* are a family of nocturnal primates consisting of three genera and are more commonly known as 'bushbabies'. They are native to Sub-Saharan Africa and can be found in forest and thicket areas across the continent. Most species are almost completely arboreal, though may come to the ground briefly when foraging. Galagos sleep during the day in nests and hollows within trees (Bearder et al. 2003). There is variation in the dietary composition of different species although common components include tree gum, insects and fruit. Some species specialise more than others in certain areas and there is often a high level of seasonal variation depending on availability (Nowack et al. 2013). Large and small galagos often inhabit the same areas due to a differentiation in niche within the same habitat (Bearder et al. 2003). The differences in size often correspond to differences in nesting sites, diet, behaviour and predation interactions (Burnham et al. 2013; Harcourt & Nash 1986b).

1

With increasing pressure being placed on primates in sub Saharan Africa and other regions there have been studies conducted to determine how they respond to human altered environments (Estrada et al. 2012; Bali et al. 2007; Butynski & Jong 2014), including within agroecosystems, which have been proposed as a viable conservation strategy for some species. However, how these methods affect cryptic primates such as bushbabies is currently unknown and they have frequently been overlooked in these studies.

The original intention of this project was to test the Giving Up Density (Brown 1988) of the severely endangered Rondo Dwarf Galago (*Galagoides rondoensis*) population, which is present in Zaraninge Forest. This has been previously shown to be an effective tool in monitoring behavioural changes in environmental pressures in galagos (Mcarthur et al. 2012). However, due to difficulties in locating a suitable population for the experiment this had to be abandoned. The target species was thus changed to the Zanzibar Galago (*Galagoides zanzibaricus*). This species is closely related and shares traits with the original focus species including social structure and size. However, the Zanzibar Galago generally avoids foraging in leaf litter and is currently listed as Least concern by the IUCN.

The original focus species of this study, the Rondo Dwarf Galago, is listed on the 25 most endangered primates in the world (Schwitzer et al. 2014) and is found exclusively in isolated pockets of coastal forests in Tanzania. These isolated pockets infer that the species previously inhabited a range extending from Northern Tanzania down to the southern region of Lindi, but have been ousted from most of their former range. The species relies on dry coastal forest (Bearder et al. 2003) and has a varied diet though it spends a larger amount of time foraging on the ground for insects as opposed to other galago species which are often more reluctant to leave the trees. It is closely related with other species of dwarf galago such as the Zanzibar galago, having a similar diet, social structure and habitat preference (Bearder et al. 2003). Although the Zanzibar galago is considerably less likely to forage in the leaf litter on the ground. For these reasons the Zanzibar Galago was deemed a suitable substitute species for this study in the absence of the Rondo Dwarf Galago when seeking to answer how dwarf galagos respond to anthropogenic changes in their environment.

Zanzibar Galagos live in small family groups typically consisting of a single male and two/three females and their offspring (Bearder et al. 2003; Harcourt & Nash 1986a). Their diet is mainly composed of insects though also contains other aspects, mostly fruit (Harcourt & Nash 1986b). They use vocal signals when foraging at night for several purposes (Bearder et al. 2003) such as long distance spacing, calls made between individuals moving as a group and to co-ordinate re-assembly before dawn. Nearby rivals will sometimes counter-call if nearby to ward each other off their respective territories (Bearder et al. 2003).

The majority of galago species are listed as being of 'Least concern' by the IUCN, including the Zanzibar galago, although in many cases there is little data and a poor understanding of populations. Some species are common and can be found in areas with a relatively high human population density, though others are rare with very little research having been

carried out to understand them. Some species have been shown to react negatively in the presence of logging (Weisenseel et al. 1993) and other human activities. However, in some instances there appears to be no effect of human activity on population densities (Campos et al. 2012).

Galagos are relatively understudied with many misclassifications which are only beginning to be corrected (Butynski et al. 2006; Pozzi et al. 2014). Due to their cryptic nature they have been side-lined in the study of primates and as a result little is known about their life history, distribution patterns and other traits. It is of importance that their full role within the ecosystem is understood before the risk of their loss further increases. It is possible that some species may occupy important roles within their respective ecosystems. These roles may include pollination, seed distribution, top down control of insect populations through predation, prey for owls etc. These are roles which have been demonstrated to be occupied by primates in other ecosystems (Howe 1980; Heymann 2011; Bidner 2014). For these reasons it is important to gain a deeper understanding of these species, many of which were only recently re-classified as distinct species and to understand how they respond to human encroachment so as to avoid their loss in future coastal forest ecosystems.

East African coastal forests are considered a global biodiversity hotspot (Myers et al. 2000) and can be found from Somalia in the North, down to Southern areas of Mozambique. There is an exceptional amount of endemic flora and fauna within the region. Although some coastal forests within Tanzania are under formal protection this is not always upheld by local populations for reasons such as a perceived lack of tangible value (Kimaro & Lulandala 2013). For this reason, forest which is at present unprotected is in danger of being destroyed. Even forest which is under formal protection is still at risk of being over exploited in some areas (Godoy et al. 2012).

These forests are worth preserving for a multitude of reasons, ranging from local to international interests, and from moral implications to economic benefits. First of all, in previously heavily forested areas of Africa there has been an increase in landslides and floods following deforestation (Ngecu et al. 2004). In addition to this there is a possibility of the discovery of medicinal properties in some of the many species that inhabit these extremely diverse forests (Peter et al. 2014). The preservation of these forests also leads to financial gain through sustainable use of resources, eco-tourism and the provision of ecosystem services such as the pollination of crops (Blomley et al. 2008; Sande et al. 2009). Local communities also receive cultural and recreational benefits from these forests, with many local religious customs placing importance on locations within the forests and the forests as an entire entity (Pakia & Cooke 2003; Kibet & Nyamweru 2008). Lastly there is also the important contribution that these forests give to the global climate as they store relatively large amounts of carbon and continue to sequester carbon from the atmosphere (Godoy et al. 2012).

The current population of Tanzania is ~50 million, with a relatively high level of density in coastal areas (Tanzanian National Bureau of Statistics 2012). This is projected to continue to rise which will obviously lead to an increased amount of strain placed on the local natural ecosystems, as areas used for agriculture

increase as well as the rate of consumption of natural resources.

The field site chosen for this experiment was Gongo village in the Pwani region of Tanzania. The reasoning for this being that it is located in an area of exceptional galago diversity, including the critically endangered Rondo Dwarf Galago, amongst others. The forest in this area was also easily accessible to researchers. The village is situated on the border of Saadani National Park, in proximity to a large coastal forest habitat known as Zaraninge Forest, which spills over the borders of the park and into unprotected land (Kiwia 2009).

Due to the relatively small amount of literature on galagos, there is not a well-established surveying method. The most common method used is transects, often relying on eye flash from torchlight. The use of transects is often employed when estimating galago density, although previous studies have not attempted to expand on this to give a more comprehensive picture of an area as this project sought to accomplish with the additional use of territory mapping.

In addition to this density study of the project a focus was placed on the land use of the local population in Gongo and their perception of local natural resources provided by the forest and within the National Park. This is of importance as it can give an indicator of the pressure that the local population will place on natural resources by expanding agriculture or if conservation will be prioritised in the hopes of attracting alternative income streams.

In summary the aims of this experiment were to establish if there is a change in galago density when exposed to a sustained human presence. Both Zanzibar galagos and the larger Garnett's galagos were recorded in the test areas. It was expected that in forests which have an increased human presence there will be a reduced density in the number of galagos present. The experiment also aimed to speculate as to whether or not the use of territory mapping is a viable method to be used when monitoring galago populations. With an additional aim to determine the attitudes of local villagers towards the forests present on their doorstep and to attempt to infer future trends that may take place in the area as a result of this.

Materials & Methods

Location

Zaraninge Forest (sometimes known as Kiona) is situated at 6.15°S, 38.60°E in Miono District, Pwani Region of the United Republic of Tanzania. It is situated on the edge of a plateau featuring a tropical coastal forest and the district has a population of 17,001 (Tanzanian National Bureau of Statistics 2012) as of 2012. The plateau rises above the coastal plain and is surrounded by thicket, woodlands and grasslands.

Two field sites were required to measure galago density. Two similar forest patches were selected, one with a relatively high human impact and the other with a relatively low amount of disturbance from humans. The two sites were similar in respects to tree composition, canopy height, leaf litter depth and species present.

Human disturbance was not measured quantitatively in the forest patches. This was determined through the presence and proximity of people living within and around the forest patch. Tangible disturbances included selective felling of trees, a continued human presence within the forest, noise disturbance and litter.

Density Experiment

A grid measuring 200mx200m was marked out in each area using cables of the appropriate length with intervals of 50m. This grid was then traversed whilst documenting the location of all galago activity, either by visual or audio observations. Galagos are distinguishable by their calls and so after a relatively small amount of training and exposure to the different calls it was possible to identify the species of an individual by both sight and sound (Bearder et al. 2013).

Each area was traversed a total number of 4 times giving 1 replicate after taking the mean number of observations. Each forest survey included five 200mx200m grids which were marked out in both the disturbed and undisturbed forest. The grids within each patch were then traversed a total number of 4 times, at dusk (ca 19:00), 2 hours after dusk (ca 21:00) over the course of two days. The average number of observations in each grid was then taken as an indication of how many individuals inhabit the area, giving a total of 5 replicates for each treatment.

To prevent any change of behaviour being documented purely as a result of the time of year and seasonality (the experiment took place over the course of 1 month) the surveying of the two different field sites was alternated so as not to favour a specific site early/late in the experimental timeline. It has been previously noted that the lunar cycle may play a role in the activity level of Zanzibar galagos (Weisenseel et al. 1993). It is possible that they would be more vulnerable to predators during a full moon thus reducing their activity level, though it appears that these galagos may respond by increasing activity during high lunar light levels as sight is their primary sense (Prugh & Golden 2014; Gursky 2003). However,

this will have been addressed in the same manner as any changes to seasonality, by alternating between sites over the duration of the fieldwork.

Questionnaire

For surveying the local people a questionnaire was written initially in English before being translated to Swahili due to the low level of English proficiency within Gongo village. Questions were chosen to give a rough indication of socio-economic background and current land use of households as well as perception of local forests and protected areas. Questionnaires were carried out on a household basis and took the form of an interview with an adult member of the family, an interpreter and a researcher. These interviews were kept short and sought to provide solid categorical responses. Responses were limited to those set out following the Likert scale in order to allow for simpler analysis of the results and to give a general overview of public opinion in the village.

Statistical Analyses

All statistics were carried out with the use of SPSS software. Independent T tests were carried out in the analysis of galago observations after determining the mean number of observations per site.

Results

Density Experiment

There was not a significant relationship between the presence of human disturbance and the number of observations of Zanzibar galago (T test: p= 0.17, df=5.43, f=1.375, t=-1.58, Lower CI= -2.07, Upper CI= 3.67). The mean population density in human altered environments was 4.45, an increase from

the mean population of 3.65 in areas with a high level of human activity.

There was a significant impact on the population of Garnett's galagos when environments are altered by humans (T test: p= 0.045, df=7.97, f value=0.094, t=2.37, Lower CI=0.18, Upper CI=1.28). Garnetti galago populations increased from 3.45 in undisturbed areas to 4.1 in areas with a relatively high level of human disturbance.

Table 1: Table showing the mean number of observations of each species within all 10 sites

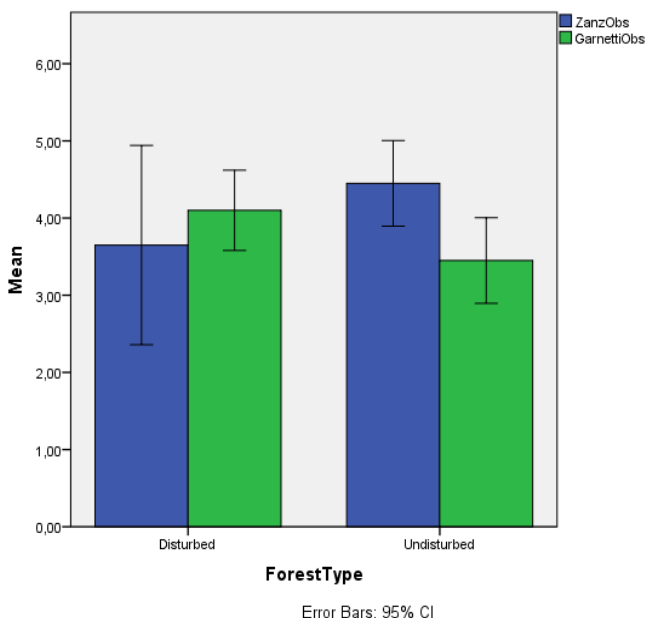| Site	Treatment	Zanz Obs	Garnetti Obs
Site 1	Disturbed	3.75	3.75
Site 2	Disturbed	5.25	4
Site 3	Disturbed	3	4.75
Site 4	Disturbed	3.75	3.75
Site 5	Disturbed	2.5	4.25
Site 6	Undisturbed	5	3
Site 7	Undisturbed	4	3.5
Site 8	Undisturbed	4	4
Site 9	Undisturbed	4.75	3
Site 10	Undisturbed	4.5	3.75

Figure 1: Mean number of observations in each treatment for both recorded species from repeated transect method

Territory Mapping

All four surveys of each site were overlaid on top of one another to show hotspots of Zanzibar galago activity. Through subjective analysis of these hotspots it is possible to estimate how many individuals inhabit each area and the social structure of the area.

These estimates are significantly higher than those taken from the mean number of observations within each site, exceeding them on average by 69%. No perceived social group exceeded more than 3 individuals.

Table 2: A comparison of the mean number observations with the estimated number of individuals within each site for the Zanzibar galago

Site	Treatment	Mean Observations	Territory Mapping Est
Site 1	Disturbed	3.75	7
Site 2	Disturbed	5.25	8
Site 3	Disturbed	3	6
Site 4	Disturbed	3.75	6
Site 5	Disturbed	2.5	5
Site 6	Undisturbed	5	7
Site 7	Undisturbed	4	6
Site 8	Undisturbed	4	7
Site 9	Undisturbed	4.75	8
Site 10	Undisturbed	4.5	7

Conservation Perception Survey

The survey gave results for a total number of 60 households within the village. The average number of adults per house was 2.4 and with an average number of 4.13 children though this was as high as 15 in one instance. The average amount of land held by a household was 3.13ha and 5% of those surveyed held no land and so relied on other income sources (answers were given in acres and then converted to hectares). The largest amount of land owned by a household was 18.21ha in one instance.
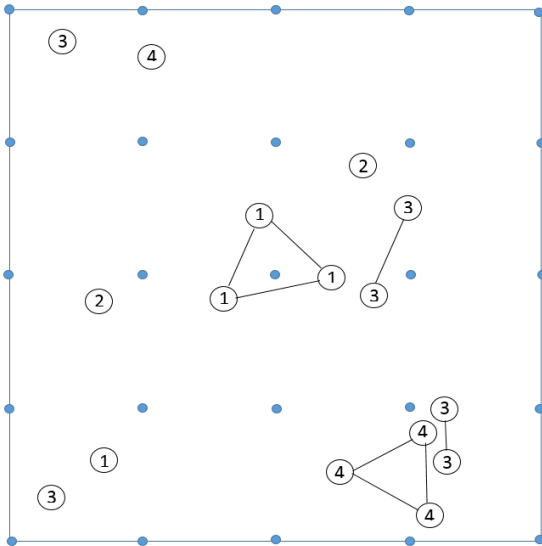
Fig 2: An example of the territory mapping method in Undisturbed Site 3 for the Zanzibar galago. Each number corresponds to an individual survey and connected observations denote individuals calling in unison.

Just over half of respondents considered it important to conserve the forests surrounding the village, with 56.7% giving a positive response, whilst 36.7% of villagers stated it was not a priority. Despite this, only 20% of households stated that they would be unwilling to make efforts to aid conservation whilst 70% said that they would be prepared to do this, the remaining 10% were unsure.

Most people (76.6%) felt that long term economic priorities were more important than conservation goals in the village and 46.7% thought that short term economic priorities were more important than conservation goals. Just over half (53.5%) of respondents did not identify a negative impact on their livelihoods as a result of living in close proximity to the forests. Of the 40% who did identify negative effects the most frequently identified was the loss of crops to animals such as baboons (91.7%). The second most cited problem was the restrictions and regulations that the TANAPA (Tanzania National Parks) organisation places on their farming practices (25%), preventing further expansion into forested areas and exploitation of resources within protected areas. A large majority (75%) of respondents stated that they believed tourism would be beneficial for the village.

Of the respondents who owned land 77.2% grew maize, 68.4% grew pineapple, 17.5% grew cassava, 19.3% grew coconut and 22.8% grew banana. Other minor crops that made up smaller proportions of agricultural land include oranges, lemons, rice, papaya, sugar and beans. All land owners grew either maize or pineapple and 45.6% grew both of these together, making them by far the most important crops in the village. The majority of respondents (65%) stated that they thought it would be beneficial for the village to operate a managed forest for important resources such as timber, whilst 33.3% thought that this would not be of benefit. Deadwood and charcoal were the only fuel sources used by those surveyed, 15% of households used charcoal for fuel and 85% used deadwood. Almost all of this fuel was claimed to have been sourced from trees in farmland (85%), with a further 10% having been purchased from vendors and 5% of respondents illegally taking resources from protected areas of the forest. However, it was evident from the responses of many of the participants that their answer to this question was not truthful and that a much higher proportion of the population obtains wood from the forest.

Factors such as family size and amount of land owned were not found to be reliable indicators of how participants would respond to questions. Nor were answers given to questions indicative of how the participant would respond to another question.
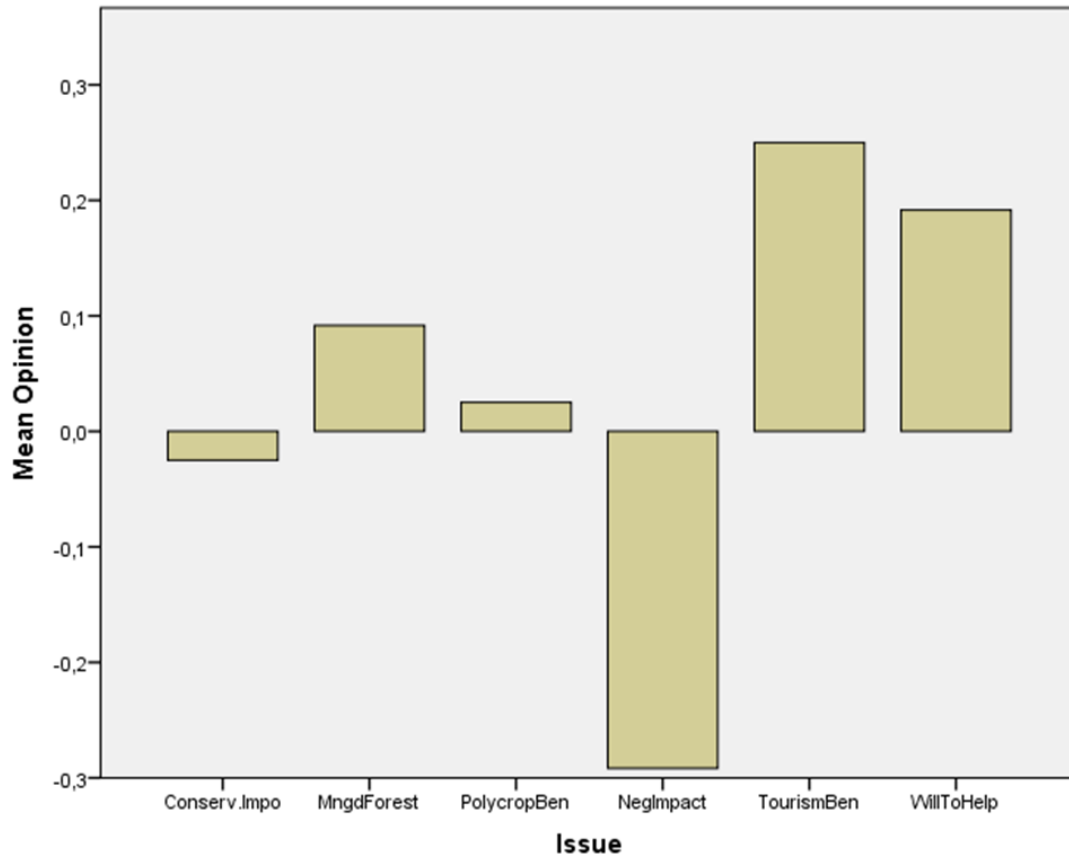
Figure 3: The average opinion on key conservation issues across the village. Total disagreement would be -1 whilst total agreement would be a value of 1 and 0 is a neutral opinion. The issues are as follows: Is conservation of importance, is there a potential benefit to a Managed Forest, Is there a potential benefit of a polycrop system, Are there any negative impacts from the forest currently, Would tourism benefit the village, Are locals willing to contribute to conservation.

Discussion

This study had a very small sample size as a result of time constraints, which may have been a contributing factor in the lack of a discernible relationship between Zanzibar galago densities and the presence of anthropogenic disturbances. However, this study suggests that similar studies must be carried out with larger sample sizes in order to establish a better understanding of whether or not there is indeed a relationship.

Human disturbances impacted populations of Garnett's galago, leading to an increase of 0.65 observations on average within the 200x200m areas. The exact reasons for

why this would occur are currently unclear. It would appear that human activities such as selective felling of trees and a reduction in understory thickness creates a more favourable environment for the larger Garnett's galagos. This species tends to remain in the high canopy and has a different social structure than the Zanzibar galago (Bearder et al. 2003; Nash & Harcourt 1986), opting to be largely solitary with overlapping territories between males and females. It has a diet consisting of around 50-50 fruit and insect/animal matter (Masters et al. 1988). Human induced environmental changes may create conditions that favour this diet composition over that of the Zanzibar

galago, which is comparatively more reliant on insects (Harcourt & Nash 1986b; Masters et al. 1988). The species may be more adaptable and able to vary its diet more than other species. They have been shown to be capable performing learned behaviours which may be advantageous in responding to human induced habitat changes (Watson et al. 1994). It is a possibility that this trend of larger galagos responding more positively to environmental changes than smaller species is also the case in regards to other species of dwarf galagos that co-exist with larger species.

A factor that may have had some impact on the study is that we may see a time lag between the initial exposure to human activity and the eventual response from galago populations, which has been demonstrated before in other species of mammal (Crooks 2005). This would mean that galago populations within disturbed forest are still going through a transitional period and have not yet reached a new population equilibrium in a human influenced habitat. If this is the case then it becomes necessary to maintain the environment in its present state and to continue surveying the population over an extended period of time. In addition to this the impact of the increased fragmentation of habitats can exacerbate these time lagged problems through a reduction in genetics (Richmond et al. 2009), as galagos are likely to struggle to disperse across fragments.

It may be possible that there was not a change in the density of species when humans are present, but merely that this facilitates a change in behaviour (Farris et al. 2014). If galagos become less vocal and active when there is a high level of human activity or vice versa then this will have affected the results of the experiment. It would be reasonable to assume that this change in behaviour will lead to population changes in the species through alterations such as reduced risk taking and less time spent foraging which has been demonstrated in other mammal species (Shannon et al. 2014).

This experiment has shown that territory mapping is a potentially viable method when studying galago populations, particularly the Zanzibar galago due to their social structure and frequent calling behaviour (Harcourt & Nash 1986a). The small number of repetitions per area meant that it was not possible in this experiment to obtain definitive evidence, as 10 repetitions are recommended when using this method in passerines (Gregory et al. 2004). However, observed results suggests that it may give a comprehensive estimate of the density of some species of galago when used effectively. Some coastal dwarf galagos are allopatric and occupy the same niche, these being the Zanzibar Dwarf, Kenyan Coastal and Mozambican Galagos (Butynski et al. 2006), which displace each other along the East African coast. The high level of similarity among these species means that they are likely to respond to the same environmental stresses, thus giving easily transferable results when assessing the health of coastal forests in East Africa. This holds the possibility of opening up the use of galago density as an indicator of coastal forest disturbance levels, an important potential tool in the conservation of these threatened habitats (Leis et al. 2008; Mathur et al. 2011; Trindade-Filho & Loyola 2011). However it is unclear if all species are as suitable for study using these methods as the Zanzibar galago has been noted to be particularly social and so they lend themselves more to methods such as these through behaviour (Harcourt & Nash 1986a).

As the majority of Zaraninge forest is located within the Saadani national park it has been afforded a relatively good level of protection and so is likely to be at minimal risk of extensive exploitation (Mligo et al. 2011). However, there are also large parts of the forest located outside the borders of the park and so are not protected from exploitation (Mligo et al. 2009). As a result, these unprotected areas of forest are being converted into agricultural land by the increasing population within Gongo and other local villages. In addition to this there continues to be minor exploitation of the protected forest as it appears that the majority of the local population venture into the forest in order to retrieve wood to use as a fuel source. Though this is formally illegal it appears to be widely practiced within the village and clearly carries a risk of over exploitation of the remaining resources. Results from the questionnaire on where people source their timber and fuel were unreliable as people were wary of repercussions should they admit to using resources from the forest. This slow and gradual process may erode the edges of the remaining protected forest if left unchecked and villagers are not given a suitable alternative fuel source which is more sustainable. Nearby villages use managed forest areas to allow for the sustainable acquisition of timber and other forest products, this would also be beneficial to Gongo and should be considered for the future.

The original intended species of this experiment the Rondo dwarf galago, is likely to have a secure future in Saadani National Park if they have a similar response to human pressures as the Zanzibar galago was found to have in this experiment. The species population within the protected areas of Zaraninge forest are likely to only face minor anthropogenic

disturbance in the form of people using the forest to source firewood. Although this study would suggest that areas where the species is known to be present should be afforded further protection by authorities due to the very small fractions of remaining habitat they have, a large portion of which is already under threat, such as Pande game reserve (Eshiamwata et al. 2008).

Because of the social structure and behaviour of Zanzibar galagos (Harcourt & Nash 1986a) it appears possible to use territory mapping methods when assessing a population in a given area, similar to how this method is used in bird populations (Anich et al. 2009; Broughton et al. 2006). As this experiment made repeated surveys of the same areas it is possible to overlay the locations of galago activity to identify hotbeds of activity and thus deduce individuals and family groups. However, because of time constraints it was not possible to carry out a definitive comparison between the two methods and so results mentioned here are merely speculative.

In all sites the repeated transect method underreported the number of individuals present in an area when compared with the number of present individuals estimated from using territory mapping methods. It also makes family groups apparent and can show the differences in social structures within populations.

However, in order to reduce errors that arise from subjection it becomes necessary to increase the number of surveys within each site. This makes the process much more time intensive for securing statistically comparable figures, rendering it impractical in some applications. Despite this issue there are some instances when these methods would be of use. Namely detailed and in depth studies of

populations in small areas, which provides information about the subtle intra and inter species relationships of target species and their habitats.

A more comprehensive comparison of these two methods would be of great benefit to the continued study of galagos. The efficacy of this method in other species of galago is unclear and is unlikely to be as useful as when used in Zanzibar galagos due to their high level of social bonds, consistent use of the same nest sites and frequent use of calling.

With just over half the surveyed population responding that they believed conservation is important it is apparent that further progress is needed in making people aware of the long term benefits that become available through conservation. This can be achieved through initiatives to educate people about these issues and the provision of alternative sources of income.

It has been shown that when people are informed of how they benefit from the presence of ecosystem services then they are more willing to make sacrifices to conserve these resources (Hutchison et al. 2013; Iniesta-Arandia et al. 2014). It is important to provide this education rather than to merely enforce restrictions as it will avoid creating resentment among the population as well as reduce costs of enforcing any regulations (Marshall et al. 2007).

A large number of people who identified negative impacts as a result of the forest stated that damage to crops caused by wildlife was problematic. Issues such as this must be addressed in order to ensure that local people support conservation. Solutions must be provided in order to reduce these negative impacts as much as possible, thus increasing the proportion of people who are happy to continue

conservation efforts in their local area. Preventative measures to prevent loss of revenue to wildlife can consist of simple and cost effective tools and strategies that can keep out animals such as baboons (Hill & Wallace 2012; Musyoki 2014), which were identified as the primary culprit. The identification of the key crops of the village in this study should also be taken into account, with a large amount of the population relying on the export pineapple as a cash crop to other regions of the country.

Alternative sources of income are necessary to give people an option that would not involve the destruction of the forest. This is already underway in the village with TANAPA providing jobs and the development of tourism in the area which will not only create a source of income but also a positive feedback loop as this then creates more incentive to preserve the forest in order to continue a stream of tourists to the area. However, there have also been instances of dissatisfaction among people living under the jurisdiction of national parks in various locations as a result of mismanagement, lack of access to revenues and excessively strict access to resources, amongst other issues (Bennett & Dearden 2014; Vedeld et al. 2012). It is therefore important to give local communities a say in how these matters are run which has previously been shown to provide a good outcome for both the conservation of the area and of local communities (Ferraro & Hanauer 2011).

Future study areas

Further study into cryptic primates as a whole is necessary in order to better our understanding of their niche in the environment and what ecosystems stand to lose in the event that galagos or other species are not afforded sufficient protection to ensure their survival in these

coastal forests. A repeat of this experiment in field sites where the threatened Rondo Dwarf Galago is present would clearly be of benefit. The perception of natural landscapes can also be looked at in other areas surrounding the national park to give a better indication of all the threats that are being faced by it. In future studies it would be of interest to continue to record the attitudes of local people in the area. This would allow for researchers to monitor how the perception of natural environments changes over time in this small village and whether specific events help to influence this.

Conclusions

This study has shown that there is potential for the use of territory mapping in depth studies of galago populations. In addition to this the findings show that human altered forests are likely to favour larger species of galagos. Showing that agroecosystems or other human altered environments are likely to favour some galago species over others if implemented in coastal forest areas of East Africa. This study aided in laying groundwork to further develop the study of these poorly understood species and how they are likely to respond to a rapidly changing environment. Having said this there is considerable further study which is necessary in order to confirm the viability of the methods outlined within these experiments. It has also given important insights into the general opinions of people who live in ecologically important areas within coastal East Africa. Although many people in the village of Gongo recognise the importance of the natural resources available to them, there is further education needed to ensure that these forests receive adequate protection. It is recommended that formal protection is extended to encompass more of Zaraninge

forest, but with local priorities also taken into account. There is still the necessity for the continuation of research into the threats faced by natural environments in these areas and the potential to change these perceptions in the hope that human pressure on these important ecological areas are reduced.

References

Anich, N.M., Benson, T.J. & Bednarz, J.C., 2009. Estimating Territory and Home-range Sizes: Do Singing Locations Alone Provide an Accurate Estimate of Space Use? *The Auk*, 126(3), pp.626–634.

Bali, A., Kumar, A. & Krishnaswamy, J., 2007. The mammalian communities in coffee plantations around a protected area in the Western Ghats, India. *Biological Conservation*, 139(1-2), pp.93–102.

Bearder, S.K. et al., 2003. Species-typical patterns of infant contact, sleeping site use and social cohesion among nocturnal primates in Africa. *Folia Primatologica*, 74(5-6), pp.337–354.

Bearder, S.K., Butynski, T.M. & Jong, Y.A. De, 2013. Vocal Profiles for the Galagos: A Tool for Identification. *Primate Conservation*, 27, p.75.

Bennett, N.J. & Dearden, P., 2014. Why local people do not support conservation: Community perceptions of marine protected area livelihood impacts, governance and management in Thailand. *Marine Policy*, 44, pp.107–116. Available at: http://dx.doi.org/10.1016/j.marpol.2013.08.017.

Bidner, L.R., 2014. Primates on the Menu: Direct and Indirect Effects of Predation on Primate Communities. *International Journal of Primatology*, 35, pp.1164–1177.

Blomley, T. et al., 2008. Seeing the wood for the trees: an assessment of the impact of participatory forest management on forest condition in Tanzania. *Oryx*, 42(3), pp.380–391.

Broughton, R.K. et al., 2006. Marsh Tit Poecile palustris territories in a British broad-leaved wood. *Ibis*, 148(4), pp.744–752.

Brown, J.S., 1988. Patch use as an indicator of habitat preference, predation risk, and competition. *Behavioral Ecology and Sociobiology*, 22(1), pp.37–47.

Burnham, D. et al., 2013. Predation by Mammalian carnivores on nocturnal primates: Is the lack of evidence support for the effectiveness of nocturnality as an antipredator strategy? *Folia Primatologica*, 83(3-6), pp.236–251.

Butynski, T.M. et al., 2006. Taxonomy, Distribution, and Conservation Status of Three Species of Dwarf Galagos (Galagoides) in Eastern Africa. *Primate Conservation*, 21(21), pp.63–79.

Butynski, T.M. & Jong, Y.A. De, 2014. Primate Conservation in the Rangeland Agroecosystem of Laikipia County, Central Kenya. *Primate Conservation*, (28), pp.117–128.

Campos, F.A., Wikberg, E.C. & Holmes, T.D., 2012. Population assessment of Demidoff's dwarf galago (Galagoides demidovii) in a Ghanaian forest fragment mosaic. In *Poster presentation at 81st Annual Meeting of the American Association of Physical Anthropologists*.

Crooks, J.A., 2005. Lag times and exotic species : The ecology. *Ecoscience*, 12(3), pp.316–329.

Eshiamwata, G. et al., 2008. Status Report for the Eastern Arc Mountains and Coastal forests of Kenya and Tanzania Region, 2007. *Response*, (November).

Estrada, A., Raboy, B.E. & Oliveira, L.C., 2012. Agroecosystems and Primate Conservation in The Tropics: A Review. *American Journal of Primatology*, 74(8), pp.696–711.

Farris, Z.J. et al., 2014. Predator – Primate Distribution , Activity , and Co-occurrence in Relation to Habitat and Human Activity Across Fragmented and Contiguous Forests in Northeastern Madagascar. *International Journal of Primatology*, 35, pp.859–880.

Ferraro, P.J. & Hanauer, M.M., 2011. Protecting ecosystems and alleviating poverty with parks and reserves: "Win-win" or tradeoffs? *Environmental and Resource Economics*, 48(2), pp.269–286.

Godoy, F.L. et al., 2012. Deforestation and CO2 emissions in coastal Tanzania from 1990 to 2007. *Environmental Conservation*, 39(01), pp.62–71.

Gregory, R.D., Gibbons, D.W. & Donald, P.F., 2004. Bird census and survey techniques. In *Bird Ecology and Conservation*. pp. 17–56. Available at: http://books.google.com/books?hl=en&lr=&id=dz67JguEeRMC&oi=fnd&pg=PA17&dq=Bird+census+and+survey+techniques&ots=P0QdUXZext&sig=RweTZsHOBncq6yqZQoP9DVcN3c8.

Gursky, S., 2003. Lunar philia in a nocturnal primate. *International Journal of Primatology*, 24(2), pp.351–367.

Harcourt, C.S. & Nash, L.T., 1986a. Social organization of Galagos in Kenyan coastal forests: I. Galago zanzibaricus. *American Journal of Primatology*, 10(4), pp.339–355.

Harcourt, C.S. & Nash, L.T., 1986b. Species differences in substrate use and diet between sympatric galagos in two Kenyan coastal forests. *Primates*, 27(1), pp.41–52.

Heymann, E.W., 2011. Florivory, Nectarivory, and Pollination - A review of Primate-Flower Interactions. *Ecotropica*, 17, pp.41–52.

Hill, C.M. & Wallace, G.E., 2012. Crop protection and conflict mitigation: Reducing the costs of living alongside non-human primates. *Biodiversity and Conservation*, 21(10), pp.2569–2587.

Howe, H.F., 1980. Monkey Dispersal and Waste of a Neotropical Fruit. *Ecology*, 61(4), pp.944–959.

Hutchison, L. et al., 2013. Stakeholder Perceptions of Coastal Habitat Ecosystem Services. *Estuaries and Coasts*, 38, pp.67–80.

Iniesta-Arandia, I. et al., 2014. Socio-cultural valuation of ecosystem services: uncovering the links between values, drivers of change, and human well-being. *Ecological Economics*, 108, pp.36–48. Available at: http://dx.doi.org/10.1016/j.ecolecon.2014.09.028.

Kibet, S. & Nyamweru, C., 2008. Cultural and Biological Heritage at Risk; The Case of the Rabai Kaya Forests in Coastal Kenya. *Journal of Human Ecology*, 24(4), pp.287–295.

Kimaro, J. & Lulandala, L., 2013. Human Influences on Tree Diversity and Composition of a Coastal Forest Ecosystem : The Case of Ngumburuni Forest Reserve , Rufiji , Tanzania. *International Journal of Forestry Research*, 2013, pp.1–7.

Kiwia, H., 2009. Species richness and abundance of large mammals in Zaraninge forest, Coast region, Tanzania. *Tanzania Journal of Science*, 32(2).

Leis, S. a. et al., 2008. Small mammals as indicators of short-term and long-term disturbance in mixed prairie. *Environmental Monitoring and Assessment*, 137(1-3), pp.75–84.

13

Marshall, K., White, R. & Fischer, A., 2007. Conflicts between humans over wildlife management: On the diversity of stakeholder attitudes and implications for conflict management. *Biodiversity and Conservation*, 16(11), pp.3129–3146.

Masters, J.C., Lumsden, W.H.R. & Young, D. a., 1988. Reproductive and dietary parameters in wild greater galago populations. *International Journal of Primatology*, 9(6), pp.573–592.

Mathur, P.K. et al., 2011. Mammal indicator species for protected areas and managed forests in a landscape conservation area of northern India. *Biodiversity and Conservation*, 20(1), pp.1–17.

Mcarthur, C. et al., 2012. The foraging tightrope between predation risk and plant toxins: A matter of concentration. *Functional Ecology*, 26(1), pp.74–83.

Mligo, C. et al., 2009. Vegetation Community Structure, Composition and Distribution Pattern in the Zaraninge Forest, Bagamoyo District, Tanzania. *Journal of East African Natural History*, 98(2), pp.223–239.

Mligo, C., Lyaruu, H. & Ndangalasi, H., 2011. The effect of anthropogenic disturbances on population structure and regeneration of Scorodophloeus fischeri and Manilkara sulcata in coastal forests of Tanzania. *Southern Forests: a Journal of Forest Science*, 73(1), pp.33–40.

Musyoki, C., 2014. Crop defense and coping strategies : Wildlife raids in Mahiga " B " village in Nyeri District , Kenya. *African Study Monographs*, 35(1), pp.19–40.

Myers, N. et al., 2000. Biodiversity hotspots for conservation priorities. *Nature*, 403(6772), pp.853–8. Available at: http://www.ncbi.nlm.nih.gov/pubmed/10706275.

Nash, L.T. & Harcourt, C.S., 1986. Social organization of Galagos in Kenyan coastal forests: II.Galago garnettii. *American Journal of Primatology*, 10(4), pp.357–369. Available at: http://doi.wiley.com/10.1002/ajp.1350100407.

Ngecu, W.M., Nyamai, C.M. & Erima, G., 2004. The extent and significance of mass-movements in Eastern Africa: Case studies of some major landslides in Uganda and Kenya. *Environmental Geology*, 46, pp.1123–1133.

Nowack, J. et al., 2013. Surviving the Cold, Dry Period in Africa: Behavioral Adjustments as an Alternative to Heterothermy in the African Lesser Bushbaby (Galago moholi). *International Journal of Primatology*, 34(1), pp.49–64.

Pakia, M. & Cooke, J. a, 2003. The ethnobotany of the Midzichenda tribes of the coastal forest areas in Kenya: 1. General perspective and non-medicinal plant uses. *South African Journal of Botany*, 69(3), pp.370–381. Available at: http://ezproxy.umsl.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=afh&AN=12150808&site=ehost-live&scope=site.

Peter, E.L. et al., 2014. Ethno-medicinal knowledge and plants traditionally used to treat anemia in Tanzania: A cross sectional survey. *Journal of Ethnopharmacology*, 154(3),

pp.767–773. Available at: http://dx.doi.org/10.1016/j.jep.2014.05.002.

Pozzi, L., Disotell, T.R. & Masters, J.C., 2014. A multilocus phylogeny reveals deep lineages within African galagids (Primates: Galagidae). *BMC evolutionary biology*, 14(1), p.72. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4021292&tool=pmcentrez&rendertype=abstract.

Prugh, L.R. & Golden, C.D., 2014. Does moonlight increase predation risk? Meta-analysis reveals divergent responses of nocturnal mammals to lunar cycles. *Journal of Animal Ecology*, 83(2), pp.504–514.

Richmond, J.Q. et al., 2009. Delayed genetic effects of habitat fragmentation on the ecologically specialized Florida sand skink (Plestiodon reynoldsi). *Conservation Genetics*, 10(5), pp.1281–1297.

Sande, S.O. et al., 2009. Proximity to a forest leads to higher honey yield: Another reason to conserve. *Biological Conservation*, 142(11), pp.2703–2709. Available at: http://dx.doi.org/10.1016/j.biocon.2009.06.023.

Schwitzer, C. et al., 2014. *Primates in Peril: The World's 25 Most Endangered Primates 2012–2014*,

Shannon, G. et al., 2014. Road traffic noise modifies behaviour of a keystone species. *Animal Behaviour*, 94, pp.135–141.

Tanzanian National Bureau of Statistics, 2012. National Census. Available at: http://www.nbs.go.tz/ [Accessed May 27, 2015].

Trindade-Filho, J. & Loyola, R.D., 2011. Performance and consistency of indicator groups in two biodiversity hotspots. *PLoS ONE*, 6(5), pp.17–20.

Vedeld, P. et al., 2012. Protected areas, poverty and conflicts. A livelihood case study of Mikumi National Park, Tanzania. *Forest Policy and Economics*, 21, pp.20–31.

Watson, S.L., Schiff, M. & Ward, J.P., 1994. Effects of modeling and lineage on fishing behavior in the small-eared bushbaby (otolemur garnettii). *International Journal of Primatology*, 15(4), pp.507–519.

Weisenseel, K., Chapman, C. a & Chapman, L.J., 1993. Nocturnal Primates of Kibale-Forest - Effects of Selective Logging on Prosimian Densities. *Primates*, 34(4), pp.445–450.

Appendix

1. How many people are there within your household?

   Adults……………..   Children……………..

2. How much agricultural land does your household own?
   ………………………….

3. What goods do you produce with this land?
   ……………………………………………………………………………..

4. What kind of fuel do you use in your household?
   ……………………………………………………………………………..

5. Where do you get this fuel from?
   ……………………………………………………………………………..

   In the following questions please select only one box

6. Is conservation of importance to you?
   Completely Disagree☐ Somewhat Disagree ☐ Unsure ☐ Somewhat Agree☐Completely Agree ☐

7. Is the acquisition of agricultural land and timber products more important than conservation in the short term?
   Completely Disagree☐ Somewhat Disagree☐ Unsure ☐ Somewhat Agree☐Completely Agree ☐

8. Is the acquisition of agricultural land and timber products more important than conservation in the long term?
   Completely Disagree☐ Somewhat Disagree☐ Unsure ☐ Somewhat Agree☐Completely Agree ☐

9. Would you agree a managed forest for wood and other products would be beneficial?
   Completely Disagree☐ Somewhat Disagree☐ Unsure ☐ Somewhat Agree☐Completely Agree ☐

10. Would a polycrop system yield benefit?
    Completely Disagree☐ Somewhat Disagree☐ Unsure ☐ Somewhat Agree☐Completely Agree ☐

11. Does the forest in its present state negatively impact your household in any way?
    Completely Disagree☐ Somewhat Disagree☐ Unsure ☐ Somewhat Agree☐Completely Agree ☐
    If yes, please give more details,
    ……………………………………………………………………………………..

12. Is the development of tourism in the area beneficial to Gongo?
    Completely Disagree☐ Somewhat Disagree☐ Unsure ☐ Somewhat Agree☐Completely Agree ☐

13. Would you be willing to help preserve local forests?
    Completely Disagree☐ Somewhat Disagree☐ Unsure ☐ Somewhat Agree☐Completely Agree ☐