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2013 Expedition To Tampolo Forest, Madagascar - Final report

An investigation on the abundance and distribution of 5 nocturnal lemur species with focus on ecologically important habitat characteristics and anthropological threats.

Newcastle University
Centre Ecologique de Libanona
Royal Geographical Society with IBG — Advancing geography and geographical learning
Gilchrist Educational Trust
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1. Executive Summary

Tampolo forest, in the North East of Madagascar, is a protected area of littoral forest, managed by ESSA- Forêts of the University of Antananarivo. Five species of nocturnal lemur are thought to be present in the forest; the aye-aye (*Daubentonia madagascariensis*), brown mouse lemur (*Microcebus rufus*), greater dwarf lemur (*Cheirogaleus major*), weasel sportive lemur (*Lepilemur mustelinus*) and eastern wooly lemur (*Avahi laniger*). However, currently there is a paucity of data on the density and distribution of these species.

Our aim was to collect baseline data on the abundance and ecology of these lemur species for population monitoring purposes, future research and conservation actions. We used 20 line transects (0.5km in length) and distance sampling techniques to establish population estimates for lemur species and analysed our results using the software DISTANCE 6.0. The characteristics of lemur-used trees were catalogued during day surveys and compared to those of randomly selected trees to determine which characteristics were ecologically important to lemur species. Sociology surveys were also carried out to investigate the relationship between the forest and the people living in the surrounding villages.

Results indicate that the estimated population size of *A. laniger* is 150 individuals (95% confidence interval: 84-267) and of *M. rufus* is 323 individuals (95% confidence interval: 199-523). Only 3 individuals of *C. major* were observed and no individuals of *D. madagascerensis* or *L. mustelinus* were detected during line transects. The average diameter at breast height (D_{130}) and height of trees used by *A. laniger* and the average height of trees used by *M. rufus* were significantly different to randomly selected trees, indicating that trees of ecological importance to these lemur species are different to the generic composition of the forest, as represented by random trees; which may enhance problems caused by selective logging. Characteristics of tree phenology on lemur-used trees were not statistically important, though previous research suggests bias was incurred from seasonality; further research into lemur feeding ecology would help establish whether lemur populations are seasonal in Tampolo forest. Repetitions of our study over years to come will also serve to monitor long-term population trends in the region. Sociological study revealed that both selective logging and lemur hunting are rife, though there lacks any alternative for people living in the surrounding villages. We propose that managing authorities such as ESSA-Foret may provide a future for Tampolo forest through environmental education, and the implementation of an eco-tourism network.

We are confident that we have helped inform and raise awareness of important issues with villages surrounding the forest, and received positive feedback from village elders about our involvement in the region. Since returning to the UK, we have submitted results to relevant scientific journals for publication, disseminated results at institutions including the Royal Geographical Society and the Anglo-Malagasy Society, dispersed an educational promotional brochure for Tampolo, and kept in contact with those living in the region.

2. Introduction

Our expedition took place in the North-East of Madagascar and involved ecological and social research within the protected area of Tampolo and its surrounding villages. The research took place over a 5 week study period (November 6th to December 14th 2013) and was a collaboration between the Newcastle University Alumni Association (UK), the Département des Eaux et Forêts de la l'Ecole Supèrieure des Sciences Agronomiques, Antananarivo (ESSA- Forêts), and the Centre Ecologique de Libanona, de Fort Dauphin (CEL).

The idea of carrying out a research expedition to Madagascar was first brought to us by team leader Rachel Blow, after the Royal Geographical Society's (RGS) "Explore Weekend 2012". Some members of the research team were at the RGS event presenting the results of their previous expedition, and made some helpful contacts linked with Madagascar. Through conversation with the leader of a previous Edinburgh University expedition the team were put in contact with Barry Ferguson, of CEL, South Madagascar. From there on, Rachel started a correspondence with Barry, discussing the prospects of conducting original research in the south of the country, precisely within the spiny forest. As a group of friends we immediately took upon the idea and enthusiastically started looking into the possibility of going, reading about Madagascar, its amazing habitats and unique biodiversity. Us 5 UK team members, in fact, were all studying Zoology and Biology together at the time, and some of us were really keen on the idea, having already carried out a research expedition the previous year.

The planning of the expedition took place over a one-year period prior to the beginning of the research. The team and Barry worked together to find CEL students willing to join, to find a research site and to come up with a structured proposal. We all carried out preliminary studies and helped with the planning of the expedition, each contributing personal experiences to produce a strong proposal. We were all motivated by the desire to contribute new data and information on the abundance and distribution of many species endemic to Madagascar, carrying out research in areas that are truly understudied. The rate at which Madagascar has lost much of its precious biodiversity is shocking, and we were determined to try and help bridge the gaps in knowledge in one of these isolated regions. We were also excited by the prospects of traveling to such a fascinating country and by the collaboration our research would have with local counterparts. After applying for funding from numerous institutions the team was finally awarded 5 grants. The project was funded by the Royal Geographical Society with IBG (RGS-IBG), Gilchrist Educational Trust, Scientific Exploration Society (SES), Newcastle University Alumni Association and Altyerre Training, as well as personal contributions.

Originally, we chose a research site in the South East of Madagascar called Vohitsiombe, however due to zebu banditry in the South, the expedition was deemed unsafe and a new research site had to be chosen, unfortunately the day before our departure. At this stage, we called upon ESSA-Forêts of the University of Antananarivo to help us find a new site. They informed us that they had three sites in the Northern regions of the island, but that Tampolo, a section of littoral forest in North East Madagascar, and one of Antananarivo University's field stations, would be particularly appropriate for an expedition of this nature. Thus, thanks to ESSA- Forêts (Antananarivo) and Barry Ferguson (CEL), that assisted us in finding a new project location and made the partnership of executive institutions possible, we were able to reorganize our research expedition to fit our new site. Granted with a research permit the team was ready to start the study.

Prior to departure the team was not sure what to expect from Madagascar and the expedition. Especially after the issues regarding security and project location, we had no certainties about where we would be based. Safe to say that reality exceeded our expectations on many fronts! The collaboration with 3 CEL students, who joined as scientific researchers, forming the Malagasy part of the expedition, was a great success; the biodiversity and culture of Madagascar captured us and made us eager to go back; and our project provided baseline data on lemur abundance and distribution, habitat diversity, disturbance and social issues in an understudied area, recently a protected forest.

3. Site Maps

3.1. Location Map

Figure 1. Shows the location of our study site within Madagascar. Map taken from www.vegmad.org.

3.2. Map of Tampolo

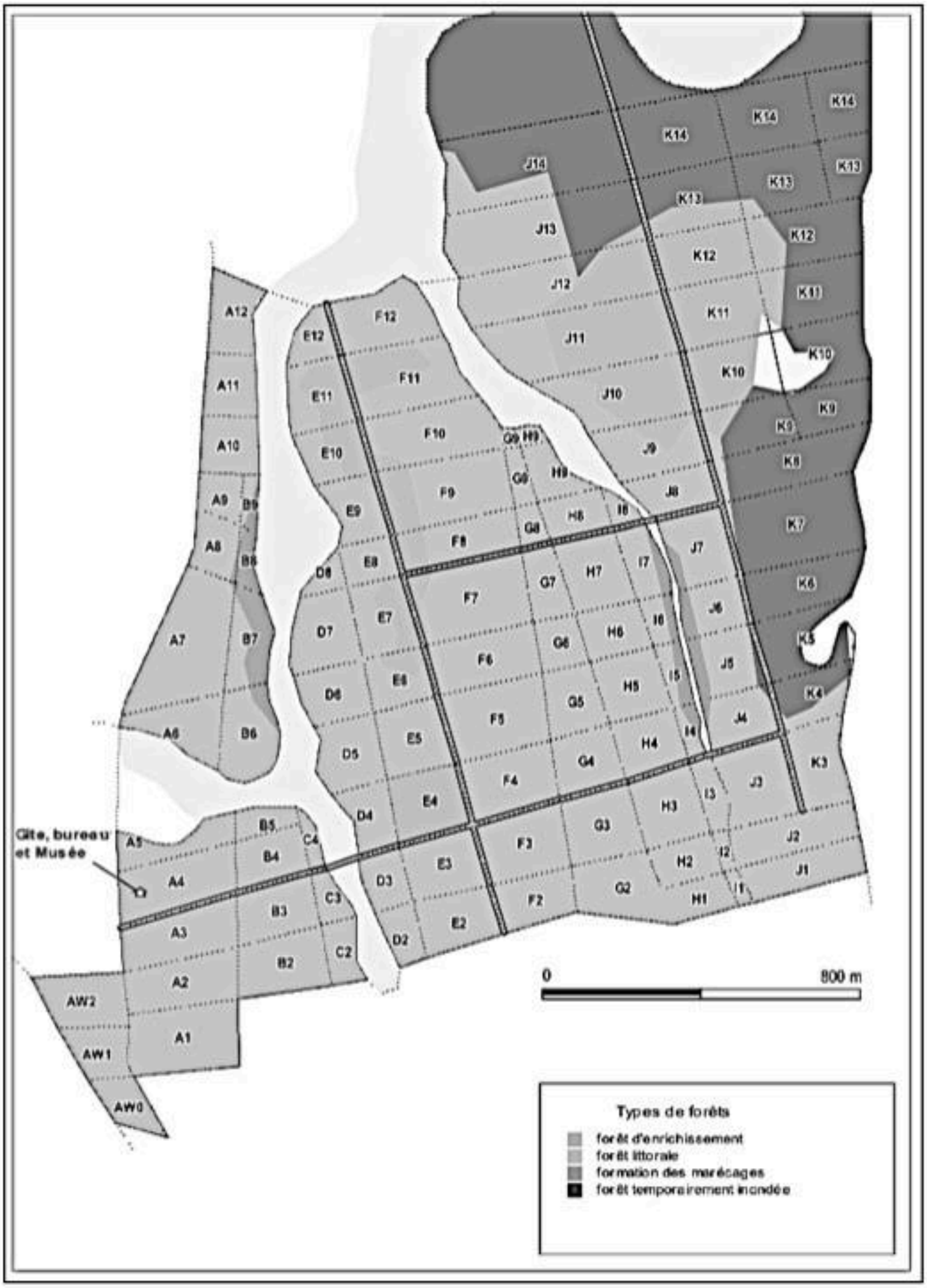


Figure 2. Shows a map of Tampolo Forest composed by ESSA-Forêts. The forest is divided into cells numbered AW1 to K14 for convenience of past logging activity. Forest types, assessed by ESSA-Forêts, include enriched forest (lightest), coastal forest (majority grey), swamp areas (darker), and temporarily flooded forest (darkest) (Ratsirarson and Ranaivonasy, 2002).

4. Expedition Members

Rachel Blow (22; United Kingdom) – Expedition Leader

Rachel acted as expedition leader for the Tampolo Expedition, with a secondary role as assistant medical officer after a basic First Aid Training course. She is a graduate from Newcastle University, with an Upper Second Class Honours Degree in Zoology. Previous expedition experience includes a research expedition to St Thomas in the US Virgin Islands to study the iguana population and the potential impacts of tourism, urbanization, and invasive species on their natural behavior, body condition, and diet. Previous scientific research experience includes: an independent research dissertation on the effects of diet on tawny owl fledging success; independent field research on the Isle of Cumbrae, studying eider duck behaviour; and carrying out bird abundance surveys at Washington Wetlands Centre (WWT) as a volunteer surveyor. Qualified in Emergency First Aid and has an intermediate level of spoken and written French. She currently works at the Cotswold Wildlife Park and volunteers as a STEM Ambassador in the Oxfordshire area, and is hoping to advance in a career in ecological field research.

Jessica Fisher (22; United Kingdom)

Jess took part in the Tampolo Expedition as a research scientist, with some role as medical officer after a 2 day ITC Outdoor First Aid certificate. Before graduating with 1st Class Honours in Zoology from Newcastle University (2013), Jess lead an Expedition to the US Virgin Islands researching human impacts on green iguanas (2012), following a research scholarship received from the University. The teams have spoken at public lectures and appeared at conferences discussing their Expeditions and disseminating results. Previous to this, Jess was selected to take part in a field course run by the Zoological Society of London in Mongolia on ecological monitoring and biodiversity techniques. In 2010 Jess worked on a conservation program focusing on invasive species on the Galapagos Islands, and at an animal rescue centre in Ecuador. In addition, she has volunteered with Greenpeace, Wildlife and Countryside Link policy umbrella body, and the IUCN Freshwater Biodiversity Group. She currently works at London Zoo and volunteers with the Natural History Museum Terrestrial Invertebrates, before undertaking a part-funded MRes at UCL in September 2014.

Camilla Blasi Foglietti (23; Italy)

Camilla took part in the Tampolo Expedition as a research scientist. She graduated in Zoology from Newcastle University with 1st Class Honours in 2013. She previously worked alongside the Centre for Research of Marine Mammals (CRiMM) in Italy, following the pattern of distribution of dolphin populations as a consequence of anthropogenic impacts. She also helped in the planning of educational workshops with the aim of increasing awareness towards conservation issues. Further to this she has volunteered for the Wildfowl and Wetlands Trust (WWT), carrying out bird abundance surveys, and at the Great North Museum in Newcastle, inputting data from ecological surveys and mapping species' distributions. After the expedition she joined the Ashoka Trust for Research in Ecology and the Environment (Atree, India) as an intern, following policy and practice of nature conservation and sustainable development. Her main interest is, in fact, to focus on how social development and political economy issues are essential to approach, understand, and implement conservation measures and actions. In October 2014 she is going to undertake an MSc in Ecology, Evolution and Conservation at Imperial College London.

Donna Wintersgill (22; United Kingdom)

Donna took part in the Tampolo Expedition as a research scientist. She has travelled the globe working alongside many conservation charities such as the African Wildlife Foundation. At university she studied Zoology and was a member of an independent research project to the Virgin Islands to study the impact of tourism on the green iguana. Both expeditions received external funding and Donna has since taken part in multiple public speaking events and workshops at the Royal Geographical Society, during vital results dissemination. Since her return from Madagascar has undertaken an internship in research and development at an environmental NGO, she hopes that her future will hopefully lead into the conservation charity sector.

Rachel Cornfoot (21; United Kingdom)

Rachel took part in the Tampolo Expedition as a research scientist. She graduated from Newcastle University with a degree in Biology. Her previous experience includes field research on the Isle of Cumbrae, collecting samples of Beadlet sea anemones and investigating their behaviours and morphology in the lab as well as assessing the productivity and species richness of grassland sites in Northumberland. She has also successfully completed a British bird and plant ID course. She currently works for the North Yorksire Country Council and is looking for a future career in a similar field.

Herman Anicet Tsiafa (Madagascar)

Herman took part in the Tampolo Expedition as a research scientist. He has a BSc in ecology from the Centre Ecologique de Libanona (CEL) in Fort Dauphin and is now studying ecology at ISSDD-GRENE University in Tamatave. He has also previously worked as an assistant at a Biodiversity and Conservation Ecology lab. His previous research experience includes acting as a translator for a social science project (Operation Wallacea 2012) as well as carrying out forest inventories, for the same project. He has also carried out research for an ecological project, on the abundance of herpetofauna and avifauna in the Ifotaka forest (Project Kobokara 2011 - http://projectkobokara.wordpress.com).

Raymond Steve Gerard Andriatahinjanahary (Madagascar)

Steve took part in the Tampolo Expedition as a research scientist. He has a BSc in ecology from CEL. In 2008 he did an internship with WWF Tulear, carrying out ground-truthing of ecological zones and creating an inventory of vegetation in the spiny forest within the Tulear region. In 2009 he worked for a Japanese NGO, in Croix du Sud (Fort Dauphin) as a photographer and interviewer for research about medicinal plants. In 2010, he was working in a New Protected Area in the Tandroy region, South Madagascar, primarily gathering research for his dissertation – making an inventory of vegetation in the and its uses – but also working as a research assistant for a Brighton University Expedition. He then went onto assist a student from the School of International Training (SIT) as a translator, for her independent study project in the Andohahela National Park on the local viewpoints on conservation and development. Steve has also volunteered with an NGO called "Hope for Madagascar" to help improve education and rural development in the South of Madagascar and with Barry Ferguson (Operation Wallacea) to assist British dissertation students with Sifaka research. Since the expedition, Steve has been a research assistant for a PhD researcher (James Cook University) and a MSc researcher (Hanbourg University) on their projects concerning *Lepilemur* metabolism and physiognomy in the private reserve of Berenty in the South. He is currently working as a research assistant for a project on fuel-wood and charcoal plantations in the North-West of the island (Blue Ventures) and will soon be leaving Madagascar for the United States, where he hopes to continue his studies in ecology.

Robert Gré du Haut Razafindrakoto (Madagascar)

Rob took part in the Tampolo Expedition as a research scientist. He has a BACC (+3) in Environmental Management from CEL. In 2008 he acted as a guide, interpreter and facilitator for a UK student's "World Challenge" project in the New Protected Area of Ifotaka, in the region of Amboasary Sud. In 2009 he took part in a socioeconomic study, investigating the impacts of the implementation of the New Protected Area of Behara-Tranomaro, also within the Amboasary Sud region. He then went onto lead the implementation of a reforestation and food-provisioning programme, which was supported by the World Wildlife Fund (WWF), MIARO Association and the World Food Program (WFP). In 2010 he acted as a botanist and social researcher for a study by the WWF on carbon, both within the Protected Area of Ranomafa in Fort Dauphin and the Ankodida spiny forest in Amboasary Sud. In 2011 he was in charge of communications for a Conservation Leadership Program (CLP) project and was a botanist and social researcher for a study on the impact of a bauxite mine in Manantenina, Fort Dauphin, run by Mirror Office Study. In 2012 he was a social researcher for an investigation concerning the creation of a global urban development plan for the Taolagnaro commune, by the UKTUS design department, Antananarivo. He then went onto be a mapping technician, zoning the Ifotaka District in Amboasary Sud. In 2013 he took part in an Operation Wallacea expedition, as a scientific researcher, studying the vegetation of the Ifotaka New Protected Area. Since the Tampolo Expedition he has been: a scientific researcher for a SAVAIVO and UNICEF-led project; a research assistant for a School for Internation Training (SIT) project on vegetation and lemurs in Saint Luce coastal forest, Fort Dauphin; a research assistant for another SIT project on the vegetation in the Tsitongambarika rainforest, Fort Dauphin; and is currently carrying out research on the physiology and metabolism of Sportive lemurs in Berenty private reserve with the James Cook University, Australia.

5. Fieldwork and Research

5.1 Introduction

Madagascar is considered one of the world's top conservation priorities, with high levels of both endemism and habitat destruction (Myers *et al*. 2000). About 90% of vascular plants, 50% of birds and 98% of amphibians, reptiles and mammals, in fact, are endemic. Anthropogenic pressures, such as deforestation, hunting, selective logging and mining are alarming threats to Madagascar's unique ecosystems and habitat loss is estimated as over 90% (Ganzhorn *et al.* 2001). The recognition of Madagascar as a conservation priority has led to numerous conservation efforts (Goodman and Benstead 2003). Many of its unique habitats, however, are now fragmented and under extreme threat of extinction, inhibiting efficient implementation of large-scale protected areas (Randrianandianina *et al.* 2003).

Separated from Africa 165 million years (Myr) ago and from India around 65 Myr ago, the diversity of Madagascar is a result of radiation to and from the island by land first and subsequently by oceanic dispersal (Krause 2010). Since human colonisation, around 2,000 years ago, Madagascar has suffered a dramatic reduction in primary forest and a constant threat to its endemic species due to deforestation, hunting and overexploitation, with an increase in pressure due to the growing human population (Clayton 2011). Amongst the anthropogenic causes of biodiversity loss, deforestation is the primary one. Only 10% of Madagascar's original forest cover exists, with unsustainable agricultural practices (such as slash-and-burn agriculture) identified as the main drivers (Clayton 2011). With deforestation come great costs such as soil erosion, causing agricultural economic loss to the country, and habitat destruction, having dramatic consequences on the wildlife. International exploitation of the country's resources has had strong implications on Madagascar's losses. International mining and timber companies, in fact, have been exploiting these resources with devastating consequences to the local community (Raik 2007). Furthermore, despite there being over 44 Protected areas, poor management strategies and misplaced responsibilities have led to many of these parks being protected only on paper. Additionally, difficult economic, political and social conditions have hampered successful conservation efforts (Raik 2007).

Because of the moisture barrier created by the mountainous conformation running North to South, Madagascar can be subdivided into distinct bioclimatic zones and consequently a huge variety of habitat types (the 'humid' eastern rainforest, the 'sub-humid' central grassland and rainforest and the 'dry' and 'sub-arid' western deciduous and southern spiny forests) (Vences *et al*. 2009).

The eastern littoral forest of Madagascar is amongst the country's most threatened ecosystems (Schatz 2000); only fragments of it remain, with most of them being small, degraded and with low levels of protection (Dumetz 1999). It is estimated, in fact, that of the original forest cover only 10.3% is left and of this, since the implementation of Durban Vision in 2003 (plan aiming to increase Madagascar's protected forests from 1.7 to 6 million hectares), 41.5% is within a protected area network (Consiglio *et al.* 2006). The littoral forest habitat is rich in diversity, with approximately 13% of the native flora.

The littoral forest of Tampolo is a protected area; it is a 675 ha reserve that has been managed since 1959 by the Department of Forestry at the University of Antananarivo

(ESSA- Forêts) and partnered by the Lemur Conservation Foundation (Ratsirarson and Ranaivonasy 2002; Radosy 2010).

Tampolo forest is a priority interest for biodiversity conservation due to its unique and diverse community of plant species as well as for its range of reptiles, amphibians, birds and mammals (Lemur Conservation Foundation 2014). It too is suffering from the threat of encroaching human activities. Despite its protection, most of the adjacent *fokontany* still utilize the forest for prime materials, such as timber, fuel, food and medicine, and this unique ecosystem is slowly disappearing. There is therefore a strong need for solid alternative sources of these products through the implementation of a reforestation programme and the establishment of alternative local employment and livelihood diversification. Furthermore the forest of Tampolo is remarkably understudied (Ratsirarson and Goodman 1998; Ratsirarson and Ranaivonasy 2002), with a paucity of published data on the density and distribution of its flora and fauna.

The main aim of this study was to provide an updated account of the density and distribution of the nocturnal lemur species in Tampolo littoral forest. This data will serve as a starting point for future conservation programmes and will outline the severity of the impact of anthropogenic activities on lemur populations. It will also be good reference for future population monitoring and more detailed ecological studies of the lemur species within the forest. Our secondary aim was to identify the habitat characteristics preferred by each lemur species. This will allow us to understand more about species ecology within different habitats and to identify what the main pressures to their preferred habitat are, and the consequent variation in degree of threat that different species suffer. Parallel to the scientific investigation, a social study was also carried out within the *fokontany* surrounding the forest. The aim of this research was to investigate the effects of the forest's protected status on the local people and to understand to what extent this influenced the level of logging in the forest. The survey was also used to determine the most important tree species used by the locals, whether lemur species were hunted and if there were any traditional '*fadys*' surrounding the forest.

Our expedition had 3 main objectives:

- To measure the abundance and distribution of five nocturnal lemur species in Tampolo Forest (Fénérive-Est); one of the few remaining fragments of littoral forest in Madagascar.
- To investigate which habitats, microhabitats and tree characteristics are important for the five nocturnal lemur species, with consideration for varying levels of disturbance.
- To understand how the management of this region may affect the residents of the villages surrounding Tampolo Forest; with regards to an increase in levels of protection, a consequent decrease in primary materials available, and the potential development of a tourist infrastructure.

5.2. Lemur Abundance

5.2.1. Introduction

As a consequence of the strong threats that the Malagasy rainforests suffer due to human impact, the wildlife living within these habitats is under severe threat as well. Lemurs are considered as a conservation priority, with 11 species and subspecies evaluated as Critically Endangered, 16 as Endangered, 18 as Vulnerable and 14 as Data Deficient (Mittermeier *et al*. 2006). Since the arrival of man on the island, around 14 species of lemur have become extinct (Richard and Sussman 1975). The main cause of lemur extinction is habitat fragmentation and destruction (Richard and Sussman 1975). Due to human activities such as illegal logging and slash-and-burn agriculture, in fact, most of the habitats preferred by the lemurs have disappeared. The remaining ones are highly fragmented, with an increase in 'edges', which may impede dispersal and reduce population viability, ultimately having an effect on genetic diversity (Craul *et al.* 2009). It appears, however, that most lemur species are edge-tolerant, which may explain how they have survived such extreme habitat loss (Lehman *et al.* 2006).

Alongside habitat destruction, the responsibility for the threat that these species suffer is often attributed to hunting and practices of the rural Malagasy communities. Despite lemurs being a good source of protein for many Malagasy tribes, in most areas there are strong taboos (*fadys*) against eating the lemurs. For the Betsimisaraka within the eastern rainforest, for example, it is *fady* to kill or eat *Daubentonia madagascariensis* (Richard and Sussman 1975). In other areas however this species is killed as a sign of evil when passing through a village. Despite the aye aye's distribution being documented in many areas this data is often based on single sightings, so there is not much understanding of the species population size and dynamics (Mittermeier *et al.* 2006).

To ensure the effectiveness of conservation efforts it is essential to know which species live within a particular habitat and their patterns of distribution and abundance. This type of data provides a starting point for effective management of protected areas and for the implementation of valid alternatives (Smith *et al.* 1997). Furthermore, long term monitoring is essential to evaluate the impact of human pressures on the forest ecosystem over time (Irwin *et al.* 2010).

The protected littoral forest of Tampolo has only recently receive this status and there is a severe lack of data on the abundance and distribution of its lemur species, with only one previous study attempting to create a density estimate. This particular project focused on the five nocturnal lemur species that are thought to be present within the littoral forest (Ratsirarson and Ranaivonasy 2002; Ratsirarson and Goodman 1998); the aye-aye (*Daubentonia madagascariensis*), brown mouse lemur (*Microcebus rufus*), greater dwarf lemur (*Cheirogaleus major*), weasel sportive lemur (*Lepilemur mustelinus*) and eastern wooly lemur (*Avahi laniger*). Both *M. rufus* and *A. laniger* are listed under the Vulnerable category of the IUCN Red List (IUCN 2013). *D. madagascariensis* is classified as Endangered (EN), *L. mustelinus* as Near Threatened (NT) and there is a lack of data on *C. major* which is listed as Data Deficient (DD). All species represent decreasing population trends.

M. rufus is an abundant species that survives in a wide range of habitats. It is omnivorous, eating mainly fruits, flowers and insects. *A. laniger* maintains a diet mainly of leaves, leading to low levels of nutrition and consequent low activity patterns (Mittermeier *et al.* 2006). Despite these species suffering from habitat loss and hunting, their populations do not appear severely threatened. *L. mustelinus* is common in the eastern rainforest with a diet of leaves, flowers and fruit. This species, however, is suffering unsustainable levels of hunting and is understudied in the wild (Mittermeier *et al.* 2006). *C. major* is a hibernating species, mainly feeding on flower nectar, fruits and buds. This species is also understudied and little is known about its distribution and social behaviour (Mittermeier *et al.* 2006).

The aim of this study was to create an abundance and distribution survey of these 5 nocturnal lemur species within one of the last remaining fragments of Malagasy littoral forest, to underline the importance of conservation action and to provide figures on what is the population estimate in this region for the different lemur species under study.

5.2.2. Methods

Preliminary work
Initially, transect lines were created by walking in a straight line through the dense vegetation of the forest, which was cleared by our guides, until 1km was reached on the GPS. However, we found that this method of survey generated a number of complications. Firstly, too much time was spent either stationary, whilst waiting for vegetation to be cleared, or looking down whilst travelling. Secondly, the disturbance generated by clearing vegetation was likely to cause flight of our study subjects and was an undesirable long-term impact of our study. Finally, the initial trail cleared proved to be too discreet to follow during repeats, particularly as transects were conducted in the dark.
We decided instead to conduct transects along pre-existing paths through the forest. We walked along the paths at an approximate speed of 1km/hr until 1km was reached on the GPS. However, we found that a slower walking speed was needed in order to detect the lemur species, so we halved both the approximate walking speed and the transect length.

Survey procedure
Line-transect surveys and distance sampling techniques were used to collect data on lemur density (Anderson *et al.* 1979). Twenty transects, 0.5 km in length, were established using existing trails and were chosen, using an existing map of the area, so that the total study area was evenly covered (Fig. 2) and a variety of habitat types represented (Meyler *et al.* 2012) (Fig. 3). Each transect was walked 3 times at a speed of approximately 0.5km/hr between 18:20 and 20:20 (Atsalis, 1998; Lehman, 2006). Repeats were conducted at regular intervals throughout the 30-day study period to minimize disturbance and account for variation within the survey period (Lehman, 2006). Two transects were surveyed per night by two separate groups consisting of 4 scientific researchers and 1 guide. To minimize observer bias: team members surveyed in alternate directions, team members were given designated roles and team composition was swapped daily (Buckland *et al.* 2001). Lemurs were sighted using strong torches to reflect eye glare (Stephenson *et al.* 1994). For each observation, the lemur species was recorded along with the time and the number of individuals present. Handheld GPS (Garmin E-Trex) were used to mark the coordinates of each sighting and to measure perpendicular distance from the transect line. Only individuals detected at a distance of 20m or less from either side of the transect line were recorded, giving a transect width of 20km^2.

Data analysis
The software DISTANCE 6.0 (Thomas *et al.* 2010) was used to estimate the density and population size of lemur species.

5.2.3. Results

During our 30 night surveys, we observed *A. laniger* (Figure 3) on 37 occasions. The mean density of *A. laniger* in the protected area of Tampolo Forest was 0.29 ind/ha (95% confidence interval: 0.16 – 0.51) generating an estimated population size of 150 individuals (95% confidence interval: 84 -267) in the 520 ha of surveyed protected area. We observed *M. rufus* (Figure 4) on 66 occasions over the survey period. The mean density of *M.rufus* was 0.62 ind/ha (95% confidence interval: 0.38 – 1.00) generating an estimated population of 323 individuals (95% confidence interval: 199 – 523) in the 520 ha of surveyed protected area. Only 3 individuals of *C. major* were observed and neither *D. madagascariensis* or *L. mustelinus* were detected during line transects (Table 1).

Species	Estimated population	Mean density per hectare
A. laniger	150 (84-267)	0.29 (0.16-0.51)
M. rufus	323 (199-523)	0.62 (0.38-1.00)
C. major	-	-
D. madagascariensis	-	-
L. mustelinus	-	-

Table 1. shows the estimated population size and mean density per hectare of each lemur species surveyed.

Figure 3. A brown mouse lemur *(Microcebus rufus)* in Tampolo Forest, November 2013 (Photo: Camilla Blasi Foglietti).

Figure 4. An eastern wooly lemur (*Avahi Laniger)* in Tampolo Forest, November 2013 (Photo: Camilla Blasi Foglietti).

5.2.4. Discussion

Results indicate that populations of *M. rufus* and *A. laniger* are highly abundant within Tampolo Forest. This is to be expected as, in general, *M.rufus* is able to occupy a number of different forest types, including forests altered by humans (Kappeler and Rasoloarison 2003). They are a highly adaptable, omnivorous species, so their diets are diverse and change depending on the season (Radespiel 2006; Atsalis 1998). Foods consumed by *M. rufus* include insect secretions, arthropods, small vertebrates, gum, fruit, flowers, nectar as well as leaves and buds (Gould and Sauther 2007). *A. laniger* also survives well in secondary growth and disturbed habitats (IUCN 2014). Their diet consists primarily of leaves and buds, which are abundant within Tampolo.

In contrast, only small numbers of *C. major* were detected and there were no sightings of *L. mustelinus* or *D. madagascariensis* over the study period. Failure to detect these species, which are expected to occur in the area (Ratsirarson and Ranaivonasy, 2002; Ratsirarson and Goodman, 1998), implies a low density, whilst even raising concerns over their current existence within Tampolo Forest. These findings are in accordance with IUCN data, indicating declining populations of *L. mustelinus, C. major* and *D. madagascariensis*, and widespread populations of *M. rufus* and *A. laniger* across the forest (Schwitzer *et al.* 2013). *D. madagascariensis* is quite adaptable and is known to dwell in a number of different habitats (Ganzhorn and Rabesoa 1986; Andriamasimanana 1994). However, population numbers throughout Madagascar are in decline due to habitat loss, fragmentation and hunting; this species is hunted for food, as a crop-pest and in some areas as a harbinger of evil (IUCN 2014). It may therefore be for these reasons that we did not detect any individuals of *D. madagascariensis* in Tampolo. Similarly, populations of *L. mustelinus* are in decline due to habitat loss and exploitation through unsustainable hunting pressure (Lehman and Ratsimbazafy 2001). According to Mittermeier *et al.* (2010) they are also out-competed by *Avahi* for leaves of high nutritional value, which may have led to their local exclusion from the Tampolo area. Finally, only 3 individuals of *C. major* were found, and whilst the status of this species is currently "Data Deficient", further studies into population status, geographic distribution and threats may warrant listing this taxon in a threatened category. It may therefore be the case that threats such as habitat loss and human interference are highly prevalent in areas such as Tampolo, but we are unaware to what extent they are affecting *C. major*.

Importantly, this finding may also suggest weaknesses in the method of analysis or length and timing of the study (Duckworth 1998; Johnson and Overdorff 1999; Meyler *et al.* 2012). For example, the ecology of *M. rufus* and *A. laniger* make them highly detectable from a transect line, whereas the low abundance of *C. major* may be attributed to the effects that habitat coexistence and edge effects have on their detection. In a study of forest edge effects, Lehman *et al.* (2006) found that *C. major* density was greatest in the forest interior, and lowest at the edge, with tree diameter being an important covariate relating to food availability. With transects positioned along pre-existing man-made forest trails, and only a small percentage of lemur-used trees in fruit or flower, it could be likely that edge effects played a role in detecting individuals. Coexistence of *C. major* with other *Microcebus* species has also been shown to cause niche separation in a study by Lahann (2007). In fact, because they are so difficult to detect in the field, there is very little data on the distribution and density of *C. major* throughout Madagascar (IUCN 2013). Ethnoprimatological knowledge from the surrounding *fokontany* suggest that *D. madagascariensis* has been recently sighted in Tampolo Forest. However, the team visited a suspected *D. madagascariensis* nest and, though a camera trap was left for one week at the site, no observations were made. Sightings of *D. madagascariensis* are also rare (IUCN 2014) and their presence is often only assumed from tree hole marks. Abundance is therefore also hard to estimate, as one individual is capable of making numerous marks.

Further research is therefore needed to determine whether these estimated population densities are a consequence of poor detection or more alarming explanations. It is recommended that alternative research methods are adopted in order to more accurately analyse the population densities of *C. major, D. madagascariensis* and *L. mustelinus.* An analysis of Minimum Viable Population (MVP) (Harcourt., 2006) would also be necessary to determine whether our abundance estimates indicate that lemur populations within this forest fragment are stable; methods of data collection such as the use of population indices may be more practical for this analysis than nocturnal searches (Setchell., *et al.,* 2011). However, repetitions of our study over years to come would serve to monitor long term population trends in the region, thus assisting any management strategies designated to the area. As such, we have included in our indices a map of the transects used during this project along with a list of the corresponding GPS coordinates (Appendix I).

5.3 Tree Characteristics

5.3.1. Introduction

Almost 90% of Madagascar's littoral forest has been lost due to anthropogenic factors. The high diversity of plant species within Tampolo littoral forest (around 163 species), in fact, is increasingly threatened to extinction, despite protection. This particular type of forest is extremely important both ecologically, as it shelters many different types of species, and regarding land protection, as it provides a natural shield from cyclones (Consiglio *et al.* 2006). 25% of the 1535 plant species known from littoral forests are endemic to this community (Consiglio *et al.* 2006). The eastern coast of Madagascar also suffers from frequent cyclone damage; therefore loss of littoral forest represents an extreme threat to the local villagers residing along the coastline (Dunham *et al.* 2011).

Different lemur species occupy different ecological niches to be able to coexist (Ganzhorn 1989). For example, species that use the same microhabitat will specialize on food with different chemical properties and species that feed on the same food types will live in separate microhabitats (Ganzhorn 1989). Different species will therefore value different types of trees and may even have an array of preferred tree types depending on what the plant is used for. The plant species within Tampolo forest are locally exploited at different rates, resulting in some species being more threatened than others (Consiglio *et al.* 2006). The impact of forest exploitation, therefore, will differ according to the lemur species. In addition, disturbance can affect many animal species in different ways, for some it can be beneficial as they can adapt and exploit new niches (Gibson 2011) or it can be detrimental; through changes in interspecific and intraspecific competition, predation or available space (Kupfer *et al.* 2006).

We investigated the tree-types most used by the lemurs to identify those of higher value to each individual species and compared them to the generic composition of the forest. We also compared the species most used by the lemurs with those most taken from the forest (Social study) to identify which lemurs might be at higher risk due to habitat loss. Finally, we measured the levels of disturbance that each lemur species is able tolerate. Understanding the impact of anthropogenic pressures and disturbance on different taxa within the forest will allow for effective conservation plans to be implemented (Irwin *et al.* 2010).

5.3.2. Methods

Survey procedure
During the day, following a night transect, lemur-used trees (LTs) were revisited to collect habitat characteristic data. For each observation the diameter at breast height (D_{130}) (so named as it is measured at the standard height of 130cm, as recommended by Brokaw and Thompson 2000), height, species and phenology of the tree were recorded along with the level of disturbance in the area. Disturbance was measured using Singer's (2008) index of human disturbance (Table 2). The same characteristics were also recorded for a neighboring tree selected at random. Random trees (RTs) were selected by walking a number of steps, generated using a random number table, in a particular direction away from the lemur-used tree. The direction was also generated using a separate random number table (1=N, 2=NE, 3=E, 4=SE, 5=SW, 6=W, 7=NW). Random number tables can be found in Appendix V.

Selective logging : 1 – no evidence of selective logging 2 – minor evidence of selective logging (one cut stump visible from centre tree) 3 – increased evidence of selective logging (at least two cut stumps visible from centre tree) 4 – much evidence of logging (more than three cut stumps visible from centre tree, physical form unchanged) 5 – habitat extensively logged, to such an extent that physical structure of forest shows major alterations
Proximity to paths (footpaths/cart tracks) : 1 – nearest path more than 30m from central tree 2 – nearest path between 20m and 30m from central tree 3 – nearest path between 10m and 20m from centre tree 4 – nearest path less than 10m from central tree 5 – central tree is on or within 2m of nearest path
Proximity to agricultural fields : 1 – no agricultural field located within 1km of the central tree 2 – nearest agricultural field is between 200m and 1km from the central tree 3 - nearest agricultural field is between 50m and 200m from the central tree 4 - nearest agricultural field is less than 50m from the central tree 5 – central tree is immediately adjacent to an agricultural field

Table 2. shows the parameters used for judging the level of disturbance of an area.

In order to get an overall view of the generic tree-types within the forest, the D_{130}, height, species, phenology and level of disturbance were also recorded for randomly selected trees, at 100m intervals down the length of each transect. A random centre point was selected by walking a number of steps, generated using a random number table, either left or right of the path. The direction was also generated using a random number table (1=right, 2=left). The D_{130}, height, species and phenology were then recorded for four trees in the immediate vicinity of the centre point. These trees were selected using the Point Centered Quarter (PCQ) sampling method (Cottam and Curtis 1956); the area surrounding the LT was divided into four quarters and the closest tree to the LT, with a sufficient diameter (>4cm), was sampled. For each PCQ tree the distance from the LT was also recorded.

Data analysis
The importance of LT characteristics compared to RT characteristics was analysed using the software Minitab Version 16; t-tests were conducted to determine whether lemur-used trees were of a significantly different height, D_{130} or phenology to random trees.

5.3.3. Results

Diameter at Breast Height (D_{130})
Those trees most important to *A. laniger* fall into the smaller D_{130} category of 7-14cm (Figure 5). The average diameter of trees used by *A. laniger* was significantly different compared to that of RTs (p=0.008) and when looking at Figure 6 it is clear that most of the *A. laniger* used trees were in the diameter range of 7-14cm whereas the RTs were primarily split between the ranges of 1-7cm and 7-14cm. Moreover, above 14cm, the number of *A. laniger* used trees was greater than the number of RTs, and below 7cm the number of *A. laniger* used trees was smaller than the number of RTs.

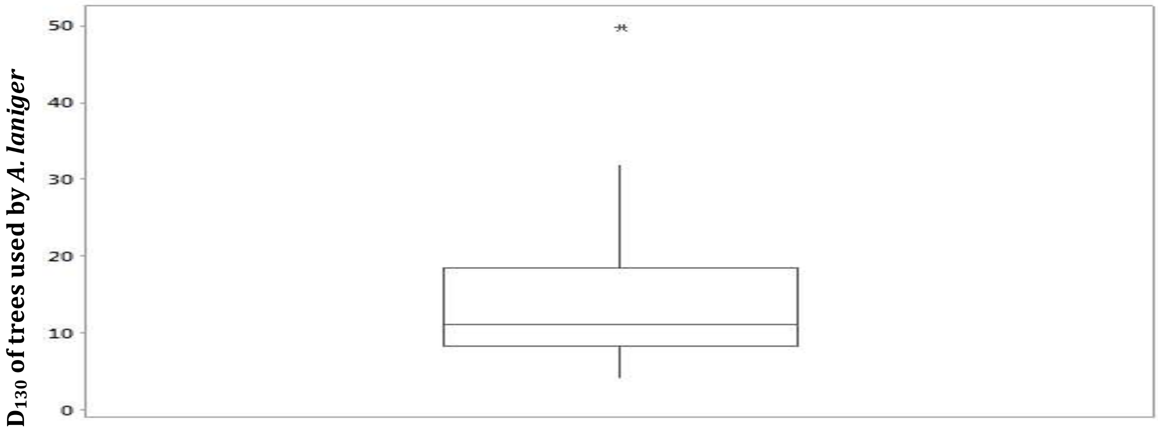


Figure 5. Shows the interquartile range for the diameters of *A. laniger* used trees.

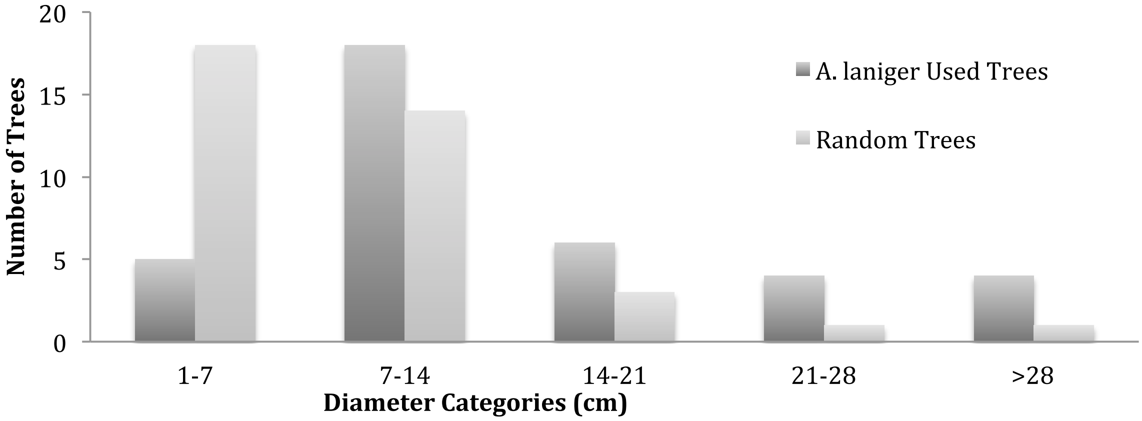


Figure 6. shows the number of trees used by *A. laniger* and the number of random trees that lie within each D_{130} category.

Those trees most important to *M. rufus* fall into the smallest D_{130} category of 1-7cm (Figure 7). The average diameter of trees used by *M. rufus* was not significantly different compared to that of RTs (p=0.058), and Figure 8 shows that both *M. rufus* used trees and RTs tended to lie within the smallest two ranges.

Height

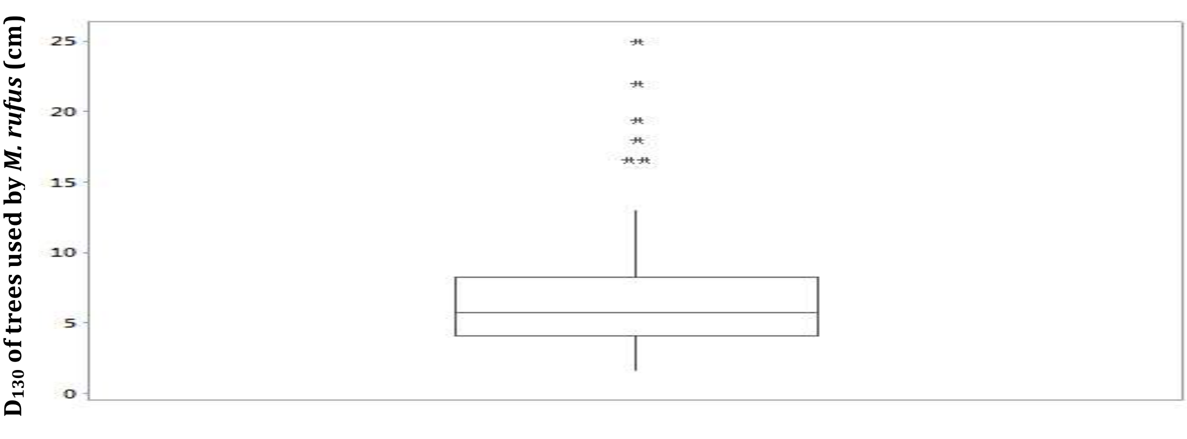


Figure 7. Shows the interquartile range for the diameters of *M. rufus* used trees.

Figure 9 shows that most *A. laniger* trees are of a small height, between 7-14m. The average height of trees used by *A. laniger* was significantly different compared to that of RTs ($p<0.00$) and Figure 10 shows that most *A. laniger* used trees lie within the range of 7-14m, with only a small number falling into the ranges on either side, whereas the number of RTs is almost evenly split between the ranges 1-7m and 7-14m.

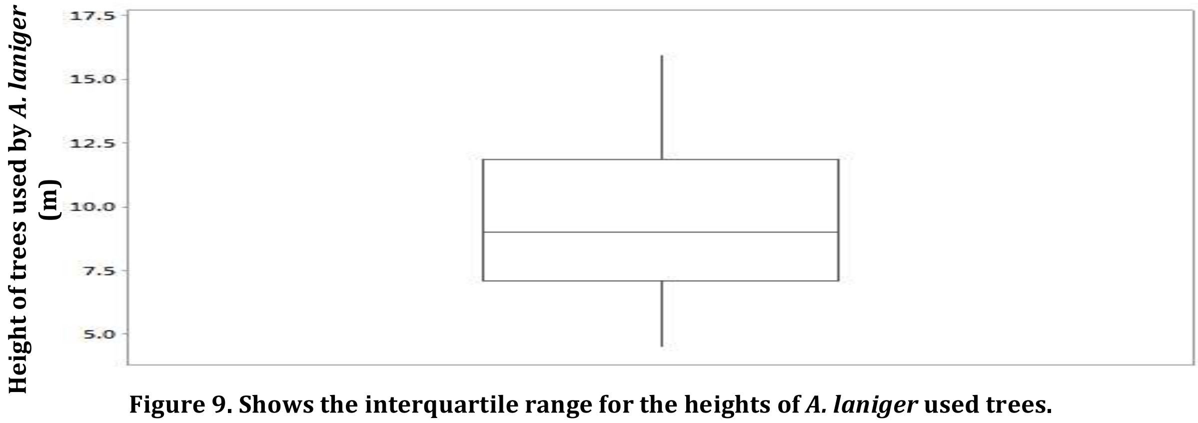


Figure 9. Shows the interquartile range for the heights of *A. laniger* used trees.

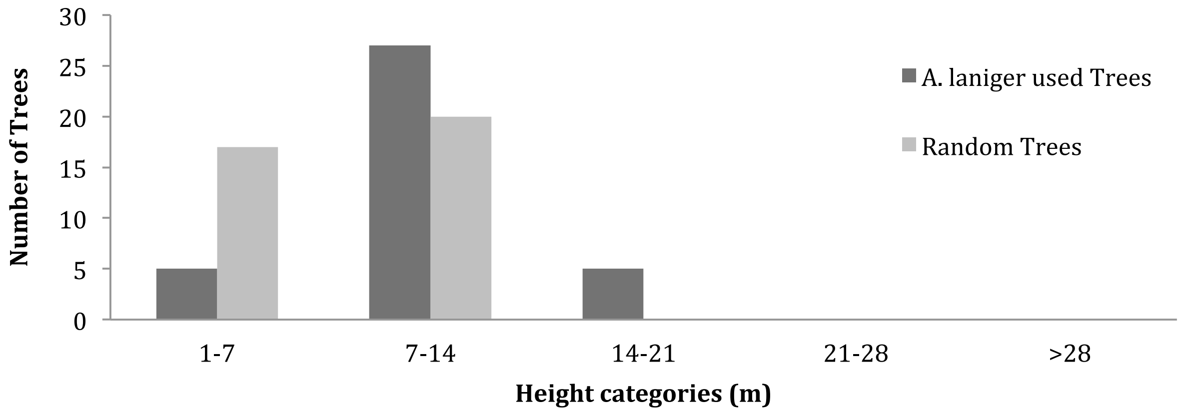


Figure 10. shows the number of trees used by *A. laniger* and the number of random trees that fall into each height category.

Figure 11 shows the average height of trees used by *M. rufus* ($p=0.001$) was significantly different compared to that of RTs. Looking at Figure 12, most of the trees used by *M.*

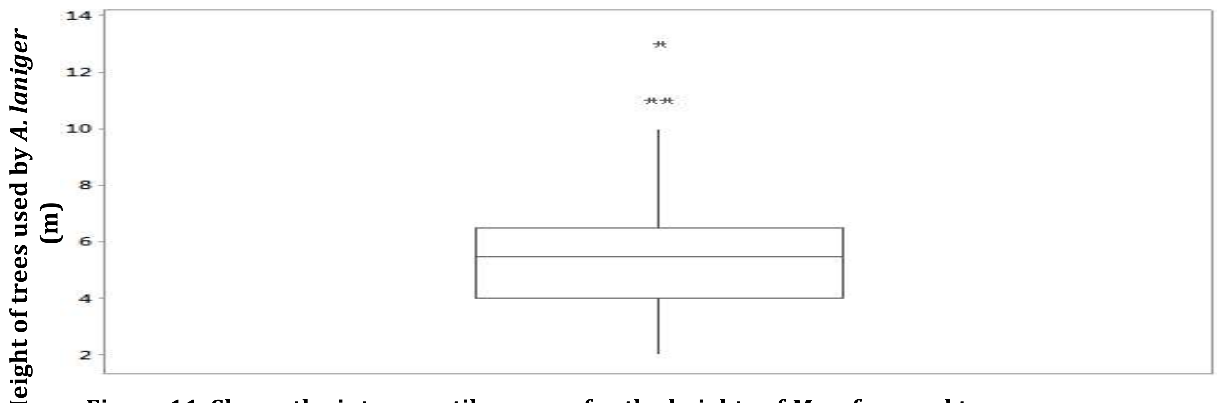


Figure 11. Shows the interquartile ranges for the heights of *M. rufus* used trees.

rufus fall into the smallest range, between 1-7m. Comparatively, the number of RTs is, again, almost evenly split between the ranges 1-7m and 7-14m.

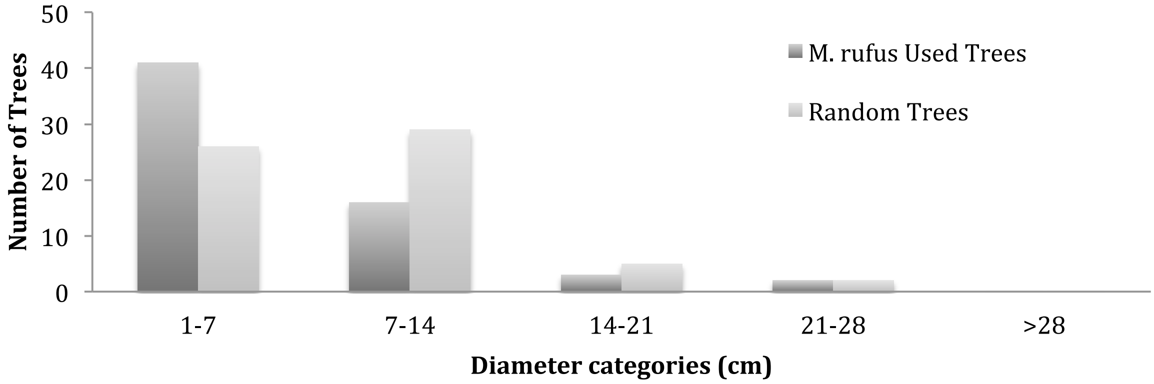


Figure 12. shows the number of trees used by *M. rufus* and the number of random trees that lie within each DBH category.

Species

A. laniger were sighted in 24 different species of tree. Three tree species showed a substantial level of use: aucoumea, maesopsis and hafopotsy (Figure 13). *M. rufus* were sighted in 46 different species of tree. Four tree species showed a significant level of use by *M. rufus*: voapaka, hasina, kafea and fotsidinty (Figure 14).

Figure 13. shows the proportion of *Avahi* used trees belonging to which species.

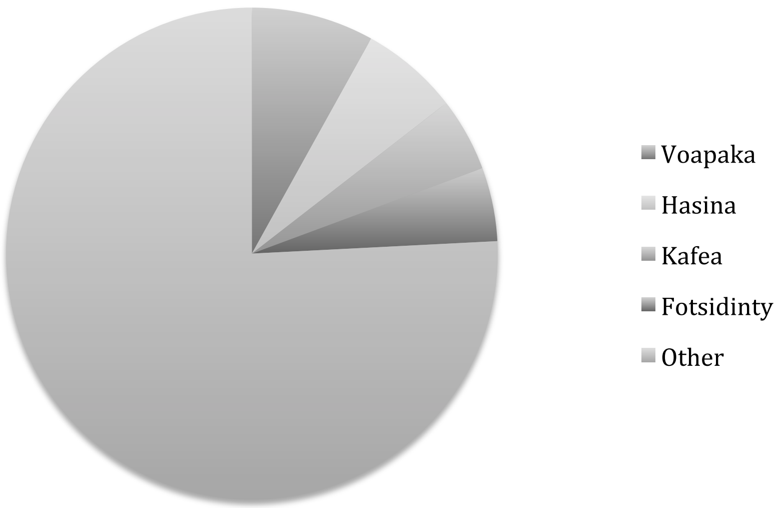


Figure 14. shows the proportion of *M. rufus* used trees belonging to which species.

Phenology
Both *A. laniger* and *M. rufus* used a significantly higher number of trees with leaves than of trees with any other phenology (p=<0.05). The phenology of the trees used by both *A. laniger* and *M. rufus* were not significantly different to those of randomly selected trees (p>0.05). A high percentage of all of the sampled trees had leaves only.

Disturbance
In accordance with Singer's (2008) index of human disturbance, the average overall level of disturbance in the areas in which *A. laniger* were found was 3. The average proximity to paths, proximity to fields and level of logging of *A. laniger* used trees are shown in Figure 15.

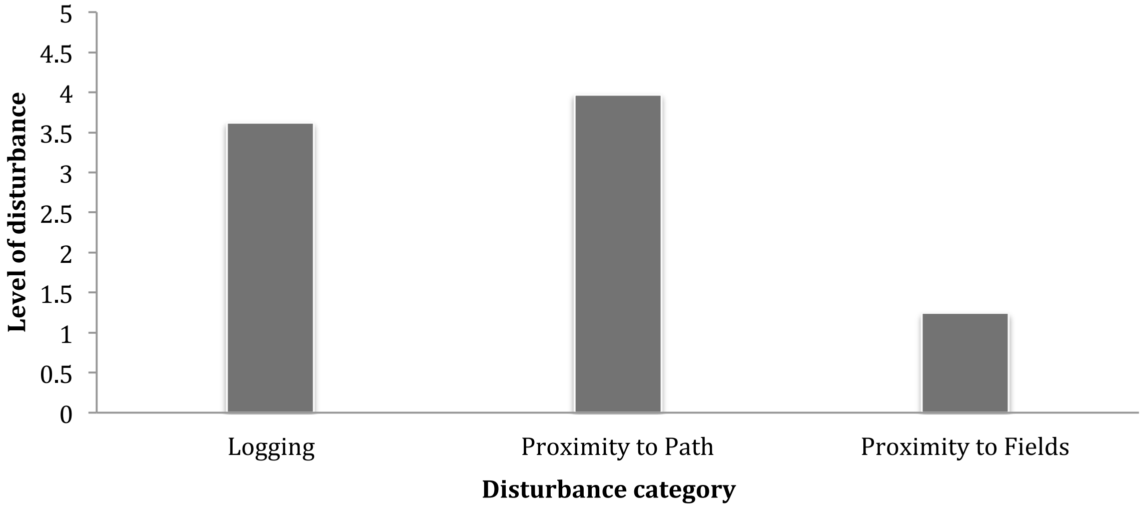


Figure 15. Shows the average level of disturbance in the areas surrounding *A. laniger* used trees. Disturbance is divided into three categories: logging, proximity to path and proximity to fields, as described by Singer's (2008) index of human disturbance.

The average overall level of disturbance in the areas in which *M. rufus* were found was 3. The average proximity to paths, proximity to fields and level of logging of *M. rufus* used trees are shown in Figure 16.

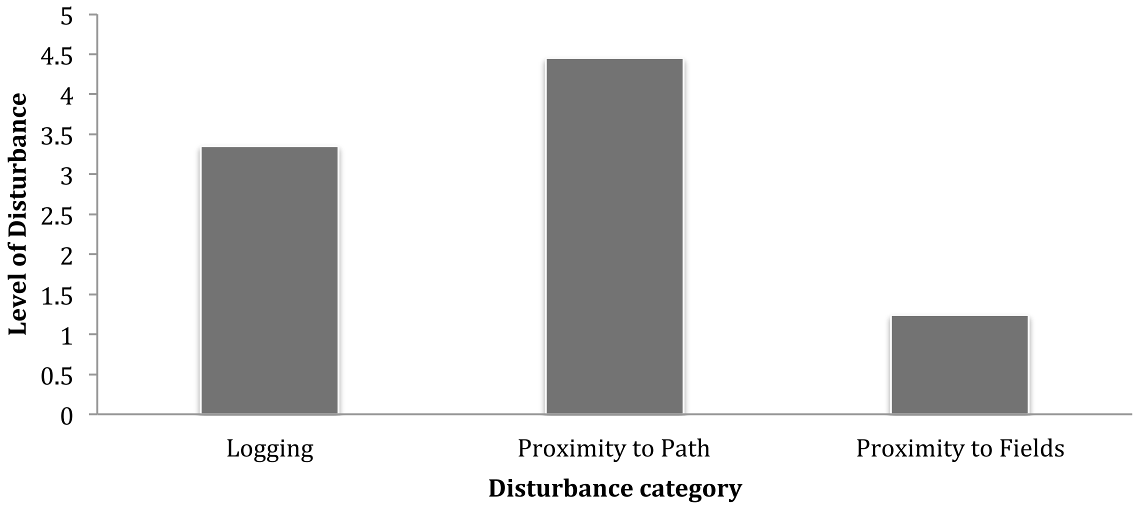


Figure 16. Shows the average level of disturbance in the areas surrounding *A. laniger* used trees. Disturbance is divided into three categories: logging, proximity to path and proximity to fields, as described by Singer's (2008) index of human disturbance.

Overall view of the forest composition

320 different trees were investigated during the PCQ sampling. A complete list of the species (vernacular and latin names) and the percentage of each found is included in Appendix II. The four most common species found were hasina, amboza, aucoumea and hazomalany beravina/kafemboeza (Figure 17). These species made up a substantial amount of the total trees recorded.

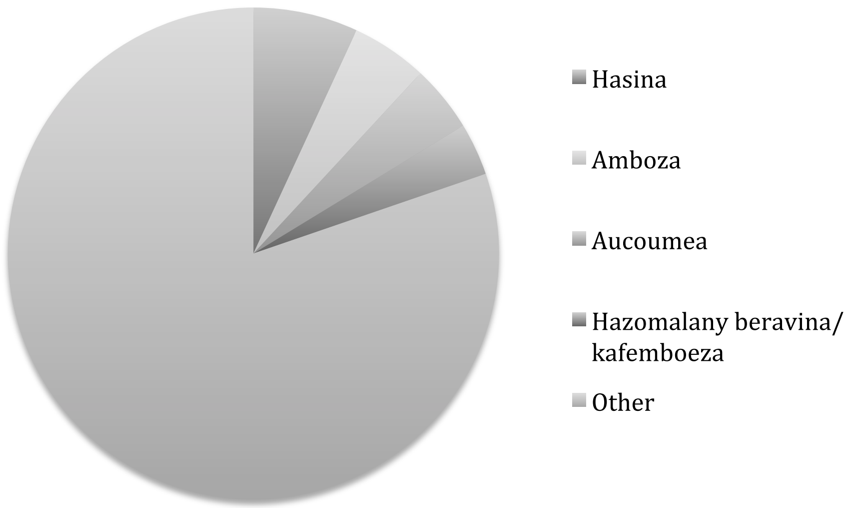


Figure 17. Shows the percentage of the sampled trees that were represented by each species.

The percentages of trees that lay within each D_{130} category are shown in Figure 18. Over half (55%) of the sampled trees were in the smallest category, between 1-7cm, and approximately a third (33%) were between 7-14cm. Fewer trees belonged to the three remaining categories with 7% belonging to the 14-21cm category, 2% belonging to the 21-28cm category and 3% belonging to the >28cm category.

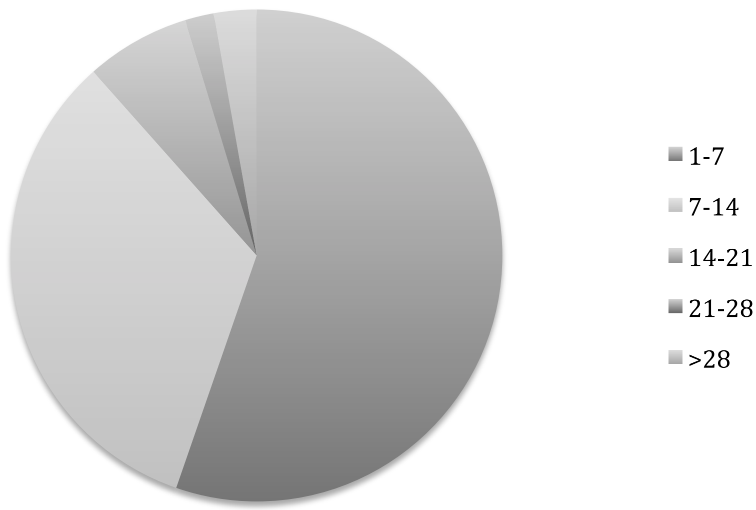


Figure 18. Shows the percentage of the sampled trees that were represented by each D_{130} category.

The percentages of trees that lay within each height category are shown in Figure 19. Again, over half (59%) of the sampled trees fell into the smallest category of 1-7m. 40% of the trees were between 7-14m and only 1% were between 14-21m. No trees taller than 21m were sampled.

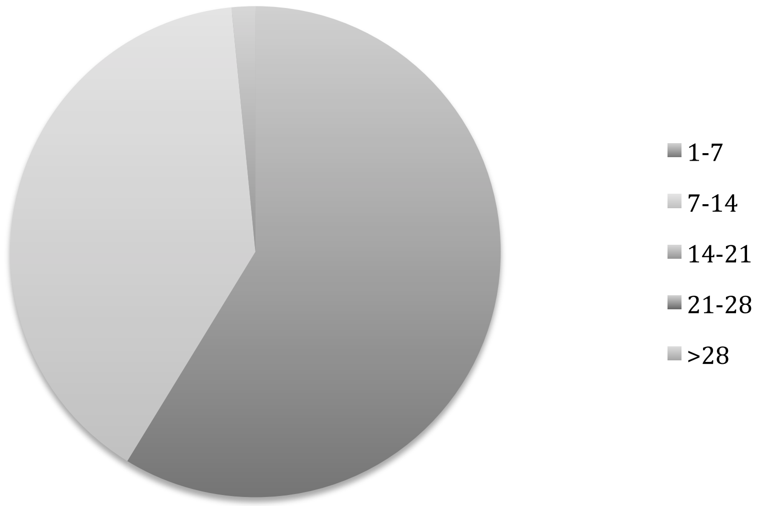


Figure 19. Shows the percentage of the sampled trees that were represented by each height category.

Concerning the phenology of the trees; 96% of all sampled trees had leaves only; 2% had leaves and fruit; 1% leaves and flowers and <1% were completely bare.

5.3.4. Discussion

Results indicate that the most important D_{130} range for *A. laniger* is between 7-14cm, suggesting they predominantly use trees of this width for feeding and resting. In a similar study, Ganzhorn *et al.* (1985) found that *A. laniger* feed from branches less than 3cm in diameter, at the periphery and tops of trees, but use slightly larger branches to support the bulk of their weight (900g-1200g). *A. laniger* are also found resting in these larger trunks, which is important as this species spends a large part of its time resting (Harcourt 1987). In fact, in a study by Harcourt (1991) at Ranomafana, it was found that resting occupied 59.5% of the night's activities, grooming 5%, travelling 13.5% and feeding 22%. However, a large number of RTs lay within the smallest diameter range and the number of *A. laniger* used trees within the highest diameter ranges was far greater than that of RTs. This suggests that, though *A. laniger* may prefer trees with a small diameter, these trees may have, in general, a slightly larger diameter in comparison to the generic composition of the forest, as represented by RTs. This is further supported by the results of the overall view of the forest composition, which shows 55% of all sampled fell within the small D_{130} category. It may be that these wider trees are more commonly taken from the forest by villagers as they are more useful (pers comms.), which may cause problems for the lemurs if no changes are made and the logging continues.

Comparatively, the most highly used D_{130} range for *M. rufus* was between 1-7cm. This can be explained by the small size and mass of *M. rufus*; it is less than than 27cm in length (Mittermeier *et al.* 2006) and weighs less than 50g (Mittermeier 1994). However, the average diameter of these trees was not significantly different to that of the RTs. This suggests that the trees used by *M. rufus* are largely similar to the generic composition of the forest, as represented by RTs and by the results of the overall view of the forest composition. In fact, a study by Bollen (2003) states that most trees found within littoral forests tend to have small diameters and rarely exceed 30-40cm.

Our results show that *A. laniger* were most often found in trees of a small height. In accordance with our findings, Ganzhorn *et al.* (1985) describe optimum feeding heights of *A. laniger* as being between 2-9m. They also state that this species commonly rests below the canopy, at heights from 2-10m, where they can utilize tree features such as lianas or the centre of tree crowns for additional support. However, the average height of trees used by *A. laniger* was significantly different compared to that of RTs ($p<0.00$). Whereas the numbers of RTs were almost equally split between the 1-7m and 7-14m ranges, there were significantly more *A. laniger* used trees in the 7-14m range than in any other. This suggests that, although *A. laniger* tend to be found in short trees, the most ecologically important trees for *A. laniger* may be taller than the generic composition of the forest, as represented by RTs. In fact, the overall view of the forest composition shows that 59% of the representative trees were in the shortest height category of 1-7m. It may be that these taller trees, as well as the wider trees, are also more commonly taken from the forest by villagers as they are more useful (pers comms), which may cause problems for the lemurs if no changes are made and the logging continues.

The average height of trees used by *M. rufus* ($p=0.001$) was significantly different compared to that of RTs. Most of the trees used by *M. rufus* fall into the smallest range, between 1-7m. This is likely because this species has a mixed diet but primarily feeds on fruit and insects (Atsalis 1998), which are abundant at these lower levels (Bollen 2003). In comparison, the number of RTs is, again, split almost evenly between the ranges 1-7m and 7-14m. This suggests that the most ecologically important trees for *M. rufus* are generally smaller than the generic composition of the forest, as represented by RTs.

Three tree species showed a significant level of use by *A. laniger*: aucoumea, maesopsis and hafopotsy which suggests that these are the most important in relation to the ecology of *A. laniger.* During sociological surveys, we found that aucoumea was one of two tree species most commonly used by villagers for firewood. During the overall view of the forest composition it was also found that aucoumea was one of the most common species of tree in the forest. This suggests that these trees may be used by both the lemurs and the villagers because they are common rather than for specific tree characteristics. In this case, the problems caused by logging are minimized. However, further research into the lemurs' ecology would be needed to verify this. Maeospsis and hafopotsy were found to be less common in the overall view of the forest composition, however villagers did not commonly use these species either, which suggests that these are at a minimal threat from logging. In addition, *A. laniger* was found on 22 different species of tree, suggesting they are able to utilize a wide variety of tree types.

Four tree species showed a significant level of use by *M. rufus*: voapaka, hasina, kafea and fotsidinty. During sociological surveys, we found that voapaka was another tree species most commonly used by villagers for firewood. However, unlike aucoumea the overall view of the forest composition did not show voapaka. This suggests that lemurs and humans commonly use this species for specific characteristics, rather than for its prevalence. Its rarity within the forest may be problematic due its suggested importance to *M. rufus*; problems which will only be enhanced by further logging. However, previous research has shown that *M. rufus* is a particularly adaptable species and our research has shown that individuals were found on 46 different species of tree. This suggests that their range of tree types has a large range, in fact, previous research has shown that *M. rufus* uses a wide variety of tree species to feed from as well as rest and travel in (Radespeil 2006).

Both *A. laniger* and *M. rufus* used a significantly higher number of trees with leaves than of trees with any other phenology. However, studies suggest that, whilst *A. laniger* is primarily folivorous (Faulkner 2006), *M. rufus* feeds mostly on fruit when it is available (Atsalis 1998). It is therefore necessary for further research to be carried out, potentially in the form of multiple short expeditions, so that the forest can be sampled year-round and especially during fruiting and flowering seasons. The phenology of the trees used by both *A. laniger* and *M. rufus* were not significantly different to those of randomly selected trees ($p>0.05$), probably because a high percentage of all of sampled trees had leaves only. In fact the overall view of the forest composition shows that 96% of all the sampled trees had leaves; only 2% had leaves and fruit; 1% had leaves and flowers and <1% was completely bare.

Both *A. laniger* and *M. rufus* showed similar results concerning the levels of disturbance in the areas in which they were found. For both species, the average overall level of disturbance was 3 out of a possible 5. This suggests that, at least in parts of the forest, the level of disturbance within Tampolo is high. It has been exposed to various levels of deforestation from selective removal of species for subsistence logging, to large-scale, non-selective removal of trees in the 1980's by the French firm, Charlemagne. This means that the level of disturbance within the forest is fragmented, the greater disturbance occurring closer to the paths created by Charlemagne. These anthropogenic activities have altered the physiognomy of the forest affecting the community and species composition. The North-East of Madagascar is also prone to cyclones, which can have devastating effects on the remaining fragments of forest. This also suggests that these species are able to endure fairly high levels of disturbance. There is little documentation about the effects of disturbance on lemur populations, but there is evidence that they can adapt through changing foraging strategies and habitat use, as some prey species become more abundant around forest edges (Ganzhorn 1995).

For both species, the areas in which they were found scored their highest disturbance scores through their proximity to the path and for *M. rufus* it was nearly as high as 4.5. In agreement with our findings, previous research has shown that both species can be observed frequently around disturbed areas and are tolerant of edge effects (Lehman *et al.* 2006). This will be beneficial for the organization of a tourist industry in the area, as it means that these species can easily be sighted from the path. The average level of logging in lemur areas was above 3 for both species, suggesting that these species are able to tolerate substantial levels of forest exploitation. In fact, multiple studies describe the adaptability of *Microcebus* species (Martin 1972; Radespiel 2007). Neither species scored highly concerning their proximity to agricultural fields, however this is likely because only a small proportion of transects were situated near agricultural fields.

Whilst it seems *A. laniger* and *M. rufus* are moderately unaffected by the disturbance within Tampolo, this may be the reason that neither *D. madagascariensis* nor *L. mustelinus* and only a small amount of *C. major* individuals were seen. For example, in a study by Andriamasimanana (1994) it was found that *D. madagascariensis* were never found in highly disturbed areas. In addition, Lehman (2006) shows that *C. major* exert negative edge response, that is they show lower densities in edge habitats, potentially as a result of heightened ambient temperatures that inhibit torpor in edge habitats. Further research is needed on the ecology of the lemurs of Tampolo forest to create an effective conservation management plan.

5.5 Preliminary Social Survey of Communities Adjacent to Tampolo

5.5.1. Introduction

Historically, the enforcement of protection in areas where resources are utilised by local communities has resulted in conflict. When many of the large nature parks were established in African countries such as Zimbabwe, locals were evicted from their homes and provided with no alternative (Hughes 1996). Such strategies have resulted in huge losses to local people, but not incurred much success on the global scale by which they are designed (Wells 1995). Despite relying on the ecosystem to sustain their livelihoods, indigenous people can make substantial contributions and play a vital role in conservation efforts, being integral to success by providing traditional ecological knowledge (Berkes 2004). In recent years, conservation organisations are choosing to work with local people and the importance of this unification was captured in the Aichi 2020 targets under the Convention of Biological Diversity (CBD). The reliance on community-based-natural-resource-management (CBNM) has consequently increased, but the success relies on a combination of the empowerment of local resource users and legitimacy of local institutions (Kull 2002).

Madagascar is a unique biome, famous for its high levels of biodiversity containing many endemic species, which have evolved since its separation from India 88 million years ago during the breakup of supercontinent Gondwana. However it is also a country that is subject to high levels of environmental degradation (Ganzhorn *et al*. 2001). It is estimated that up to 90% of the original forest cover has been lost (Quemere *et al.* 2012) and the rate of vertebrate species extinctions has increased over the past 2,000 years, coinciding with human colonisation (Dewar 2003). Extraction of timber for building and fuel along with clearance for agriculture are the main drivers behind forest loss and consequent extinctions. Madagascar National Parks are designed to protect a broad range of species and are located at 44 sites around the island, covering an area of 170,000km. However it is believed that many of these have fallen to 'paper park' status and the conservation laws they are bound to are not enforced. A military coup in 2009 led the country into a political crisis and since then the extent of illegal logging and poaching in the protected areas has increased (Schuurman and Lowry 2009). Despite having an excess of exploitable resources, Madagascar is one of the poorest counties and 68.7% of the island's population exist below the poverty threshold, 85% of which live in rural areas and rely on local resources for subsistence living (National Board of Statistics 2005). This can lead to resentment and conflict when local communities are denied resources and access to farmland, resulting in high levels of illegal logging and poaching.

Tampolo forest is located in the North-East of Madagascar and comprises of 675ha of protected coastal forest, an important vestige of this diminishing habitat. It received protection status in 1959 and has since been managed by ESSA-Foret who conduct and manage activities such as educational workshops provided in the new environmental educational workshop, Enviro-Kidz. Accommodation is also available on site, and eco-tours are provided for visitors. The villages surrounding the forest together form a '*fokontany*' and comprise of a population estimated to be around 6,000 people. Two local men from the near village of Tampolo are employed by ESSA-Foret to police the area and arrest people found illegally logging (pers comm). During the biological surveys of this research expedition, it became evident that illegal logging was severe in the area, despite the efforts of the guards. The objectives of this survey were:

- To investigate the effect of the protection on the local people and why logging continued despite the threat of arrest.

- To determine the most important tree species used by the locals, whether lemur species were hunted and eaten and if there were any traditional '*fadys*' surrounding the forest.
- To try and ascertain the reaction of locals to the prospect of expanding eco-tourism in the area as, although the facilities existed, they were not used to their full potential (pers obs). An increase of tourism could provide an influx of employment, using the forest as a source of income whilst promoting sustainability and protecting the species within.

5.5.2. Methods

Preliminary work

Informal interviews were conducted with the two guards of Tampolo forest in order to obtain background information on the history of the forest and its protection. Key tree species were also identified in terms of economic value and recreational use. During these interviews three villages were identified as having had the greatest dependency on the forest prior to the protection. These villages were within the district of Fenerive, the boundary of which can be seen in Figure 20. Structured interviews were conducted with the chiefs of each village to gather demographic information and gain permission for the research.

Tampolo, Andapa-Deux (hereby known as Andapa) and Rantolava were the three villages where the sociological surveys took place, with Tampolo being the closest in proximity to the forest. A preliminary questionnaire was then written, using the information we had gathered, and ten *ménages* (households) were interviewed in the village of Tampolo, the questions were then altered and refined based on responses and the success of the preliminary work (the final version of the questionnaire used for interviews can be found in Appendix III).

Figure 20. shows the boundary area of the district Fenerive, where all three villages are located, image taken from www.google.co.uk/maps.

Subjects

At least one adult (aged 18 and above) was questioned as a representative of their *ménage* from the villages of: Tampolo (n= 32), Andapa (n=30) and Rantolava (n=30) producing a total sample number of 92.

Survey procedure
The surveys were opportunistic in regards to sample selection. Research teams walked through the villages and approached houses at random. One of the Tampolo guards would approach the house members first and gain consent before the questionnaire began. Each research team consisted of at least two people, one Malagasy student who translated and an English researcher that transcribed. Before each survey was conducted, the research was described in an opening speech, this was said in Malagasy by one of the English researchers as a way of breaking boundaries. A wealth index was used to determine the economic status of each person interviewed (table 3). The questionnaire was then started, and answers were transcribed in as much detail as possible.

Economic Status	Definition
Bracket 1	• All house material taken from the forest (wooden floors, walls and roofs)
Bracket 2	• Tin roof • Windows • Fenced-off, garden-like area
Bracket 3	• Shop owners • Concrete floors • Multiple buildings
N/A	• Unable to determine economic status

Table 3. Shows the definitions for each category of the wealth index used to measure the economic status' of interviewees.

Data analysis
Data were analysed in Microsoft Excel (2013) and the figures in the results were also created using this software package.

5.5.3. Results

Demographic analysis
The sociological surveys provided information from the three villages that surrounded the protected area. Andapa had the largest households, with an average of 4.5 people, Tampolo was similar with an average of 4.25 and Rantolava had the smallest with an average of 3.8 people in each *ménage*.

In Andapa 54% of people from the *ménages* that were interviewed were children and 46% were adults, 56% were male and 44% female. In Rantolava 45% of people in the *ménages* were children and 55% were adults, 60% were male and 40% were female. Likewise in Tampolo the children represented 45% of the population from the *ménages* that were interviewed, 49% of the adults and children were male whilst 51% were female.

Figures 21, 22 and 23 show the percentage of interviewees that fall into each bracket of the wealth index, from each village. Tampolo village had the highest percentage of people in the lowest bracket and also the smallest percentage in the highest. Rantolava had the smallest percentage of people in the lowest bracket but the same percentage in the higher bracket as Andapa. Analyses using the wealth index is also supported by further findings from the questionnaires. 84% of the adults in the *ménages* interviewed from the village of Tampolo worked and 52% of their children were schooled. Comparativley, in Andapa 92% of the adults worked and 80% of the children attended school. 97% of adults in Rantolava worked and 75% of their children were educated. The most common occupation in all of the villages was farming however other livelihoods included fishing, shop keeping and craftsmanship.

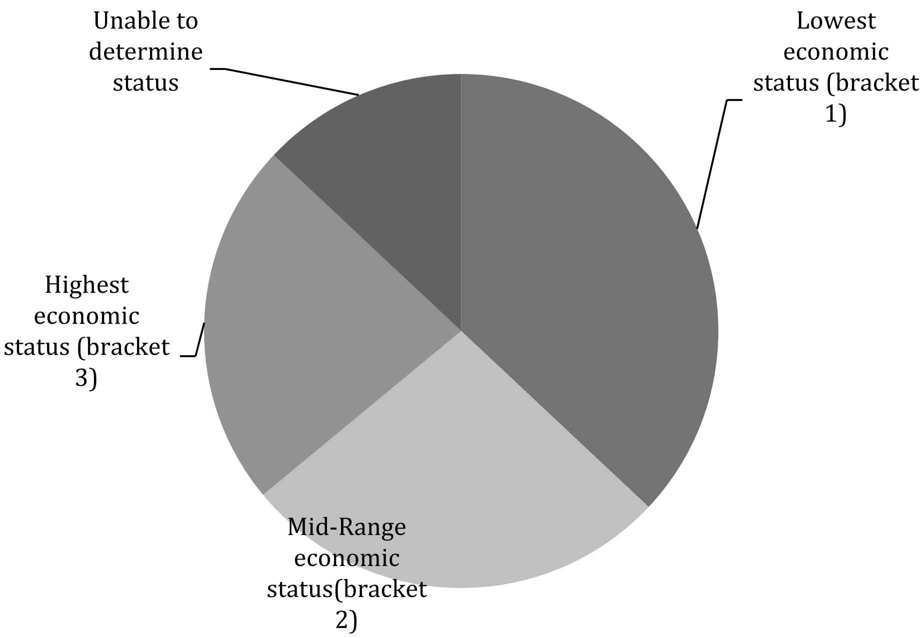


Figure 21. shows the economic status of the people interviewed in the village of Tampolo. 50% of people interviewed fell into the lowest economic bracket (1), 28% were midrange (2), and 13% were relatively well off (3). Data was unavailable for 9% of those interviewed (n/a).

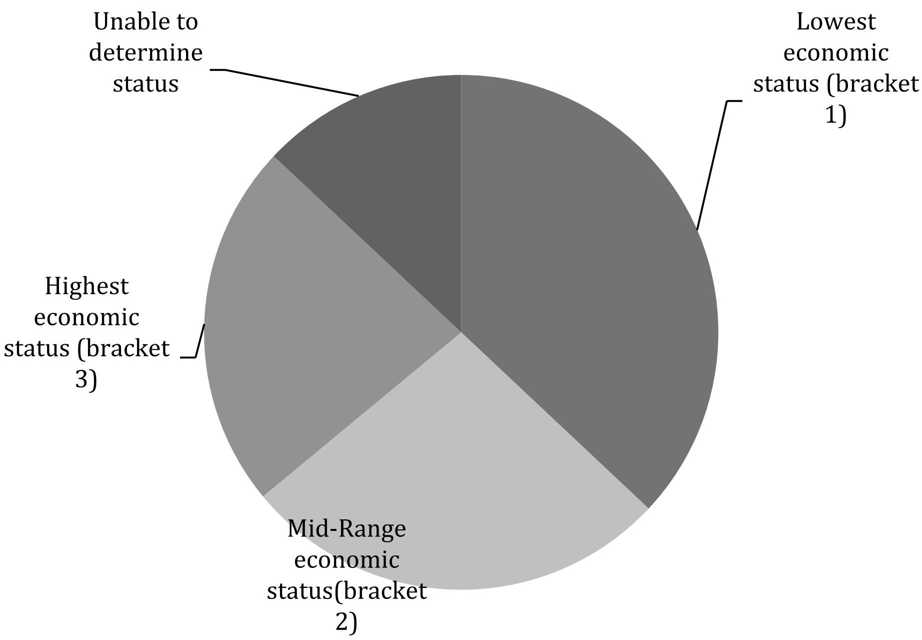


Figure 22 shows the economic status of those interviewed in the village of Andapa. 40% fell into the poorest rank (1), people in the mid (2) and highest bracket (3) took up similar proportions at 23 and 24% respectively. 13% of those interviewed could not be defined in relation to their economic status.

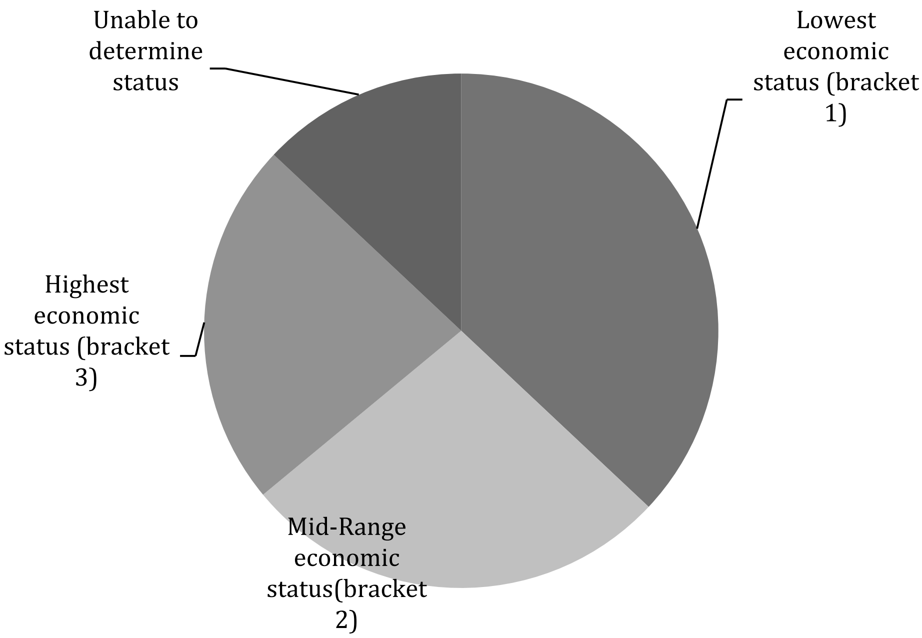


Figure 23 shows the economic status of those interviewed in the village of Rantolava. The majority of people fell into the lowest bracket (1), 27% were in the middle (2) and 23% were in the highest (3) 13% of people's economic status could not be determined (n/a).

Analysis of Lemur data

The two diurnal species, the eastern less bamboo lemur (*Hapalemur* griseus) and brown lemur *(Eulemur fulvus)* were the most commonly seen in the forest by the villagers interviewed. *M. rufus* and the *A. laniger* were the most commonly seen of the nocturnal lemurs and *C. major* was the least observed (Figure 24). 15% of people interviewed had never seen any of the lemurs whereas only 1% of people believed they had seen all seven species. When asked if they hunted the lemurs for food, 21% admitted that they did, with *H. griseus* and *E. fulvus* being the most common, 74% denied hunting the lemurs and 5% stated that they used to before the protection.

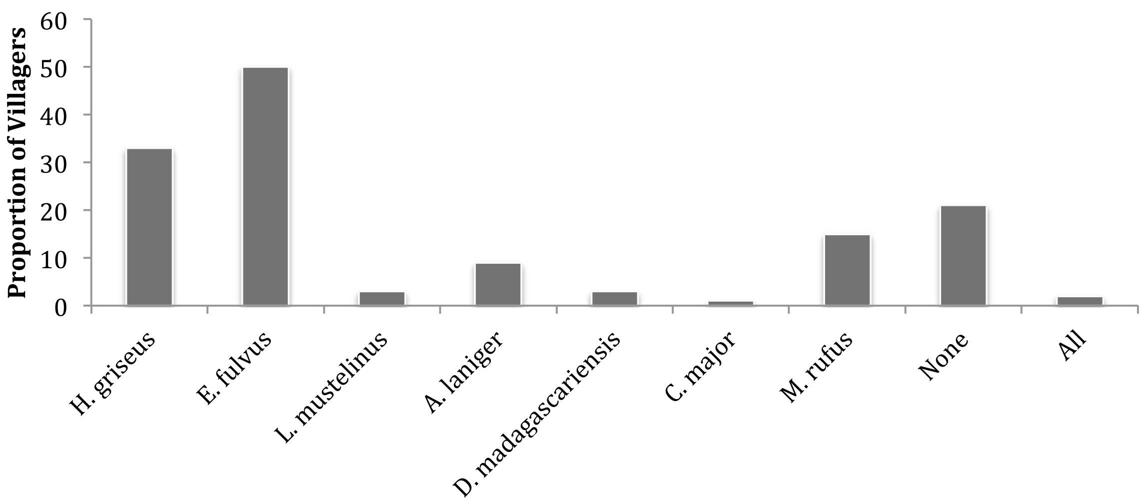


Figure 24. shows the number of villagers that had seen each lemur species in the forest including two diurnal (Brown and Bamboo) and five nocturnal species (Sportif, Avahi, Aye-aye, Dwarf and Mouse). Results were based on the one representative from each *ménage* that was interviewed. The Y axis shows the proportion of villagers that had seen each species.

Results from the questionnaire revealed there were two main *fadys* surrounding the lemurs; one that you couldn't kill or eat any lemurs (27 people interviewed believed it would bring bad luck) the other *fady* was less common (only three people interviewed described this) with people believing that it is bad luck seeing *D. madagascariensis*. However 51 people said they there were no *fadys* from their culture that involved lemurs.

75% of villagers had a positive view on the lemurs; 38% said they enjoyed seeing them, 36% believed they were good because they dispersed seeds and 3% liked them because they generated tourism. However a small percentage of villagers admitted to being scared of them (8%) and others stated that the lemurs ruined crops (15%), as seen in Figure 25. When asked what the solution was to overcome crop destruction by lemurs; 11% of people responded stating that the pests should be killed. 90% of the people interviewed knew about the protection of the lemurs and only 10% stated that they did not.

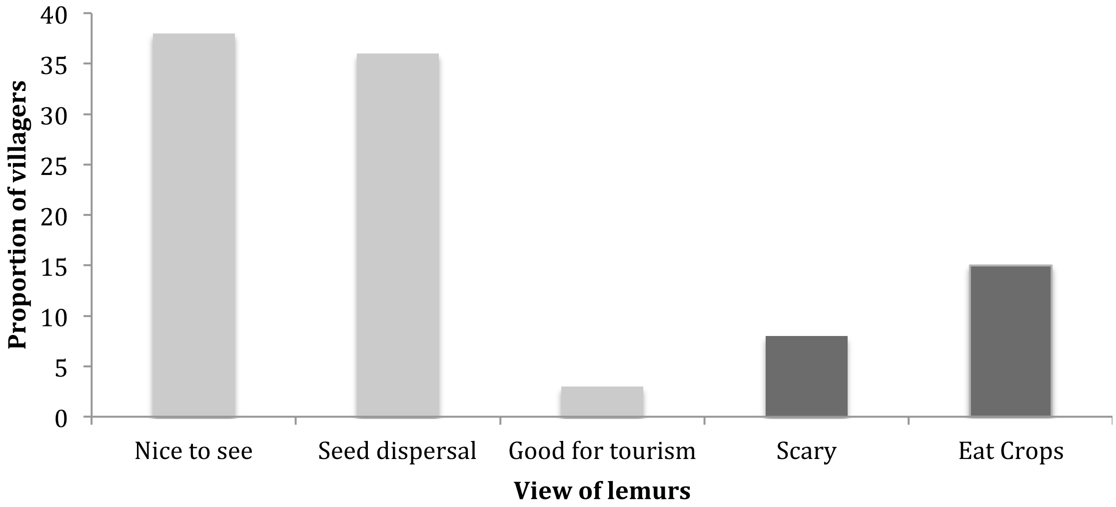


Figure 25 shows the positive and negative views the villagers had on the lemurs of the forest. Dark-shaded columns represent negative views. The Y axis shows the proportion of villagers with each perception.

Tourism

When asked '*Is tourism good or bad?*' 80% of the *ménage* representatives responded positively. 6% either didn't know how they felt about the industry or they felt that it was both good and bad. When asked the open-ended question; 'What does tourism bring to Madagascar?' the majority of the responses were positive, the most frequent responses were categorised into teaching and cultural integration. The only negative answer related to sexual tourism (Figure 26). One question aimed at determining the reaction to an increase of tourism in Tampolo specifically, showed that 97% of people would welcome more tourists and only 3% would object. Following on from this, representatives were asked if they would like to work in tourism, 91% said yes if they were given training, 8% said no and only 1% said that they would not be interested.

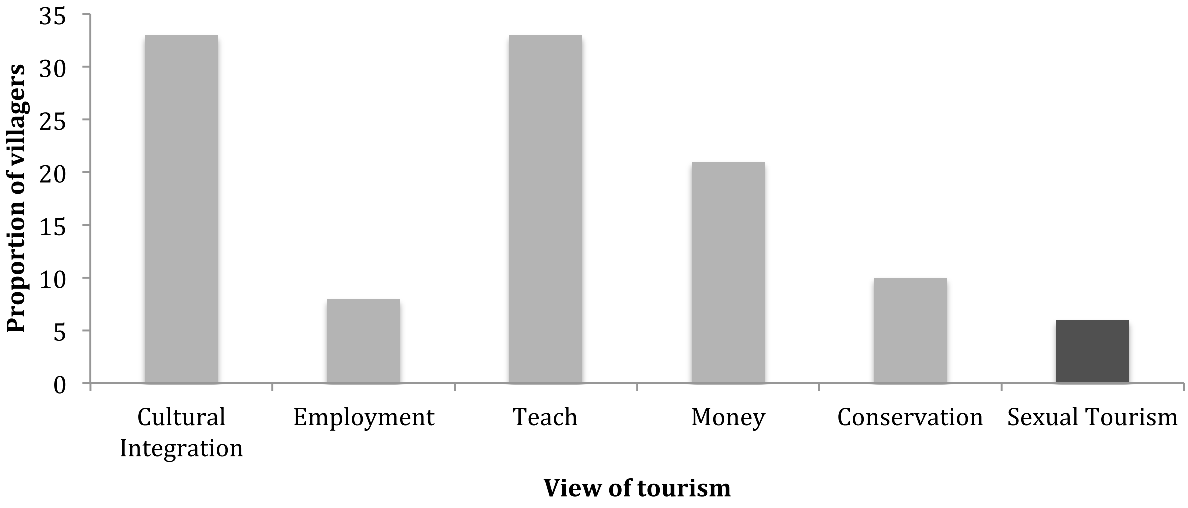


Figure 26 shows the response of the *ménage* representatives to the question 'What does tourism bring to Madagascar?' Dark-Shaded columns represent negative views. The Y axis shows the proportion of villagers with each perception.

Forest Resources

The three most common uses for the forest resources were firewood, medicine and timber (Figure 27). Although other uses included charcoal, food, furniture and pirogue making, the number of *ménages* that used the resources for these purposes were considerably less.

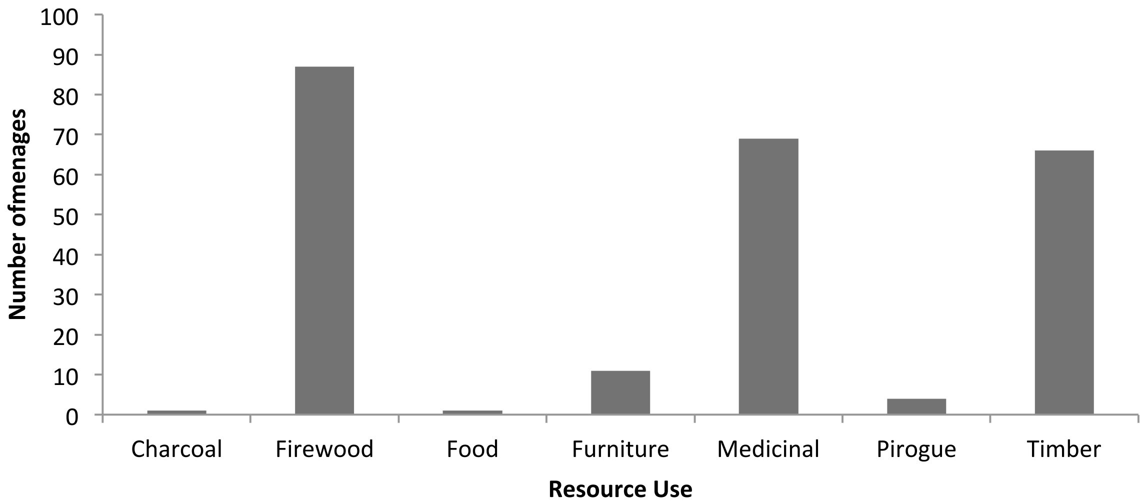


Figure 27 shows the response to the question 'What do you use the forest resources for?' with the most common uses on the X axis and the number of *ménages* on the Y axis

Figures 28, 29 and 30 show the three most common uses for the forest resources and which species are taken for each. Voapaka and Aucoumea were the most common species used for firewood (Figure 28) whereas Hazoambo and Fotsy avadika were more likely to be used for medicine (Figure 29) and Voapaka, Nanto and Hazoambo for timber (Figure 30). The species Hazoambo is the most utilised species as it is taken for all three purposes, Nanto and Voapaka are similarly diverse being used for both timber and firewood.

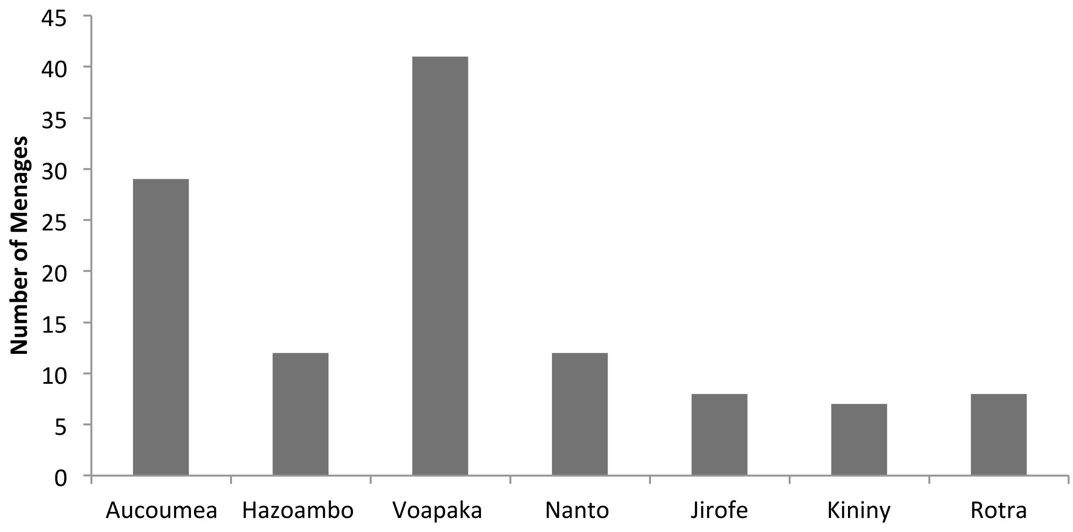


Figure 28 shows the most common species used for firewood in all three villages. The number of *ménages* that used each species for firewood is shown on the Y axis.

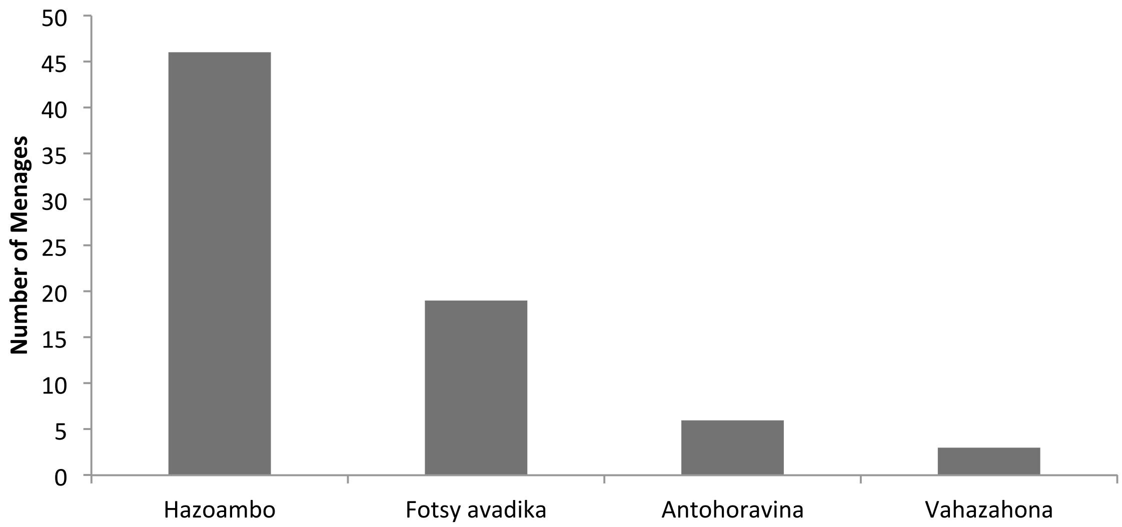


Figure 29 shows the most common species taken from the forest by the villagers for medicinal purposes. The Y axis depicts how many *ménages* take each species.

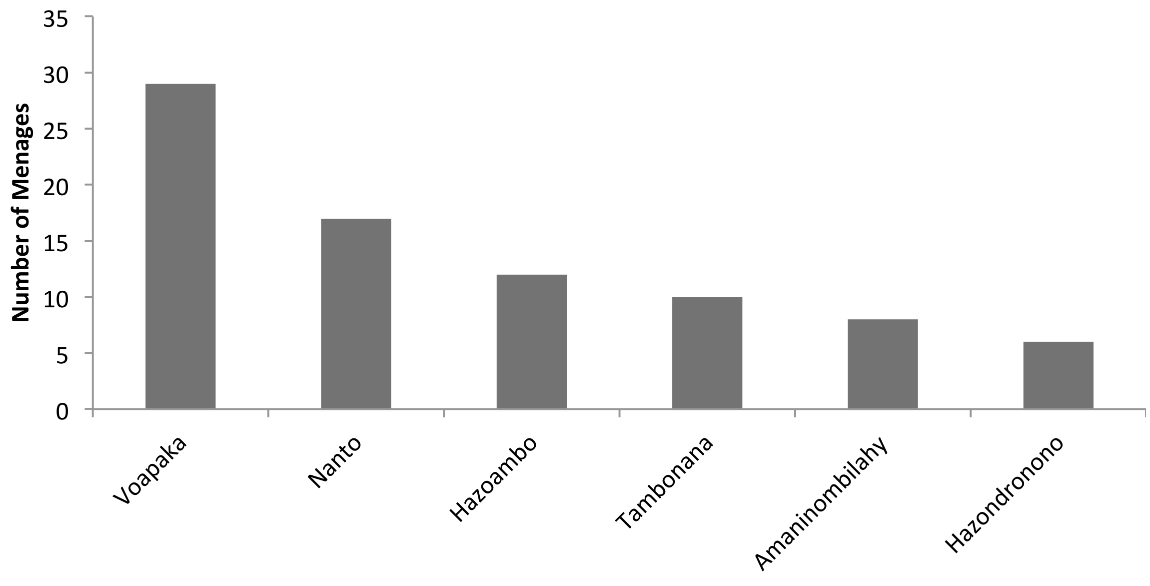


Figure 30 shows the most common species taken from the forest for timber. The Y axis shows how many *ménages* used each species.

Figure 31 shows that only 9% of the people interviewed admitted to selling the resources that they took from the forest.

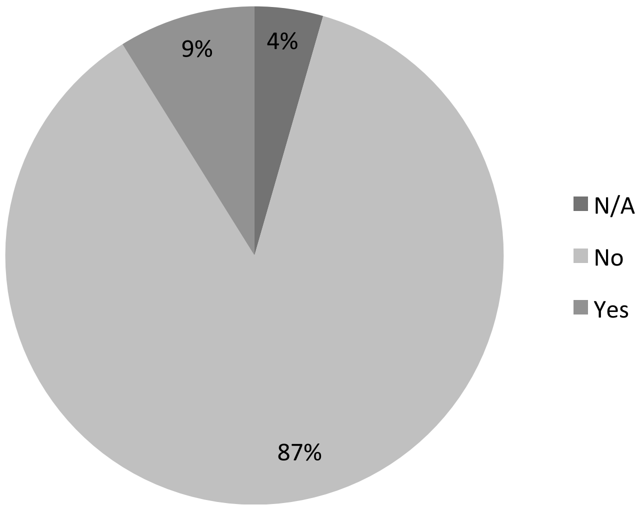


Figure 31 shows the response from every *ménage* interviewed in response to the question 'Do you sell any of the resources that you take from the forest?'

95% of people interviewed knew about the protection of the forest, 5% stated that they were unaware of this status. When asked what they thought about the protection of the forest, 74% believed that it was good as it preserved the resources for future generations, 17% felt that they were unaffected by the protection and 9% felt it was bad because people needed it.

Following the preliminary study, the answers revealed that when the protection was enforced, the residents of Andapa and Rantolava were given a section of the forest in which they were allowed to log, however the people from the village of Tampolo were given no alternative. When asked if the reserves of forest they were given were enough, 52% said they were not sufficient, 22% were not even aware they existed and only 11% said they were enough (Figure 32).

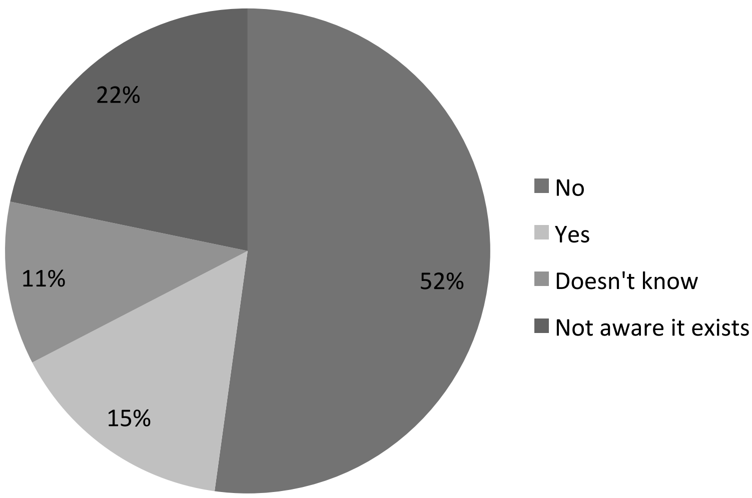


Figure 32 shows the responses given by the villages to the question 'Is the alternative part of the forest you have been given to log sufficient for your needs?'

5.5.4. Discussion

The results of the sociological research revealed some fundamental information in regards to the underlying causes for the substantial illegal logging activity in the Tampolo region. The most significant being that despite small areas of forest being designated for the villagers to use, they were not sufficient for their needs, and for the poorest village, Tampolo, an alternative to the protected area has never been provided.

During open discussions, it was understood that prior to the protection laws many people relied on selling forest resources as a main source of income. However, only 9% of people admitted to selling resources from the forest at the time the interviews were conducted. Instead, following demographic analysis, it became apparent that the most common occupation was farming which may mean that people in this area are increasingly relying on farming practices and land management opposed to forest resources.

The average number of people in each *ménage* was similar in all three villages and so were the proportion of females to males and adults to children, mostly around the 50:50 ratio. However, when analysing the wealth of the villagers, it became apparent that the people from Tampolo village were the poorest. The wealth index is a common technique used to establish a household's living standard and is regularly used on a larger scale in countries where there is limited data on income and expenditures (The DHS Programme 2014). However, it is usually done on a larger scale and questions are asked to the householders about their ownership of consumer items. In this research, measurements of wealth were partially based on discrete observations made about the house in which the interview took place, which was constraining because at times the interviews took place outside where information was limited. Tampolo's lack of wealth may have been a consequence of the protection laws as Tampolo villagers were not given an official VOI (area of forest to legally log) and with it being the closest in proximity to the forest, this could account for a greater dependency on resources. Field observations of conservation projects worldwide have shown that they can have a negative effect on the livelihoods of the people that live nearby (West and Brechin 1991, Kiss 1990). A study conducted in the southeast of Madagascar, revealed that the opportunity costs to the local people could extend to $3.37 million dollars (Ferraro 2002) during the formation of Ramanofana National Park. Although the present study revealed no quantitative economic data, the detrimental effects of the protection were still evident.

Of the villagers that regularly went into the forest, the most common lemurs observed were the diurnal species; *H. griseus* and *E. fulvus*. However nocturnal species such as *M. rufus* and *A. laniger* were also seen, this suggests that villagers were entering the forest at night, when logging activity was observed frequently during the research period. The fact that *M. rufus* and *A. laniger* were most frequently observed by the villagers was reflected in our research, however, identification errors are likely to have been present as *M. rufus* has very similar physical characteristics to *C. major* as does *A. laniger* to *L. mustelinus*. Prior to surveys all researchers had to learn how to distinguish between the similar species and in addition identification cards were taken on the first few transects. However many local people may not have had the resources to enable them to correctly identify the species.

15% of the people interviewed stated that they had never seen a lemur, which would suggest that they rarely entered the forest. This may have been because the majority of people questioned were female and would not have been involved in the logging (pers comms). A small percentage were found to have seen *D. madagascariensis*, however this was one of the species not observed during the transects. Discussions were contradictory about the presence of *D. madagascariensis* in the area, some believing that a small number of individuals existed in the area whilst others stated that they had not been present for a number of years.

Despite 90% of those interviewed confirming that they were aware that the lemurs were under protection, 21% still admitted to hunting and consuming them. The most popular species being the *H. griseus* and *E. fulvus* a further 5% admitted to hunting before the protection. These results indicate that lemurs are an important part of people's diets as a form of meat and protein that is accessible and affordable. It further shows that local people are still hunt ing and consuming the lemurs even though they are aware that it is against the law. Research has shown that the hunting of lemurs for bush meat has increased substantially since the military coup in 2009 (Jenkins *et al*. 2011). However traditional beliefs (*fadys*) surrounding the lemurs also existed in the area and many opposed hunting and killing them as it is believed this would lead to bad luck.

Overall people generally had a positive view on the lemurs, many said they got enjoyment from seeing them in their natural environment and knew of the benefits that they delivered, such as seed dispersal. Through the interviews it became apparent that the charity "Avertem" had taught local people about the importance of lemurs and the role that they play in the ecosystem. This charity has been working in Tampolo since 2009 and its main objective is to teach local people about the importance of the forest resources, with particular focus on medicinal plants. They run a medicinal garden at the ESSA-Fôret site along with supplementary educational workshops (Avertem France 2012). 16% of people thought negatively of the lemurs because they destroy crops and eat important farming produce such as lychees. When asked what the solution to this problem should be, 11% stated that the perpetrators should be killed. As farming is a common occupation in the region, new strategies should be used to reduce crop destruction by the lemurs and deter them from farming areas. Deterrence methods used worldwide include alarms (Gilsdorf *et al.* 2004) and supplementary feeding (Putman and Staines 2004). Studies would need to be done in order to determine their effectiveness on the Tampolo lemur population, but could ultimately help maintain it and reduce active killings by locals.

Eco-tourism is one of Madagascar's most significant foreign-exchange providers and within the Tampolo region there is an opportunity to increase this industry (Schwitzer *et al*. 2014). Dormitories and a villa style house already exist at the ESSA- Fôret site, along with a museum. This is just a 2.5km walk away from a beautiful and completely undisturbed beach. There is also the opportunity to take out visitors on guided tours of the forest to see the flora and fauna, which can be done both by day and night. Tampolo is already on the tourist route as in lies between the large city of Tamatave and a very popular island in the North, Ile Sainte-Marie. In order to determine how the local people would receive an increase in tourism, the survey included a section on the topic. The vast majority of those asked said that they believed that tourism was beneficial to Madagascar because it created jobs, generated income for the country, allowed for cultural integration and provided learning opportunities in language, medicine and conservation matters. The only negative response to tourism came from some people's concern over the sexual tourism that is an increasing and very apparent problem in the country; research has shown that around 12% of adult females in Madagascar work in the sex trade (Vandepitte *et al.* 2006). However when asked if they would welcome tourism in the area, 97% of people stated that they would and 91% were willing to work in the industry. This provides a positive outlook on the expansion of tourism in the area as it would provide more jobs for the villagers and create teaching opportunities both in field-guide training and language skills. Consequently it would also help people protect the forest, as a means of providing a motive for following the laws of protection fostering a local valuation of the ecosystem (Schwitzer *et al*. 2014).

When determining what the most common uses of the forest resources were, three main categories became apparent; medicine, timber for houses and firewood. *Voapaka sp.* and *Aucomea sp.* were two species that were most commonly used for firewood, the latter of which was found to be of ecological importance to *A. laniger* and *M. rufus. Voapaka* was also commonly used for timber as well. These findings suggest that if the illegal logging continues, then this could have ramifications for the lemur populations that depend on them, either through feeding or sheltering. Additionally, previous research has suggested that the collection of firewood and construction timber in the area generates the greatest threat to the ecosystem, whereas the collection of medicinal plants is comparably less damaging. Furthermore, the illegal logging activity takes place at night and fire is used to light the area, causing a significant hazard (Ratsirarson and Goodman 1998). This suggests that the illegal activity may pose additional threats than just habitat destruction.

Hazoambo was the most common species used for medicinal purposes. Our research suggests that these plants are not as ecologically important for the lemur species studied, however, as little or no samples were identified for *C. major, L. mustelinus* or *D. madagascariensis* no conclusions can be drawn from the findings. Through open discussions it was found that all parts of the *Hazoambo* plant were used for medicinal purposes, from roots to leaves. This species is therefore extremely important to local people as they depend on it for a range of ailments. *Hazoambo* was also the most commonly used species as it is used for building and firewood as well. However, with the laws enforced and most of the logging being done illegally, there is currently no sustainable management. This may lead to the local extinction of this species, leaving the local population with no access to their natural medicines. Further socio-botanical research would be needed to determine the level of threat here.

The vast majority of those interviewed knew about the protection of the forest and most thought of this as a positive because it preserved the forest for future generations. However nearly 10% didn't agree with the protection because they felt that local people needed to use the forest for their own means. A further 52% said that the alternatives given were not sufficient for their needs and 22% of people were not aware of the VOIs. Through the surveys we learnt that both Rantolava and Andapa-Deux were provided with areas of the forest called VOIs in which they could log, if they obtained a license. The villagers of Tampolo village, however, were not provided with an alternative. Through personal communication it became apparent that these licenses were hard to obtain and that the areas of forest were so heavily logged, that nothing remained in the area. Following inspection of the VOIs we were able to confirm that these areas were not suitable for villagers to use, in one of the sections a fire had destroyed all that remained and the area was left unsuitable for re-growth (figure 33). Without the knowledge of re-planting and sustainable resource use, the areas were devoid of large species and provided no suitable resources.

Figure 33. Shows the remaining, minimal vegetation in an over-used and under-maintained VOI area. Photo by Rachel Blow.

Through informal interviews, we found that the initial deforestation of Tampolo forest dates back to decades ago, when the French logging company "Charlemagne" organized an intense operation in the area. The result was the deprivation of large, economically important species such as *Dalbergia spp* (rosewood)(pers comms). The effects of Charlemagne's presence are still evident in the two large paths that dissect the forest and which were used by the research team to access sites, along with the bridges that were built and used by the loggers. During the time when the company were operating in the area, the logging would have generated employment and income for the local people, only to be taken away when Charlemagne left the area.

The future of Tampolo seems uncertain, it is the only forest remaining in Fenerieve-Est and consequently the anthropogenic threats are high. Without an alternative it seems apparent that the people are left to log illegally if they want to be able to cook, house and heal their families. At the same time, this illegal logging activity could have disastrous consequences for the lemurs that inhabit the forest and particularly depend on some of these tree species. The forest also plays an important role as is acts as a barrier of protection from cyclones, which are becoming increasingly more frequent in Fenerieve-Est. From the research we gathered and through personal observations our group propose that through both sustainable use and an increase in tourism and education of forest management this part of dwindling natural habitat could be saved. Towards the end of the research period, tourism brochures were made by the team to try and encourage tourism in the area (figure 34.) and given to the University of Antananarivo to distribute.

Avertem are still working in the area and are managing a reforestation programme, using the Enviro-kidz centre. Here children are taught how to distinguish certain medical species and the importance of the forest. They are then taken into the forest to plant seedlings of species such as *Xylopia buxifolia,* a medicinal plant endemic to Madagascar and IUCN classified as Vulnerable (See Figure 35).

The study revealed some interesting issues surrounding the Tampolo region. It has brought to light that despite local people being given parts of the forest to log in, this practice is not working in the area because of the lack of education in sustainable use and the degradation of the VOIs. We propose that a training programme is implemented, potentially through ESSA-Fôret, to teach local people how to use the resources sustainably and which areas are suitable for the replanting of economically and ecologically important species; similar to the work that Avertem do with the medicinal species. Tourism would help the area become more affluent and, as many locals would welcome this, it would be well received. It could generate income through selling crafts, guiding, cooking and cleaning. We propose that in the future, studies replicating this one should be conducted, to determine the lemur population and logging activity as well as to investigate whether tourism has increased and what effect it has had on the local people. Working on a University field site will hopefully lead to a continuation of studying in the area, resulting in conservation management that benefits both the eco-system and the people that depend on it.

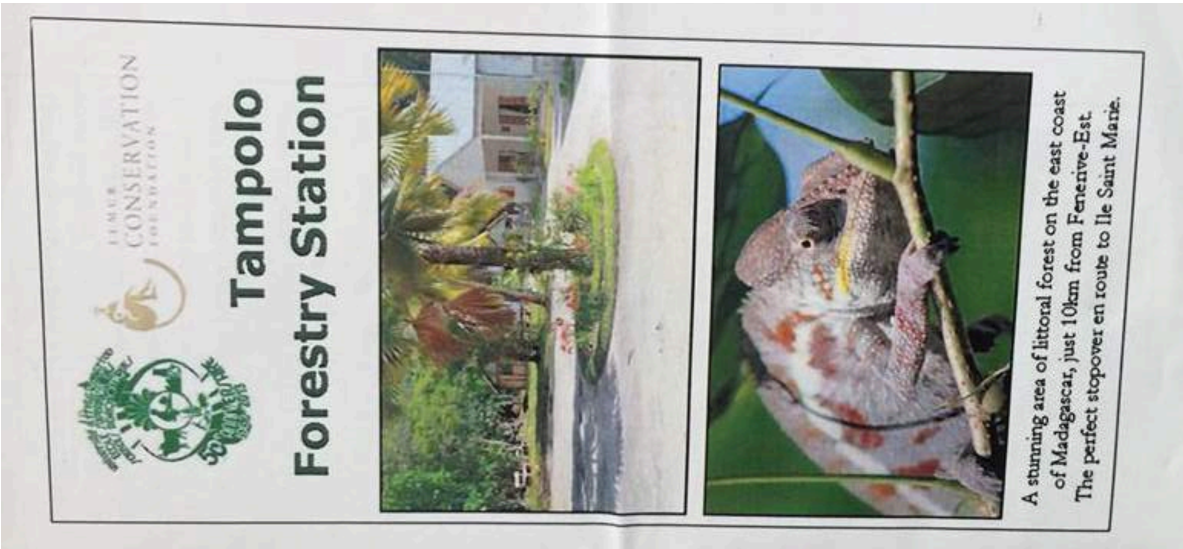


Figure 34. Shows brochures designed and created by the research team to encourage eco-tourism in the Tampolo region.

Figure 35. children taking part in Avertem's replanting and education programme. Photo by Donna Wintersgill.

6. Adventurous Activities

Some weeks were set aside before the project began to explore some of Madagascar. We were lucky enough to visit first the Northeast including Andasibe National Park, Ile Saint Marie, and Tamatave, followed by a journey Southwest to Antsirabe, Miandrivazo, Morondava, Kirindy Forest Station, and the Avenue of Baobabs (Figures 36 and 37). The team enjoyed some beautiful wildlife and scenery, and tasted a huge array of unsuspecting street food, leaving us bed-ridden back in Antananarivo sorting out last minute project logistics. The team used both the Lonely Planet and Brandt guides to Madagascar (2012).

Though we encountered fires, storms, and strong tidal currents, it was the public transport that set the team in the most danger. With the common taxi-brousse varying hugely in quality, age, and driver sobriety, travel was always a gamble; the journey from Miandrivazo to Morondava included ear-slitting un-oiled breaks, a window that shattered on a teammate mid-journey, and a water tank that was topped up on the bonnet throughout the ride.

Meanwhile, the Southern region became rife with criminal activity. Zebu bandits, known locally as 'dahalo', were robbing buses, setting fire to villages, and murdering innocent people. The headlines spelled out 'terrorists', whilst the Foreign Office was quick to the mark in warning foreigners of travelling south in Madagascar. Dashing all hopes, and a years worth of planning for our project in an un-explored, volcanic plug in the spiny forests of the south, we did a bit of networking and soon brought a new project together with the University of Antananarivo.

Figure 36. Avenue of Baobabs. Visited by the team during their pre-research travelling. Photo by Rachel Blow.

Figure 37. A foosa the team were fortunate enough to see whilst at Kirindy Forest Station. Photo by Rachel Blow.

Madagascar's travel surfaces come in the form of 'roads', fairly well-surfaced, long-haul routes, and then 'paths' not so "well-surfaced" dirt tracks. Unfortunately, 'paths' dominate much of the country's infrastructure. With rainy season beginning, potholes soon became caverns, and weaving around each in an over-crowded mini-van took the best part of a day. Sadly, throughout these long journeys we witnessed the rural landscape was ablaze with fire, as slash and burn agriculture is still tearing down the forests at an alarming rate and leaving huge brown scars in the hillsides.

Once we were settled in Tampolo Forestry Station, the adventures continued. One team member was lucky enough to celebrate her birthday in Madagascar, which involved a day-off, some cold beers in the market town, and a Malagasy-made birthday cake (rice-flavoured!). Another highlight was making improvements to our very restricted British skill-set. Known by every Malagasy on the island, is the art of killing a chicken. After rejecting some questionably coloured meats in the market town, we set about purchasing two plump chickens to take back to camp. Two of the team members learnt the process from our resident cook, before taking their own turns at this new skill.

Transects were a daily adventure. With selective logging widespread in the forest, team members had to watch the trees for lemurs as well as their step, with sharpened 'stakes' punctuating each transect. Whilst the paths were littered with remnants of bark, some transects were simply nicknamed 'tree graveyards', with logs and sticks tearing our clothing into shreds. Animals also posed a threat during data collection. Hornets and wasps were abundant in the forest, as were mosquitos, suspected to carry Malaria. Snakes, though lacking venom, were also highly present after the rains began, making for exciting photographic opportunities.

At the start of our research period, there was a slight misconception amongst villagers that the reason we were in Tampolo was exclusively to help enforce the protection of the forest. But as the project drew to a close, we learnt that our expedition had changed the way locals thought about tourists, and that they were really appreciating the work we were doing. To thank them for taking part in our surveys, we donated school books to the poorest families, and hosted a party for the elders of each village. Team leader Rachel even encouraged their respect with a long speech in broken Malagasy.

The return to the capital 'Tana' was much appreciated, and the purple jacarandas that line the streets were in full blossom. We were grateful for toilets absent from snakes and cockroaches, though not for the hostels and their male expatriate inhabitants, most of which had come to Tana solely seeking the sexual tourist trade. Tana provided other delights, including hot showers, bustling markets, and chinese restaurants.

7. Administration and Logistics

7.1 Food and Accommodation

As the team was based in camp for the majority of the research, travelling for food supplies during the project was not an issue. Weekly trips were made to the nearby market own of Fenerive (see Figure 1) by taxi-brousse. As many team members as could fit were crammed in to help purchase a weeks supply of rice, beans, torch batteries, and other expedition essentials. Fresh fruit and veg was normally bought and eaten within the first 3 week days to avoid rotting. We also purchased the town's entire supply of chocolate, and any other expensive Western delicacies that were found on the shelves. The day after the market was always a great food day! Diets were healthy and regular, with rice and beans being the winner food items, as part of almost every meal for 5 weeks. When lychee season came into effect in December, we feasted on the fresh fruits at every interval. Our meals were prepared by Vivienne, a lady from the village employed by the Forestry Station as cook. She then became our delightful friend who managed to make our meals exciting and delicious despite the monotonous combinations of… rice and beans. The team used the water pump at the Forestry Station to gain access to drinking water. The water was filtered using a 1-micron water filter bag and water tablets were then added for purification. The team had brought two 10 litre plastic containers to store water, these broke after the first day so we resorted to filling endless numbers of plastic bottles. The daily 'water filling' process was an expedition in itself. One person would pump the water while another balanced to hold the bottle and the filter and a third would put the water tablets in the bottles. Thus our warm, yellowish, clorine-tasting water was ready to drink! Another treat of going to Fenerive once a week was the chance to enjoy a cold drink. Despite its name, however, the UK team members were not keen on the sweet *Bon-bon Anglais* soft drink, extremely popular amongst the Malagasy.

Tampolo Forestry Station is used by the University of Antananarivo for field trips. The recently built site therefore housed a covered area with tables and plug sockets, a guest house for paying visitors, an education centre, museum, cheaper accommodation, a kitchen, and a wash area, complete with long-drops and rusted water pump. Tents were set up in a field by the kitchen, which backed onto a large wooded area frequented with brown lemurs by day, and wooly lemurs by night. During our stay in Tana, we visited 'Moonlight Hostel', and 'La Karthala', both located in the central-northern district of the city.

7.2 Travel, Transport and Freighting

Anyone that has been to Madagascar will know how difficult it can be to travel within country. Distances are large and travel is slow and tortuous. The Malagasy team members had to travel 3 continuous days by taxi-brousse to reach Antananarivo (Tana). The UK team members arrived in Tana by flight (via Nairobi) from London Heathrow. From here the team hired a private taxi-brousse to travel with all equipment to reach the expedition site, luckily only a full days drive away. The expedition site was around 500 km North-East of the capital.

The team managed to carry all of the expedition equipment with them by flight and then by taxi brousse. The 5 UK team members stored a 9 people tent in a big bag as well as endless supplies of duck tape, measuring tape and torch batteries. The flight baggage allowance was high and the equipment needed was not excessive so the team managed to avoid freighting. Furthermore some of the equipment, (2 tents and the GPS's) were carried by the Malagasy team members by taxi brousse from Fort Dauphin (South).

What other transport could be used locally if not the famous Malagasy taxi-brousses? This was the main/only means of transport available in country and it was used by the team to and from the expedition site and for the daily trips to the market in Fénérive. In Tana, however, the team travelled by taxi to reach the University, the bank, the airport and other sites. This was for safety reasons regarding the amount of money carried and the high risk of robbery within the capital.

7.3 Environmental and Social Impacts

Environmental and social impacts were kept to a minimum during the expedition. Whilst organising kit prior to the expedition, the team ensured any liquids were degradable or environmentally friendly where possible, such as Ecover branded detergents. We ensured not to leave litter and keep packaging to a minimum. The forestry station was fortunate enough to be equipped with recycling facilities, with general waste burned on-site, whilst any glass was returned to be re-used from where it was sold. Used batteries were kept and returned to the UK for recycling. During the research period, we ensured that disturbance in the forest was kept to a minimum, using pre-existing forest trails as transects and cutting through vegetation only where necessary. Transect repeats were conducted approximately 4-5 days apart to allow for any disturbed fauna to re-colonise, also beneficial for study purposes. Whilst all efforts were made to ensure environmental impacts were kept to a minimum, it was difficult to source 'green' products such as insect deterrents and disinfectant. Some grass was degraded by the presence of the tents, whilst the pit-toilets and water pump had not had such regular use in the past, and likely suffered as a result. Although we chartered a taxi-brousse to Tampolo, this was necessary to ensure that heavy equipment and baggage was safely contained; much of Madagascar's public transport is economical in lift-sharing, although the quality and age of the vans likely compromises any 'green' savings made. We recommend that every effort is made to minimise environmental impacts in the field, especially when our main research concern is the conservation of the forest itself.

With a sociological study a key component of the research, we took great care to treat the subject with sensitivity whilst raising awareness of the problem at hand. We designed the survey with the help of the students to erase any language or phrasing discrepancies. Permission was granted from each subject to continue with the questionnaire after a member of the team explained the research in Malagasy to reduce cultural boundaries. The chiefs of each village were informed of the research and consented before it was conducted. Each survey was done anonymously and in gratitude, certificates were presented once the questionnaire was completed. We also purchased and donated books and writing equipment to young children in underprivileged families to reduce the costs of attending school.

We were made aware from village elders that our conversations with villagers and presence in the area had greatly assisted in positively changing attitudes toward foreigners and the forest in general, which we expect has encouraged a legacy of change since we left the area. We left some equipment as gifts to staff, and purchased others such as a new sharp knife for our cook. The participation of our Malagasy students from the Centre Ecologique de Libanona (CEL) was a key driver to achieving a successful research project. All students were funded as interns from our budget, whilst the project helped advance their education through hands-on field research. Though we paid all participating staff, we suspect that disagreements might have resulted due to debauched management at the forestry station. Since our departure we have kept in contact with a peace-corps volunteer working in the area. We are actively disseminating results in the UK to raise awareness of the issue further afield, and to encourage future study and assist in networking this.

7.4 Insurance

The insurance company used by the team was Protect your Bubble. During the course of the expedition the team did not make any claims to the insurance and thus were not able to verify the strength of the company and whether they would have been helpful in case of emergency. The insurance policy, however, was appropriate for a research expedition and the team was satisfied with the cover and the quote received. The cost of the insurance for all team members was £422.

7.5 Risks and hazards

All team members were briefed of medical evacuation procedures in the event of an emergency. Classified into Medium, High, and Emergency priority situations (Appendix VI) cases were identified to fall into one of these 3 categories, and their solutions defined.

Potential risks the expedition faced included adverse weather conditions, cultural differences leading to aggression, infections and injuries, unreliable transport, venomous flora and fauna, and theft; all were addressed in the risk assessment (Appendix VII). We safely stored a copy of our emergency contact details on-site, as well as in the hands of relatives at home.

Fortunately, no serious problems arose for the duration of the expedition. There were minor cases of intestinal discomfort, mosquito bites, minor infections, and insect stings; these were all handled with basic first aid equipment. Guides made sure to alert us to any dangerous or poisonous plants and animals, such as scorpions or the insect they call the "king of the sand".

Prior to the expedition research during the traveling period of our visit to Madagascar, there were a few incidents that might have been avoided. Firstly, team members experienced a bout of serious dysentery and high fevers. This situation was handled again with basic first aid, whilst all team members bought mebendezole tablets to take before leaving Madagascar; checking food is cooked well, drinking bottled water, and avoiding unwashed vegetables is advisable. A second incident arose with an unsafe vehicle; the taxi-brousse, driven by a young man who appeared to still be learning to drive, had un-oiled breaks, a water tank that was topped up on the bonnet, and a window that shattered glass upon a team-mate. It is advisable that vehicle condition is checked prior to travel of any distance; we were publicly made aware of a number of taxi-brousse crash incidents that appeared to be relatively frequent in Madagascar, in combination with questionable road surface quality. Finally, whilst visiting Ile Sainte Marie, several team members were unaware of strong currents in the sea. Whilst it became difficult to swim, others spotted the situation and were able to pass encouragement to those struggling in the water. Although everybody made it back to shore, it is extremely advisable to swim only where others are, and to take advise from locals about the best spots.

The southern region where our initial expedition was due to take place became very unsafe, and we were thus advised to re-arrange a new project. This was a near miss that was only avoided thanks to solid communication with in-country contacts and advisers. Throughout our time in Madagascar we became increasingly aware of the political instability within the country. With a new president to be elected December, the day before our flight to London was due, the team booked a hotel next to the airport and spent the last night within walking distance of the terminal. It was advised that riots and disruption were likely on routes to the airport, whilst the main square in the capital of the city was often a political target. However, we are since unaware of any serious incident having arisen from the election.

7.6 Medical arrangements

As detailed in the risk assessment and emergency procedures (Appendices VI and VII), all necessary control measures were taken to ensure hazards did not escalate and risks did not materialize. Some preparatory medical training was undertaken, with two team members knowing basic first aid procedures, and one other team member undertaking further training (ITC Certificate in Outdoor First Aid SCQF Level 5, 2013). Facilities and details for emergency evacuation can also be found in our risk assessment documents.

A list of medical equipment can be found in Appendix VIII.

All team members were immunized prior to travel against prevalent diseases such as Hepatitis A and Tetanus. Each team member had their own personal supply of Doxycycline anti-malarial medication.

7.7 Destination Area

Tampolo Forestry Station is located north of Fénérive-Est (see Figure 1), in the Northeast of Madagascar. This fragment of littoral forest is a 675 ha protected area, and contains an abundance of unique flora and fauna. Situated at the edge of the forest, meeting the road North from Fénérive-Est, is the village of Tampolo, and the field station where our expedition based its accommodation facilities. As one of the field stations used by the ESSA-Forêts department of the University of Antananarivo, facilities present include a covered work and table area, a guest house, three basic sleeping dormitories, an 'Enviro-kidz' educational centre, museum, kitchen, basic wash facilities, long-drop toilets, and a water-pump; there is also a grassy space behind the field centre where tents may be pitched. Solar electricity is available through most of the day. From here, it is easy to make walks into the forest, by night or by day, through logging trails left by logging firm Charlemagne in the 1960's. There is a direct route to the beach (approx.. 1.5km), as well as smaller trails that take visitors through alternative microhabitats including humid rainforest, scrubland, swamps, and a large, central lake (Lac Tampolo).

7.7 Fundraising

Much research was conducted into sourcing potential funding bodies in the year prior to the expedition. The team searched for institutions looking to support young people, international research, and conservation biology. Of the applications made, the team was successful in receiving support from the Gilchrist Educational Trust, Newcastle University Alumni Association, Royal Geographical Society with IBG (RGS-IBG), Altyerre

Training, and the Scientific Exploration Society. The team made standard applications, with references, to Gilchrist Educational Trust and The Scientific Exploration Society, whilst both the RGS-IBG and Newcastle Alumni Association required formal interviews, the former made by Skype. Additional funding from Altyerre Training was successfully acquired through an event hosted by the RGS-IBG, for corporate leadership and teamwork building. Team members hosted a workshop for visitors to demonstrate these skills within a biological fieldwork context, whilst the success of the demonstration earned the team further funding toward the expedition. It is necessary to apply to funding bodies early, some holding deadlines up to a year in advance of the planned expedition. Others hold multiple deadlines throughout the year, whilst some require interviews and academic references. Please see Appendix X for details of all income and expenditure.

7.8 Finances

The team opened a business bank account with HSBC. Money from funding bodies and personal contributions were transferred directly into this account, accessible to all team members. To gain access to the money in-country the team was planning on withdrawals from local ATMs. However, we were advised to withdraw the whole amount in pound sterling before departure and to keep the money safe with us, divided amongst team members. Each team member ended up with an envelope full of cash, that was guarded with their lives! This was then converted into local currency, *Ariary,* resulting in multiple envelopes. The money was kept safe and with extreme care throughout the expedition and the team did not encounter any threatening situation. The reasons for carrying around large amounts of money were the lack of many ATM machines throughout the country and the need for big amounts of cash all at once to pay for expedition team expenses. The money remaining in the account to date is being used for divulgation purposes, such as travel for team members to talks and printing of the expedition report. Please see Appendix X for details of all income and expenditure.

7.9 Training and Equipment Testing

There was no specialist training required to undertake the expedition to Madagascar. Aside from research skills acquired during our University degrees and in scientific literature, all team members were well travelled, besides all basic facilities being included at the research site. Two team members possessed basic First Aid procedures, whilst further medical training was undertaken by one team member (ITC Certificate in Outdoor First Aid SCQF Level 5, 2013). Further to this, preliminary transect walks were conducted to gauge an idea of the conditions within which we would be working; all team members were adequately prepared for all expected weather and terrain.

All practical and scientific equipment including Garmin Etrex GPS units, torches, tape measures, and tents were tested prior to the expedition; one tent compartment experienced zip problems, and thus became the storage area. Though a generous supply of UK standard batteries were brought from home, it was necessary to buy more batteries and torches in country as the focus of the research changed from diurnal to nocturnal study. Although these were of sub-standard quality, they were cheaply sourced; all used batteries were brought back to the UK for recycling. Failed equipment included 10 litre water storage containers purchased from reputable UK outdoors suppliers. Instead, the team used plastic bottles which were steadily replaced over the 5 week period (a full equipment list can be found in Appendix IX).

7.10 Research Materials

A map of Tampolo forest and the component trails, habitat types and water bodies was obtained from the Forestry Station. This map was created by students from the University of Antananarivo. Information about the biology of the forest was obtained from the collections of Dissertation reports available only at the University of Antananarivo, ESSA-Forêts department, which the team visited prior to Tampolo. Useful books were also found at the on-site museum, which also houses a wealth of information about Tampolo, forest use, and some biological artifacts. Staff members at the University were particularly helpful in pointing us to sources of research materials.

7.11 Communications

Communication with in-country contacts and students was mainly via email. A short meeting in the UK was also made with our main in-country advisor prior to the expedition. Students were selected from the CEL by this in-country advisor, who was teaching at the University. They were then put into contact with us through email and logistics organised from there. Whilst in the field, some mobile reception was available in the forest, increasingly so on transects that ventured close to the sea, but largely obstructed by the canopy in the majority of cases. As the two groups were often studying neighbouring transects, communication between parties was not difficult. To communicate with families, friends, funders and other important contacts it was necessary to travel to Fénérive-Est to use an Internet cafe. It was also possible to use portable internet devices at the Forestry Station, as some visitors were doing, and there were plug sockets available to connect and charge laptops and other devices.

7.12 Permission and Permits

The research permit was received through ESSA- Forêts, Antananarivo (see appendix XI). The process did not take long and the team was allowed to travel to the expedition site promptly. Only one permit was needed for this research expedition as no specimens were handled or exported.

Figure 38. Shows the team at the entrance to Tampolo Forest.

8. Expedition Log

Each day we woke up to a meal of rice, followed by a trip into the forest to measure plants and disturbance levels. We would then return to camp for another meal of rice, input our data, have a short rest, and then head out into the dark for our night transects. Finally, we would return to camp after 14 hours of mosquitos and sunshine for a final meal of rice.

Our itinerary for the duration of our time in Madagascar was logged as follows:

October 12: Flight to Madagascar, Heathrow > Antananarivo
October 13 - 30: Acclimatisation and exploration of Madagascar
November 1 - 5: Antananarivo: Expedition plans changed, meeting with students, meeting with officials at University of Antananarivo to finalise plans
November 6: Travel to Tampolo Forestry Station via chartered Taxi Brousse
November 7: Briefing of research team, kit preparation, emergency medical procedures discussion, set-up
November 7 - 17 Preliminary research
November 18 - 26: Field Data Collection
November 27: Midpoint day of rest
November 28 - December 13: Field Data Collection
December 14: Appreciation ceremony with village presidents
December 15: Pack-up
December 16: Travel to Antananarivo via chartered Taxi Brousse
December 17 - 20: Brochure and preliminary report production and dissemination at University of Antananarivo, meeting with supervisor Barry Ferguson, final data collaboration, debriefing of students
December 21: Flight to London, Antananarivo > Heathrow

9. Conclusion

Deforestation and habitat fragmentation are threatening biodiversity worldwide, with hotspots such as Madagascar rapidly suffering species losses. Demand for land to feed, house, and provide income for an increasing human population are exacerbating these problems (Myers *et al.* 2000; Ganzhorn *et al.* 2001). We travelled to Madagascar to experience some of these problems first hand, and contribute our knowledge and skills to a worthwhile project. From our research study in the littoral forest of Tampolo, we came to several important conclusions.

Firstly, we found that three out of the suspected five species of lemur thought to reside in Tampolo Forest were apparently absent (Ratsirarson and Ranaivonasy, 2002). It seems *C. major, L. mustelinus and D. madagascariensis* lemurs can no longer be found in Tampolo, perhaps as a result of competitive exclusion and habitat degradation (Mittermeier *et al.* 2010), ethnoprimatological anecdotes from our survey also suggest the latter was subject to direct anthropogenic persecution. In addition to these findings, we suspect that methodological and analytical errors may have created erroneous results, whilst edge effects, niche differentiation, and seasonality are thought to have affected lemur populations present at the time of study (Meyler et al. 2012; Lehman *et al.* 2006; Lahann., 2006). The study showed large population densities of *A. laniger and M. rufus*, possibly related to their onmivorous and adaptable lifestyles (Kappeler and Rasoloarison 2003; Gould and Sauther 2007), although follow-up population monitoring is necessary to determine any direction of change, genetic variability, and stability. All results are consistent with available data from the IUCN Red List (IUCN, 2014).

Secondly, our vegetation study suggested that certain characteristics including tree height and breast height (D_{130}) were important to *A. laniger* and *M.* rufus, a conclusion that is supported by Ganzhorn *et al.* (1985) and Harcourt (1987). This enhances concern over whether these trees, notably species of voapaka and aucoumea, are particularly susceptible to selective logging, with potential secondary impacts on lemur populations. Further study is needed to determine whether trees of a particular phenology are important to these lemur species. Our samples were biased towards trees with leaves, with only a few samples collected from trees with fruits and/or flowers, supposedly due to the availability of these phenologies at this time of year. We suggest multiple, short expeditions conducted throughout the year to collect an even spread of samples. Monitoring levels of disturbance along the transects using a Human Disturbance Index (Singer 2008) revealed that some areas of the forest were highly disturbed. However, it appears that *A. laniger* and *M. rufus* are able to cope with this disturbance particularly well. It has been suggested that the high levels of disturbance may have, however, negatively impacted populations of *D. madagascariensis, L. mustelinus* and *C. major.* Whether disturbance was a major influence on these populations required further investigation, whilst perhaps revealing insights into the future of other, less damaged areas of Tampolo forest. A proper ecological study using GIS would establish whether niche differentiation is important in Tampolo.

Thirdly, the villages of Tampolo, Rantolava, and Andapa are highly dependent on the primary resources protected in Tampolo forest, and readily harvest them despite current protection laws. Whilst the latter two villages claimed to have access to an alternative area of land, Tampolo villagers were not awarded any such area, with thus greater dependency on illegal resources; it was also noted that such alternative areas were overexploited and insufficient. Though lemur hunting is illegal across Madagascar, 21% admitted to hunting in the forest, whilst many implied that lemurs attacking important cash crops should be killed (and likely were). Results also indicated that *D. madagascariensis* has been the subject of persecution by the communities on account of historical *fadys*, although it was suggested that this species had not been present for a number of years. We propose that management authorities, such as the ESSA-Forêts department of the University of Antananarivo, may restore a future for Tampolo through capacity building with environmental education, provision of routes to alternative income, and the implementation of an ecotourism network and the associated infrastructure (Schwitzer *et al.* 2014). Deterrents for lemurs interfering with cash crops may also be beneficial (Gildsdorf *et al.* 2004; Putman and Staines 2004). Our interviews helped raise awareness of the problems facing Tampolo, whilst village elders indicated we had positively changed attitudes towards foreigners, of those residing in nearby villages.

Though a future for Tampolo forest seems uncertain, if managing authorities act quickly then there may be time to rescue what damaged fragments are left of this unique habitat. We would like to recommend future studies to those interested in conserving Madagascar's littoral forest, with the infrastructure readily available. The team are currently disseminating expedition results in the UK, in a bid to raise awareness and encourage additional research in the region.

10. Acknowledgements

The authors would firstly like to thank Jeannin Ranaivonasy, Mia Razafymahef, Joel Ratrirarson of ESSA-Forêts department, University of Antananarivo, for their collaboration and permissions to conduct our research at Tampolo Forestry Station, alongside the Ministry of the Environment and Forests for issuing the research permits.

Our expedition to Madagascar was funded partly by Gilchrist Educational Trust, Newcastle University Alumni Association, Royal Geographical Society with IBG, Altyerre Training, and the Scientific Exploration Society; without their financial support we would have never left London Heathrow.

Special thanks goes to Barry Ferguson for his generous guidance with expedition logistics and scientific advice, both from the UK and in Madagascar; his enthusiasm for our project was nothing short of inspiring.

Thanks are also due to those who live and work at Tampolo, especially to our guides Patrice and Olivier; without their exceptional knowledge of the field we would have been left without any data at all! Big thanks to our ever-smiling cook Vivienne for her tireless efforts, on-site manager Christian for accommodating us, and the villagers of Tampolo, Rantolava, and Andapa for participating in our study.

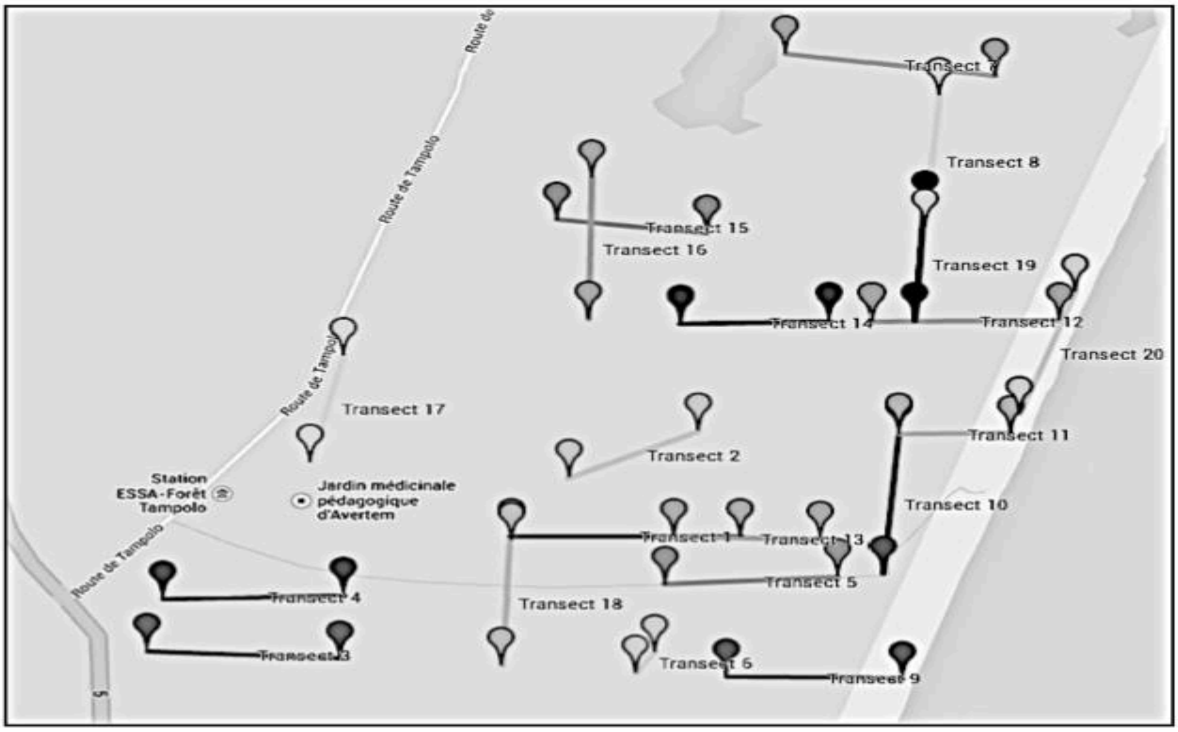
In the UK, we would like to thank Newcastle University and the Alumni Association who contributed both time and financial support toward the project. Specifically, we much appreciated the help we received from Dr Gordon Port and Dr Peter Garson from the School of Biology, and the wonderful positivity and support from Gigi Herbert of the Alumni Association.

Additional thanks goes to Dr Peter Long, Danielle Parkinson, and our families and friends, who all provided valuable support over the year leading up to the expedition. We also thank the Bartholomew School for loaning us some key pieces of equipment.

Full credit for the writing of this report goes to Rachel Blow, Camilla Blasi Foglietti, Jessica Fisher and Donna Wintersgill.

11. Appendices

Appendix I – Transect Map and List of Coordinates



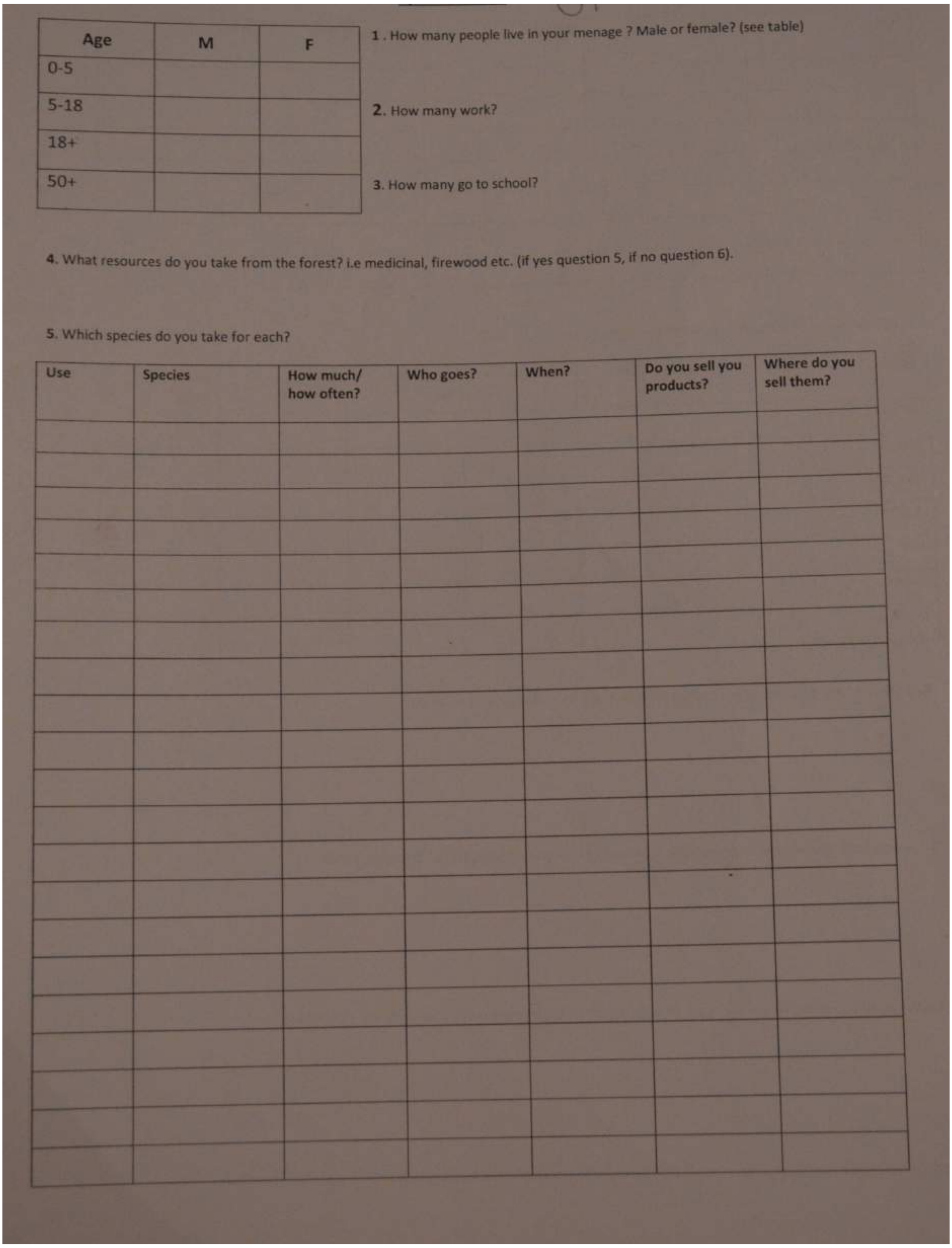
Transect Number	Start Latitude	Start Longitude	End Latitude	End Longitude
Transect 1	17°17'08.2	049°25'03.8	17°17'08.2	049°25'26.4
Transect 2	17°16'54.9	049°25'22.2	17°17'00.8	049°25'09.5
Transect 3	17°17'22.8	049°24'28.3	17°17'23.7	049°25'47.2
Transect 4	17°17'16.2	049°24'29.9	17°17'15.7	049°24'47.5
Transect 5	17°17'14.3	049°25'18.9	17°17'13.4	049°25'35.9
Transect 6	17°17'25.6	049°25'16.1	17°17'22.9	049°25'17.9
Transect 7	17°16'06.8	049°25'30.8	17°16'09.7	049°25'51.4
Transect 8	17°16'12.2	049°25'45.9	17°16'28.8	049°25'44.4
Transect 9	17°17'26.3	049°25'42.2	17°17'26.1	049°25'25.0
Transect 10	17°17'13.0	049°25'40.3	17°16'55.3	049°25'41.9
Transect 11	17°16'55.1	049°25'52.8	17°16'54.9	049°25'41.9
Transect 12	17°16'40.8	049°25'57.7	17°16'40.9	049°25'39.3
Transect 13	17°17'08.2	049°25'19.9	17°17'08.6	049°25'34.2
Transect 14	17°16'40.9	049°25'35.1	17°16'41.2	049°25'20.5
Transect 15	17°16'28.0	049°25'08.3	17°16'29.7	049°25'23.1
Transect 16	17°16'22.7	049°25'11.8	17°16'40.6	049°25'11.4
Transect 17	17°16'45.2	049°24'47.5	17°16'58.7	049°24'44.3
Transect 18	17°17'24.6	049°25'02.9	17°17'08.7	049°25'03.8
Transect 19	17°16'40.8	049°25'43.4	17°16'26.5	049°25'44.4
Transect 20	17°16'37.2	049°25'59.2	17°16'52.7	049°25'53.8

Appendix II – List of Tree Species Found

Vernacular Name	Latin Name	Percentage
Hasina	*Draceana reflexa*	6.9
Amboza	*Dypsis arenarum*	5.0
Aucoumea	*Aucoumea klaineana*	4.4
Hazomalany beravina/kafemboeza	*Casearia nigrescens*	3.4
Hazombaronana	*Protorhus dintimena*	2.2
Hintsina	*Intsia biguga*	2.2
Lohindry	*Cleistanthus capuronii*	2.2
Maitsoririnina	*Olax sp.*	1.9
Tsifontsoho beravina	*Rhodocolea sp.*	1.9
Aferonakavy	*Elaeocarpus alnifolius*	1.6
Ambora	*Tambourissa religiosa*	1.6
Fotsidinty	*Bosquela obavata*	1.6
Nantokiriky	*Faucherea sp.*	1.6
Sadodoko	*Gaerinera sp.*	1.6
Tarantana	*Campnosperma micrantheia*	1.6
Tsiboraty	*Vitex pachyclada*	1.6
Tsifo beravina	*Canthium medium*	1.6
Anivona	*Ravenea sambiranensis*	1.3
Fandramanana	*Aphloia theaformis*	1.3
Hafotra	*Dombeya laurifolia*	1.3
Hazoambomaitso	*Ambavia gerrardii*	1.3
Hazomainty madinidravina	*Diospyros mapingo*	1.3
Hazombato	*Homalium thoursianum*	1.3
Hazombato beravina	*Rinorea rabia*	1.3
Hazondahy	*Burasaia madagascariensis*	1.3
Rara	*Brochoneura acminata*	1.3
Tambonana	*Asteropeia multiflora*	1.3
Tavolomalama/tavolobelelo	*Cryptocaria acuminata*	1.3
Tsibabena	*Drypetes madagascariensis*	1.3
Tsiletry madinidravina	*Noronhia seyrigii*	1.3
Tsilongodongotra	*Dicoryphe stipulacea*	1.3
Voapaka mena	*Uapaca sp.*	1.3
Famelondriaka	*Donella fenerivensis*	0.9
Hasimbe	*Dilabeya thouarsii*	0.9
Hazoambo beravina	*Xylopia humblotiana*	0.9
Hazoambo madinidravina	*Xylopia buxifolia*	0.9
Hazomafana	*Diospyros haplostylis*	0.9
Hazomaintina	*Diospyros squamosa*	0.9
Hazombato fotsy	*Homalium sp.*	0.9
Hazondronono	*Stephanostegia capuronii*	0.9
Hompa	*Syzigium pluricymosa*	0.9
Maherihely	*Pacytrophe dimepate*	0.9
Maimbovitsika	*Pittosporum sp.*	0.9
Menahihy beravina/Beando	*Erythroxylum corymbosum*	0.9
Ombavy	*Polyalthia ghesquieriana*	0.9
Rotra	*Syzigium sp.*	0.9

Somotrorana	*Ind*	0.9
Tafononana	*Ocoiea sp.*	0.9
Tsifo madinidravina	*Canthium vandrika*	0.9
Tsiletry	*Noronhia sp.*	0.9
Tsimahamasatsokina	*Memecylon sp.*	0.9
Voapaka	*Uapaca sp.*	0.9
Voatsiritra	*Vaccinium madagascariensis*	0.9
Amaninombilahy/Amaninombilahimena	*Leptolaena multilora*	0.6
Azinina	*Symphonia sp.*	0.6
Famelona	*Chrysophyllum boiviniana*	0.6
Hasintoho	*Oncostemum elephantipes*	0.6
Helana beravina/helambe	*Sarcolaena grandiflora*	0.6
Hompamena	*Syzigium cloiselii*	0.6
Maesopsis emnii	*Maesopsis emnii*	0.6
Makaramandahy	*Macarangua alnifolia*	0.6
Matrambody	*Asteropeia matrambody*	0.6
Menahely	*Scolopia erythrocarpa*	0.6
Molotrangaka	*Enterospermum pachyphyllum*	0.6
Tamenaka	*Hirtella tamenaka*	0.6
Tangena	*Cerbera venenifera*	0.6
Tavolopika	*Cryptocaria elliptica*	0.6
Tsifontsoho madininidravina	*Rhodocolea racemosa*	0.6
Tsikafekafe	*Coffea richardii*	0.6
Vakona	*Pandanus sp.*	0.6
Voantsilana	*Cuphocarpus aculeatus*	0.6
Amaninombilahyfotsy	*Eremolaena rotundifolia*	0.3
Ambitry	*Amhavia gerrardii*	0.3
Befelatanana	*Vitex chrysomallum*	0.3
Fandramdambo	*Pandanus sp.*	0.3
Hafotrakora	*Rhopalocarpus thouarsianus*	0.3
Harongampanihy	*Psorospermum chronanthifolium*	0.3
Hazoambo	*Xylopia sp.*	0.3
Hazomalany	*Masarisia pyramidata*	0.3
Helana	*Sarcolaena multiflora*	0.3
Livory	*Tabernaemontana rotusa*	0.3
Maimboholatra	*Brexiella cauliflora*	0.3
Mampay	*Cynometra sp.*	0.3
Manarimbintana	*Olax glabriflora*	0.3
Maroampototra	*Saldinia sp.*	0.3
Nantomena	*Faucherea glutinosa*	0.3
Rotra madinidravina	*Syzigium emirnense*	0.3
Tambonana 1	*Asteropeia micraster*	0.3
Tsiarinarina	*Schizolaena sp.*	0.3
Tsitakotrala	*Homalium involucratum*	0.3
Valanirana	*Nuxia capitata*	0.3
Vintanona 1	*Calophyllum inophyllum*	0.3
Vintanona 2	*Calopyllum chapelieri*	0.3
Voamatata	*Astrotrichilia sp.*	0.3
Voapaka beravina	*Uapaca louvelii*	0.3

Appendix III – Sociology Questionnaire (Final Copy)



Age	M	F
0-5		
5-18		
18+		
50+		

1 . How many people live in your menage ? Male or female? (see table)

2. How many work?

3. How many go to school?

4. What resources do you take from the forest? i.e medicinal, firewood etc. (if yes question 5, if no question 6).

5. Which species do you take for each?

Use	Species	How much/ how often?	Who goes?	When?	Do you sell you products?	Where do you sell them?

6. If you don't take you resources from the forest, where do you get them from?

Use	Species	Where?	How much/ how often?	When?

7. Which species of lemur do you see in the forest? (table)

Species	See?	How often?	When?	Nuisance? How?	Solution to problem?	Source of meat?
Mouse						
Dwarf						
Aye aye						
Sportive						
EW						
Brown						
Bamboo						

8. Is there a fady concerning any of the species in the Tampolo region? If so what?

9. Do you think tourism has improved the livelihoods of people in Madagascar? If yes/no, how?

11. What do you think the general local attitude would be to the increase in tourism in the Tampolo region?

12. Do you think that local people would be interested in working in the tourism industry... e g guides or cooks?

Appendix IV – Data Input Sheets

POINT-CENTRED QUARTER (PCQ) DATA SHEET

Observers:		
Trail:		
Date:		
Centre Tree: (Random OR Lemur used)		
If random; what is distance from random point:		
Sample Number:		
GPS Coordinates	**Latitude**	**Longitude**
Centre Tree Species (vernacular name):		
Diameter at Breast Height (DBH_{130})*:		
Height (m):		
Phenology (seasonal timing of flowering and fruiting) NB circle all that apply	**In Fruit/ In Flower/ Leaves Present/ Tree is Leafless**	
Index of Disturbance**	**Evidence of Grazing (1-5)**	
	Selective logging(1-5)	
	Proximity to Path (1-5)	
	Proximity to agricultural fields (1-5)	

Data on four quarter trees

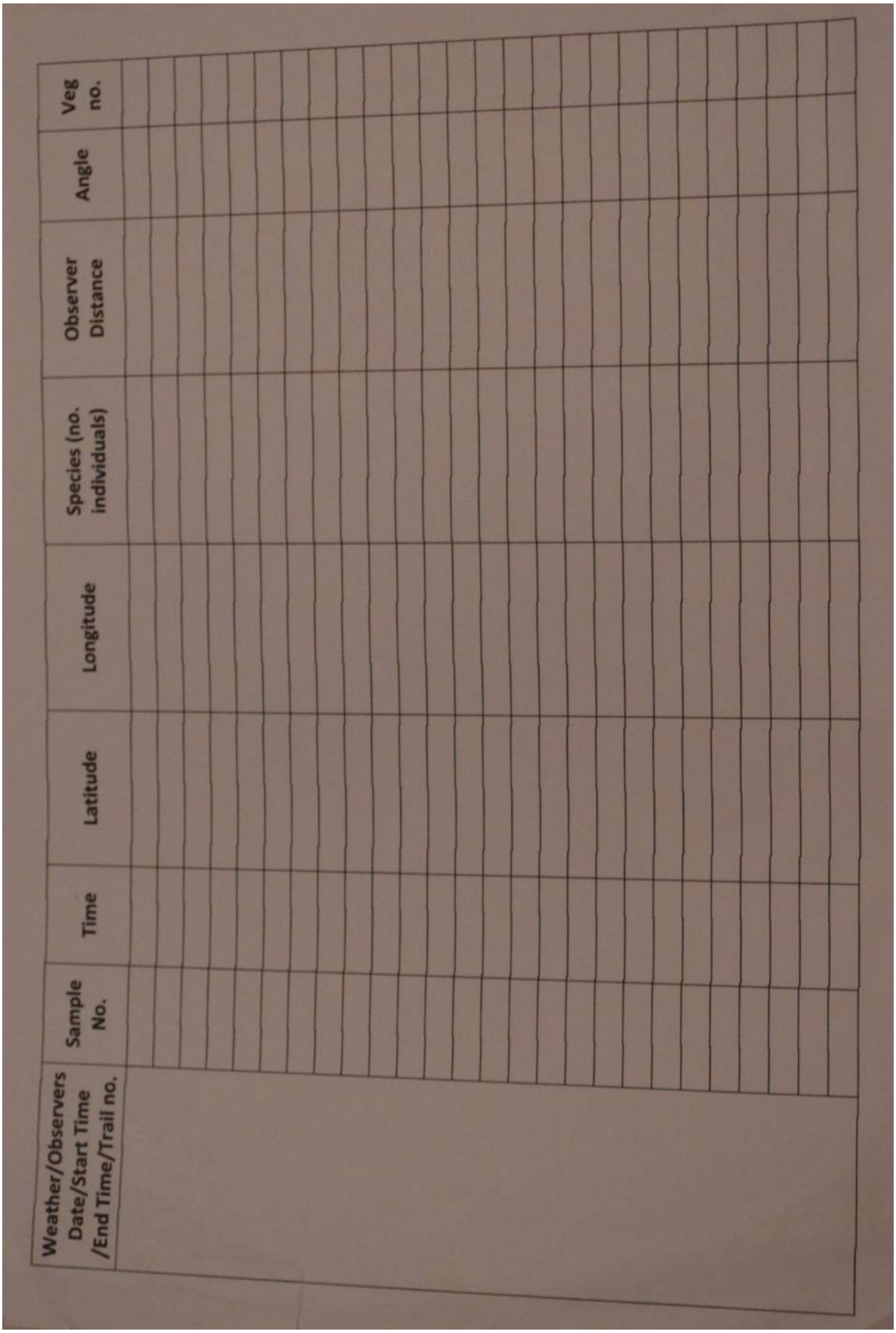
	North-East Quarter	**South-East Quarter**	**South-West Quarter**	**North-West Quarter**
Distance From Centre Tree (m)				
Species				
DBH_{130}				
Height (m)				
Phenology				

Notes (any other relevant information eg. Terrain or peculiarities observed):

*NB – If tree has multiple trunks at breast height, record data for each.

**See Index of Disturbance Sheet (1= undisturbed, 5= Highly Disturbed)

Lemur Abundance Sheets



Weather/Observers Date/Start Time /End Time/Trail no.	Sample No.	Time	Latitude	Longitude	Species (no. individuals)	Observer Distance	Angle	Veg no.

Appendix V – Random Number Tables

Random Trees

1W7N3SW5NE	0N7E5N7NW	7NW3E0SE5NW	3S5NW6S2NE	8NW8NW3SE4W
0SW9NW8SW6W	9SW9SW2S1SE	3S0SE1NE1S	1S7NW3NW7W	6W3W2W2N
3SE5NE9SE3SW	6W1NW5NE7NE	6SE8NW8SW6W	3SW6SE8SE5SE	5S6NW6S7NE
7SW9NE9SE2NE	2N2S5SE9S	5NE8N7N8SE	2NE8SW1E9NE	6NW3SW6NW1E
6S8SW4E9SE	2NE4N9SW1S	3NW9SW1NE8W	4SW4NE1E9NE	6SW2W6E4SE
9S8SE8SW9SE	8N4NE4NE4SW	0E8SW7S8N	5NE7W1S1SW	4S1SE0SW9E
7NW0S9E6E	0SW3NW3SE1S	9N4W9E5N	6S1N5W8N	3W2NW3N0W
4NE1SE1W0NE	6SE2E0SE2NW	8NW8NE9E3SW	1N1SW9NW4NW	7W8NE9NE7NW
2NE9N7N3NE	2S2S4N6NW	3NE4N4N8SW	3S5SW5NW9NE	0S5S9E9N
2NE4W9E7NW	4NW3N7E6E	3SE0NW1S2W	2W7E9S6NW	5N1S7E9N
0NE3NE6NE4E	9N6S0E6N	8E1NW5NE2NW	3E7SE1SW1SW	4SE4NW1S4W
5W1NW7SW0S	5S9NE1S1E	1E8NE3SW3SE	8S5NW2NW4W	3E1SW8S7N
8N7E9E5W	9E2NE5S9S	6NW4NW9N6N	7NW9S2S6N	2S7SE2SW1SE
8E2SE5N9NE	5SW8N6W2N	1N5NE1S4NW	3S7W5W6W	5W7NW9SW1S
6E2SE5N3NE	6NE7W5NW4W	7S3N4E2N	2W3W1S1SW	7N4S4E5W
1NE1S7NW2S	4S8S4NE2E	1W3S9SE7SW	7SW2NE1SW9E	2N6SE7S2SE
4S5SE3SW8NW	0SW5E5W7NW	0SE8SW7NE2SE	1N4S7SE7NW	5E2W4W0NW
6E8SE0N5NW	3S9E8SE9NW	5S8E5N6S	3SW8NW9NE3W	2N2SW2SW5NE
7W3N5NW6E	3SW7SW5E1SW	1S6SW8SE8E	7W6S5E2SW	8N2E0NE8S
0SW4SW9NE0E	7S6W1NW7SE	2E5E9S7S	8W1N2SW1NW	7S9SE0NE8S
7NW8NW0S7E	1W2NE1SE5E	8E5N4NE2NE	5N4S2NE0E	4S4N0W2N
5N6SE2S5SE	1NE1W9SE3E	1NW4E7SE2NE	7SW3NW3W8N	7S4S9E9N
6NE2NW4E2NW	9SE5W3W6SW	6SE0SW9NE3S	5SE1S5W3S	1N8S1NE6E
7SW2W2W9W	7NE0SE4SE5NW	5SW7E9E7E	8NW5NW6NE2NW	8W5W0S1SW
1E8W9W2NW	3S3W5E2SE	0SW9N7SW9W	7SE0SW5W7NE	8S9NW0NW4W
9N2SW4SW1NE	6SE0SE2W5NW	7N9NW4S5NE	1SW3S3N2S	7W6E0S2NW
1E9W0SE4SW	0N1N7NW0N	9S3NE2N4NE	5NW8E9SE4NE	9E6N7S9NE
4SE9E1S2SW	4N1W4E9S	7NE8E7W3SE	4SW7N4W7E	6E1N6NW3N
4N4SW8SW9NW	7SW8W1NE9N	5E2SE8SE1N	8E6S1SE4NW	2NW1SE7E0W
2SE9W6NE5SE	5S4S7NE6SE	7W8S9NE4E	1W1S7NE2W	2N3W8NW8S
1SW9SW6SW7SW	2W1NW7E8NE	6W4E5SE7N	9N3S6SE3N	2E9E8NE2NW
0SE5SE8N6NE	4N0S4SW6S	9NW6NE8SW7E	7N7N7NE7S	0W6W8E0SW
6E6NW4SW5N	3SW4NW8SW9S	3N2SW2E7NW	6NW2NW1SE6S	7N3W2S1W
5W5NW9NW9W	8SE2NE7E8W	8W1S9E0S	5NE7E1NW2W	7NE3W2S1W
3SW6SW7E4SW	5N1SE5S2S	3N4NW4N7E	6SW8NW3E9NE	7NE3W4SW5NE
9E3S2NW2NW	7SW4W3E5NE	5SE6NW8NW8S	7NE3S7NW8E	9N6W9S6SE
3SE6N7N5NW	6SE2W2SE7E	1NE8N3SE9W	4SE7S4SE7NE	2NW5S1NE7W
8S8W3S9SW	0N4SW5SE3S	9S0NE3W4S	6W5N1E9W	4S2S8W0NE
9NE1S7E6W	4NE5N6W7N	3S9S8N5W	4N9NE9E1E	6E9NE8W5E
6SW8E7W6W	0W7SE0S3NE	8W2N7SW6E	3NW3N3S7W	9W3W4E8NE
0E6SW7NE1S	3SE0NW8S8SE	4W0NE1E2NW	5NE1E0NW9W	5NW7S3N7W
5W8NE3E5W	2NE5SE0W4N	7SE8S5S3SW	8NE7SE3NW	3N1NE4E7E
4SE2E3N5N	4NW9NE5W7SE	7E7NE1NE9N	0SW1NE2NW2E	9W8N4E7E

Disturbance Transects

2R	5L	9R	2L	9R	1L	1R	0L
4R	6L	1R	1L	3R	1L	7R	2L
6R	9L	3R	5L	7R	7L	8R	1L
7R	1L	1R	6L	0R	6L	9R	9L
2L	3R	5L	7R	3R	6L	3R	7L
7L	3R	6L	3R	3R	3L	3R	9L
9L	9R	1L	5R	1R	1L	7R	3L
7L	4R	5L	7R	1L	7R	4L	0R
1L	1R	1L	8R	3R	1L	5R	1L
3L	2R	3L	1R	7R	4L	1R	0L
1L	2R	7L	1R	3R	2L	2R	1L

Appendix VI – Crisis Management Plan

CRISIS MANAGEMENT PLAN

Emergency contacts

CEGA Air ambulance 24 hour emergency line: (UK) +44(0) 1234 621525
National logistics coordination: +8816 3250 0618
Missionary Aviation Federation: +2613 3116 5605
Madagascar Helicopter: +2613 2072 1254
Trans Ocean Airways: +2612 0225 3838 (medical evacuation number: +2613 2070 0123
Aeromarine: +2613 2114 4444
Hospital in Tamatave

Each team member will carry a personal first aid kit and the team will have a full medical kit. While in the field, each field group will carry a mobile phone (there is reception from Orange in the area). Each group will carry a GPS device, compass and map. In the unfortunate event of an emergency a team member with Outdoor First Aid Training will examine the victim and assess the situation.

The crisis management plan below will then be implemented:

(a) For minor injuries (e.g. sprains, minor lacerations): patient, medical officer and Malagasy student will walk back to Tampolo Forestry Station and will take public transport to Tamatave. The home contact will be informed.

(b) For moderate injuries that require quicker evacuation (e.g. straightforward fractures, chronic stomach conditions): a call will be made by mobile for 4x4 (that will come from Fénérive) to collect the patient immediately. Patient, medical officer and Malagasy student will drive to the nearest hospital in Tamatave. The home contact will be informed.

(c) For serious conditions (e.g. acute malaria, typhoid, open fractures, unconsciousness): One of the emergency contacts (above) will be called and notified as soon as possible. A call will be made for a helicopter from Antananarivo to collect at base camp or the nearest possible landing point. The patient will be transported to base camp via stretcher. If the patient cannot be moved they will wait to be evacuated. A call will also be made to the insurance company and home contact. The patient can be sent for medical attention in Reunion Island, South Africa or Europe from Antananarivo or Tamatave if necessary. All U.K. team members will have comprehensive health insurance. There will also be the provision for repatriation on medical grounds if necessary. The Malagasy team members will have comprehensive health insurance. All UK team members will carry a mobile phone at all times. No team member will work alone and no groups will be further apart than seven kilometres.

Appendix VII – Risk Assessment

Madagascar Risk Assessment

Project Title	Abundance of five nocturnal lemur species and the structure of their forest habitat, in Tampolo, North-East Madagascar		
In country contact	Barry Ferguson Ferguson.barry@gmail.com Irridium Satellite Phone: +881632568225 AIRTEL Mobile Phone: 0337167488	**Team Members**	Rachel Blow, Jessica Fisher, Camilla Blasi Foglietti, Donna Wintersgill, Rachel Cornfoot, Robert Razafindrakoto, Herman Anicet, Rayomond Steve Gerard Andriatahinjanahary
Travel dates	4th November – 20th December 2013		

Emergency Contacts

Contact overseas	International access code for Madagascar – 261; From the UK – Prefix 00 before 261 Name: Gordon Port Email: Gordon.port@ncl.ac.uk Telephone: +44 191 222 6894 Address: Room 5.64, School of Biology, Ridley Building, Newcastle University, Newcastly Upon Tyne, NE1 7RU (see also crisis management plan for further in-country emergency contacts)
Accommodation	Camping in Tampolo Forestry Station
British Embassy	British EmbassyTel: (261) 20 22 330 53 Tour Zital AnkorondranoOut of hours Tel: (44) 207 008 3353 Ravoninahitriniarivo StreetEmail: bismada@moov.mg Antananarivo 101 Madagascar
Insurance	Silver Policy - Protect Your Bubble
Training	Rachel Blow and Jessica Fisher – certified First Aiders
Travel Itinerary	International return flight from London to Antananarivo Taxi Brousse from Antananarivo to Tamatave Taxi Brousse from Tamatave to Tampolo

Hazard 1	Accommodation
Risks	Risk to team members of: theft and exposure to aggressive behaviour resulting in injury; potential burns and fatalities as a result of fire and smoke inhalation.
Control Measures	• FCO and NU guidance will be followed. When in country purchase lockable container for storing valuables. • Emergency evacuation procedures and routes of evacuation to be checked upon arrival. • A safe campsite will be established on a flat area, away from rivers or lakes that could pose a risk of flooding. All members of the expedition will maintain a good level of hygiene. • In case of injury, contact local hospital immediately for any injuries acquired. Later, notifyin-country and out-of-country contacts.
Hazard 2	Dealing with People and cultural differences
Risks	• Risk to team members of causing offence and confrontation. Legal action, physical injuries. Risk to team members of political disruption and civil disputes, leading to riots, arson, street protestors and crowding.
Control Measures	• Research in preparation for the trip. Plan routes in commonly used areas and avoid areas of concern, including cultural or political events. Maps and travel guides to be purchased and used. • Be aware of crowded areas, opportunistic theft and cultural sensitivity. • If confronted hand over whatever items the aggressors request and report the incident to the police. • Update FCO locate • Contact insurers and embassy. • Stay informed via radio or local people. • Stay in safe environment. Avoid all high-risk situations where possible.

Hazard 3	Dealing with health infections and health conditions
Risks	• Risk to team members of infection, dehydration, exhaustion, lethargy and digestive/stomach conditions.
Control Measures	• Seek medical advice prior to trip to be made aware of any current health conditions in country. One of our team members, Donna Wintersgill, is anaemic and will be taking the appropriate medication for the entire trip. Take precautions for food and drinking, pack medication to treat digestive complaints, Medical attention to be sought where symptoms are experienced / persist. • Ensure all team members have relevant vaccinations; Hepatitis A, tetanus. • Knowledge of location of local hospital or clinic, and doctor • Ensure access to a mode of transport is available at all times when in remote areas • Keep well provisioned first aid kit at all times • Wear suitable clothing and footwear at all times • All water will be filtered or boiled before use and water purification tablets will also be used. • All team members with various levels and certificates of First Aid qualifications. • Ensure team members are rested and in good health for field work activities • Keep a private sum of money in the case of needed to pay upfront for any medical emergencies • Comprehensive and reputable insurance policy to be taken out by all members • Create a hierarchy of medical issues and evacuation procedures to be carried out for each (see sheet attached) • Nearest hospital for medium – high medical issues
Hazard 4	Travel & Transport
Risks	• Risks to team members of road/air accident causing risk of theft, injury and fatality
Control Measures	• FCO travel advice checked and followed, use safest possible transport available. • Reputable travel companies will be used. • The insurance certificate and insurance cover will be taken and made available if required. • Electronic copies or photocopies of passport to be held where required. Visa applied for and granted. • In case of accident; first aid applied if necessary and victim taken to hospital. Contact university. • Avoid any form of travel at night unless it's an emergency especially by taxi brousse
Hazard 6	Physical Hazards
Risks	• Risks team members of extreme weather conditions, cliffs, caves, mountains, marshes, quicksand, fresh water, mines, quarries)
Control measures	• Keep updated on weather reports – time of travel coincides with the rainy season ensure protective clothing and equipment are taken and shelter is substantial to cope with the weather • Take advice from locals and in country contacts (Barry Ferguson) • Stay in safe environment • Ensure shelter is available if events are predicted. • Team members to use appropriate products to avoid sun damage. • Students to carry bottle of water at all times and drink 3 litres of water a day. • Avoid sun at peak times where possible. • Appropriate medical attention given to any weather-affected students.
Hazard 7	Biological hazards
Risks	• Risk to team members of bites, attacks, saliva, animal collisions, consumption of provisions, stings, trampling, allergies, diseases, venomous plants/animals (scorpions only threat)
Control Measures	• Keep safe distance from animals - There will be a guide with us in the field at all times. • As our knowledge of local flora is incomplete, none of the team members will ingest any vegetation found in the field and will consult guides for information on particular plants to avoid. • Insect repellents and mosquito nets will be used, each member will take anti-malarial tablets. • In case of injury, contact local hospital immediately. Notify out-of-country contacts and in-country contacts.
Hazard 8	Crime
Risks	• Risk to team members of loss of valuables such as passports, phones, bank card, ID or damage to personal safety. Stranding; need for repatriation.
Control measures	• Keep documents safe at all times • When travelling, keep valuables in zipped up compartment. • Emergency funds back up in case of money loss – e.g. travellers checks, bank card. • Carry an adequate sum of money for the day; this should be kept to a minimum. • Advising our banks of the dates of travel as to disregard any activity in unusual locations. • In case of loss of valuables visit police station (for report), contact British Embassy. • Team will avoid any large rallies or demonstrations

Appendix VIII – List of Medical Equipment

Medical checklist	
Water purification	Venom extractor
10L water container	Flucanazole and Clotrimazole
Water purifier	Travel sickness tablets
Plasters bandages	Typhoid pill series
Antiseptic cream	Diarralyte rehydration sahcets
Antiseptic spray	Glucose tablets
Antihistimine cream	Triangular bandage
Antihistimine pills	Aqueous calamine cream
Immodium	Paracetamol
Venom extractor	Doxycycline antimalarial course
Aspirin	Cystopurene
Matches and lighter	

Appendix IX – List of Research Equipment

Research Checklist	
Duck tape	Small first aid kit
Tape measure (5m) x 4	Mobile telephones
Calculator	Random number tables
Compass	Survey sheets
GPS Handheld (Garmin Etrex)	Interview participant certificates
Batteries	Laptop and chargers
Species identification list – Flora	Hardback notebooks
Species identification list – Fauna	Logbook/diary
Pens and pencils	

Appendix X – Income and Expenditure

Source	Income	Item	Cost (£)
SES	500	Flights	3188
Gilchrist	500	Accommodation	550
RGS	1500	Cash machine charges	21
Newcastle	500	Communication	39
Altyerre	750	Cooks	225
		Equipment	60
Total Funding	**3750**	First aid	59
		Food and drink	1110
Own Input	6986	Guides	268
		In-country travel	275
Total Income	**10736**	Insurance	422
		Administration	73
		Permit	34
		Solidarity contributions	33
		Students (other)	184
		Students (scholarship)	804
		Travelling	1814
		Visas	300
		Travelling extras	739
		Dissemination	300
		Miscellaneous	238
		Total Expenditure	**10736**

Income - Expenditure **0**

Appendix XI – Research Permit

REPOBLIKAN'I MADAGASIKARA
Fitiavana-Tanindrazana–Fandrosoana

SECRETARIAT GENERAL

DIRECTION GENERALE DES FORETS

DIRECTION DE LA CONSERVATION DE LA BIODIVERSITE ET DU SYSTEME DES AIRES PROTEGEES

AUTORISATION DE :
x- RECHERCHE
- ETUDE

N° 266 /13/MEF/SG/DGF/DCB.SAP/ SCB

NOM	BLOW
PRENOMS	Rachel
ADRESSE	BP 175 Antananarivo
FONCTION	Chercheur

ACCOMPAGNE DE : Camilla Blasi Foglietti, Donna Wintersgill, Jessica Fisher, Rachel Cornfoot, Christian Rahendrimanana, un représentant du CAFF/CORE.

ORGANISME TUTELLE : ESSA/Département des Eaux et Forêts.

EST AUTORISE(E) A FAIRE DES RECHERCHES / ETUDES DANS :
La Forêt de Tampolo – Analanjirofo – Nord Est de Madagascar.

MENTION SPECIALE EVENTUELLE :
Abondance des cinq espèces de lémuriens nocturnes et la structure de leur habitat forestier.
Cartographier l'abondance et la répartition des espèces : *Cheirogaleus major, Avah laniger, Microcebus simonsi, Daubentonia madagascar, Lepilemur grewcockorumdans.*
Etudier la structure de l'habitat forestier pour les espèces à grandes valeur économique et de l'importance écologique.
Comprendre comment la gestion de cette réserve peut affecter les communautés locales avec l'augmentation du niveau de protection, diminution conséquente des matières premières disponibles et le potentiel de développement de l'infrastructure touristique.

DUREE : Un (01) mois.

N.B : L'ESSA/ Département des Eaux et Forêts doit remettre à la Direction du Système des Aires Protégées, en quatre (04) exemplaires EN FRANÇAIS, le rapport préliminaire à la fin de sa mission et le rapport final avec les résultats des recherches au plus tard deux ans après la mission. Rapports en versions papier et électronique
Le bénéficiaire de la présente autorisation doit :
- faire viser la présente par la Direction Régionale de l'Environnement et des Forêts Atsinanana et/ou CEF concernée avant toute descente sur terrain, conformément à la note **n° 394- 10/MEF/SG/DGF/DVRN/SGFF du 18 Mai 2010.**
- prendre le ticket d'entrée auprès de MNP (Madagascar National Parks) dans le cas où la recherche s'effectue dans les Aires Protégées gérées par celui-ci.

AMPLIATIONS :
- CAFF/CORE
- DREF : Atsinanana
- CEF : Concernée
- DCAI
- Reserve Tampolo
- Commune concernée
  « Pour contrôle et suivi »
- ESSA/Forêts
  « Pour le rapport »

Antananarivo, le 13 NOV 2013

LE DIRECTEUR DE LA CONSERVATION DE LA BIODIVERSITE ET DU SYSTEME DES AIRES PROTEGEES

RASOAVAHINY Laurette Hermine
Ingénieur des Eaux et Forêts

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- Departement Des Eaux et Foréts, Antananarivo University, BP 175, Madagascar

Weblinks

www.madagascarexpedition.weebly.com
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www.facebook.com/MadagascarExpedition

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14. Distribution List

Please contact expedition leader Rachel Blow to request a copy of the final expedition report or raw data from the expedition (rachelblow777@gmail.com).