UNIVERSITY OF EDINBURGH MADAGASCAR EXPEDITION
PROJECT KOBOKARA 2011 – FINAL REPORT

A MULTIDISCIPLINARY RESEARCH EXPEDITION TO THE COMMUNITY OF KOBOKARA IN THE IFOTAKA-NORTH PROTECTED AREA

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1 EXECUTIVE SUMMARY

Project Kobokara was a multidisciplinary, student-run expedition to the community of Kobokara, in southern Madagascar, between July and September 2011. This expedition was a collaboration between the University of Edinburgh (UoE) and the Centre Ecologique de Libanona (CEL). Ecological research focused on an assessment of the status of a Utility Forest, investigating reptile and plant diversity, and how they are influenced by anthropogenic disturbance. Additionally, a study was conducted on the status of a critically endangered tortoise species. Anthropological studies were conducted in the village of Kobokara and other surrounding villages. Four short documentaries were produced, highlighting key aspects of the area.

HERPETOFAUNAL SURVEYS – Surveys performed at various levels of disturbance within the forest, utilizing time-constrained and opportunistic searches, in addition to pitfall trapping. We recorded a total of 22 species of reptiles, including a potentially new species of snake. 100% of recorded species are endemic to Madagascar. We conclude that disturbance may be causing a shift in herpetofaunal species composition. We stress the need for further research in the area, particularly during the wet season.

TORTOISE SURVEY – A survey of the status of the radiated tortoise, *Astrochelys radiata*, within the forest. We found a total of 35 individuals in an area of 3.29 km^2, and therefore put a conservative estimate of 55 tortoises over the total forest area of 5.19 km^2. We observed a 1.83:1 ratio of males to females amongst adult tortoises. We highlight the need for studies on the mode and specifics of sex determination in *A. radiata*. We emphasise the need for additional tortoise studies, particularly in the unstudied area of Conservation Zone forest to the north of the Ikonda River, and review tortoise conservation efforts in rural southern Madagascar.

BOTANICAL SURVEY – A survey of the plant diversity in the forest, and how it is affected by anthropogenic disturbance. We recorded 66 species, approximately 95% of which are endemic to Madagascar, representing over half of the known species from the Mandrare River Valley. We observed a shift in botanical species composition related to disturbance. We propose a scheme of active replanting, cactus culls, and rotating usage zonation be implemented to mitigate further loss of forest integrity.

DISTURBANCE SURVEY – A survey to assess the overall disturbance levels within the study forest. We found there to be a persistent, low level of disturbance within the forest, increasing with proximity to its edges. We judge livestock grazing and selective deforestation to be the most detrimental practices. We propose a rotating scheme of usage and protection, coupled with active re-forestation and cactus culls, in order to maximise the longevity of this forest.

ORAL TESTIMONIES AND NGO IMPACTS – Four documentaries were produced from footage shot in the field entitled “A day in Kobokara”, “Madagascar’s Biodiversity and Local Resource Use Patterns”, “Project Kobokara”, and “NGOs in Kobokara”. These will be made available on our website, www.projectkobokara.wordpress.com.

ANTHROPOLOGICAL RESEARCH – An assessment of Kobokara’s potential for tourism. We present the pros and cons of Kobokara as a potential tourism destination. We conclude that ecotourism should be encouraged only if it is not detrimental to the wellbeing and lifestyle of the local people, and should therefore be approached with caution.

2 PUBLISHING

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For blogs and other articles, see our website: http://www.projectkobokara.compaktclub.com/

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5 ACRONYMS AND ABBREVIATIONS

ANGAP	-	Association Nationale pour la Gestion des Aires Protégées
ANOVA	-	Analysis of Variance
ASOS	-	Action Socio-Sanitaire Organisation Secours
BP	-	Before Present
CBET	-	Community Based Ecotourism
CDU	-	Cantonnement de Droits d'Usage (Usage Rights Zone)
CEL	-	Centre Ecologique de Libanona (Libanona Ecology Centre)
CI	-	Care International
CITES	-	Convention on International Trade in Endangered Species
CMR	-	Capture-Mark-Recapture
COBA	-	Community-based Forest Management Association
dbh	-	diameter at breast height
ESSA-Forêts	-	Départment des Eaux et Forêts de l'École Supérieure des Sciences Agronomiques
HST	-	High Spiny Thicket
IUCN	-	International Union for the Conservation of Nature
LST	-	Low Spiny Thicket
masl	-	metres above sea level
MNP	-	Madagascar National Parks
mya	-	million years ago
NGO	-	Non-Governmental Organisation
NPA	-	New Protected Area
OpWall	-	Operation Wallacea
RGS-IBG	-	Royal Geographical Society with the Institute of British Geographers
RSGS	-	Royal Scottish Geographical Society
SAPM	-	System d'Aires Protégées de Madagascar (System of Protected Areas of Madagascar)
UK	-	United Kingdom
UoE	-	The University of Edinburgh
USAID	-	U.S. Agency for International Development
WWF	-	World Wildlife Fund for Nature
ZdC	-	Zone de Conservation (Conservation Zone)
ZdR	-	Zone de Restoration (Restoration Zone)
ZSL	-	Zoological Society of London

6 ACKNOWLEDGEMENTS

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7 INTRODUCTION

7.1 The Expedition

This multidisciplinary University of Edinburgh expedition to the community of Kobokara in southern Madagascar, in collaboration with the Centre Ecologique de Libanona (CEL), provides baseline data on biodiversity, disturbance and culture in an area of previously unstudied, newly protected forest. We hope this report will supply much-needed information for interested explorers, researchers and management organisations alike.

7.2 Madagascar

Madagascar is the world's fourth largest island (de Wit, 2003). Isolated for 84 million years (Wells, 2003), its flora and fauna have diversified to almost unparalleled levels (Goodman & Benstead, 2003). Some 90% of all species present on the island are endemic, representing 3.2% of global floral and 2.8% of global faunal diversity (de Wit, 2003). Relatively recently colonised by humans (Goodman & Benstead, 2003; de Wit, 2003; Blench, 2006; 2007; see Section 7.2.3), the island now retains approximately 10% of its original forest, which continues to be diminished (de Wit, 2003). The high levels of both endemism and habitat destruction in Madagascar have brought it to the forefront of many conservation initiatives (Randrianandianina et al., 2003; see Section 7.3).

7.2.1 Geological and Natural History

Indo-Madagascar (the sub-continent composed of India and Madagascar) separated from the African east coast approximately 165 million years ago (mya) (Wells, 2003; de Wit, 2003; Yoder & Nowak, 2006). It maintained connection with India, and, through Antarctica, South America, into the late Cretaceous (although exactly how this occurred remains unclear; reviewed in de Wit, 2003 and Yoder and Nowak, 2006). These landmasses separated around 90 mya, and Madagascar became isolated 430 kilometres from the nearest landmass (Wells, 2003; Yoder & Nowak, 2006). Geologically its history is even more complex, with some rocks dated to over three billion years ago (de Wit, 2003). This ancient geological record reveals the afore-mentioned patterns of continental drift, and the extinction and diversification events known from other fossil records (de Wit, 2003).

Madagascar's modern fauna are poorly documented in the fossil record (de Wit, 2003; Glaw & Vences, 2007; Samonds et al., 2012), and their origins are therefore difficult to infer. Some, like the chameleons, appear to have evolved in Madagascar and subsequently radiated to Africa and India by oceanic dispersal (Raxworthy et al., 2002). Others, such as lemurs, have continental African and Asian roots, and therefore probably represent oceanic radiation events to Madagascar (Krause, 2010). How this occurred for larger and less saline-tolerant species remains unclear (de Wit, 2003; Krause, 2010), but the cases for vicariance and dispersal, both of which appear to have been prevalent in various taxonomic groups, are reviewed by Yoder and Nowak (2006) and Samonds et al. (2012).

Madagascar was the last place to experience a megafaunal mass extinction, occurring within the last two millennia (de Wit, 2003). Although this event coincides with the arrival of people on the island circa 2500 years before present (BP) (Crowley, 2010), it has not been conclusively shown that human settlement was wholly responsible for the mass extinctions and coincident vegetation changes (reviewed in de Wit, 2003). The settlement of humans on the island occurred at the southern tip of Madagascar, and they radiated from there outward (de Wit, 2003; Blench, 2007; Serva, 2012). The hunting of large-bodied species likely contributed to rapid declines, both at the time of colonisation and afterwards, but human-induced habitat size reduction and transformation were also involved (Crowley, 2010; Blench, 2007). This left the island devoid of

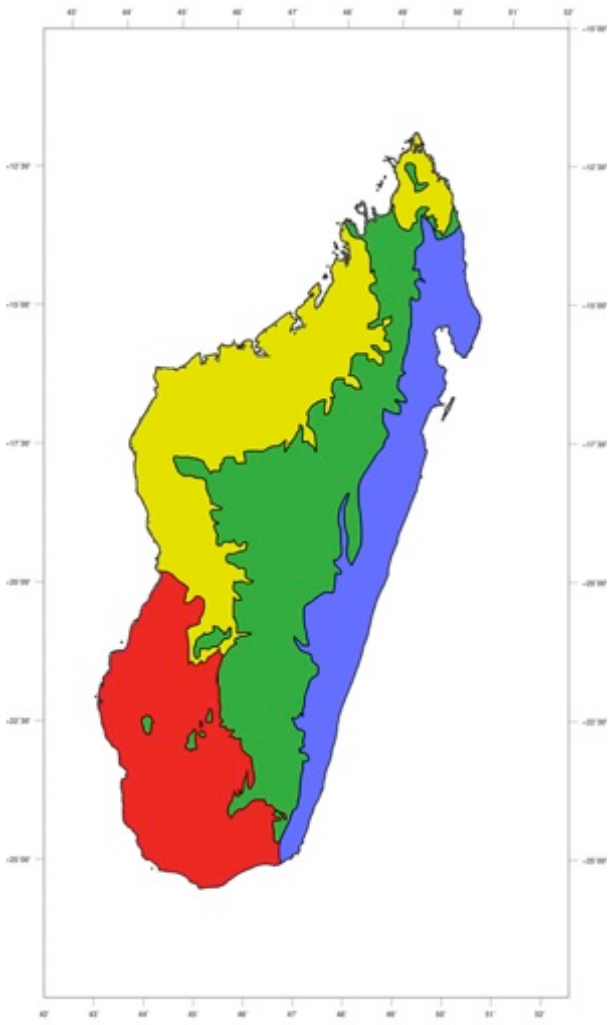


Figure 7.1 - The climate zones of Madagascar. Red = Semi-Arid; Yellow = Dry; Green = Sub-Humid; Blue = Humid. Based on Cornet, 1972; GinkgoMaps Project: www.ginkgomaps.com

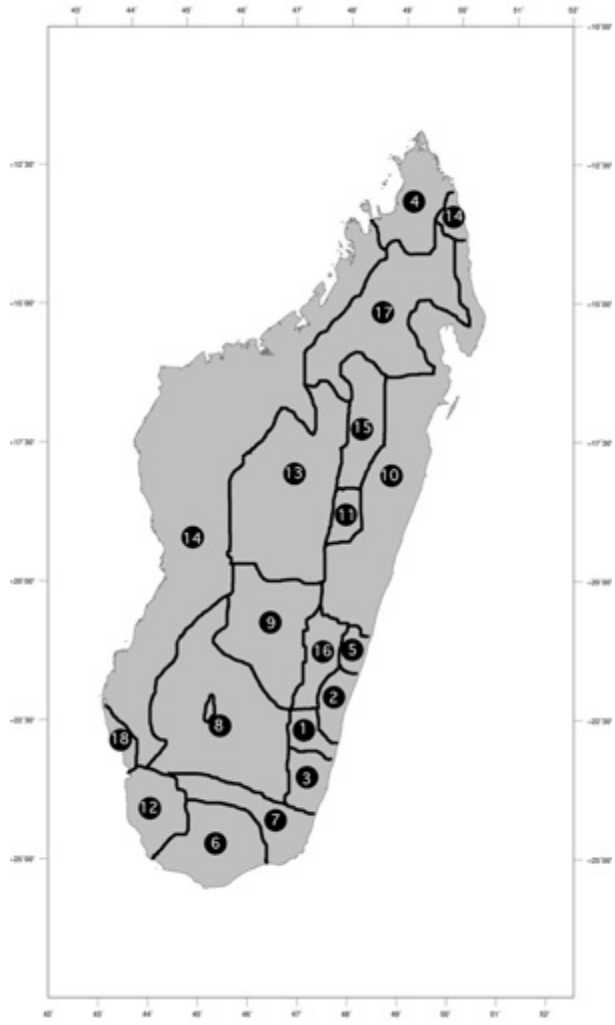


Figure 7.1 - The Ethnic Groups of Madagascar: (1) Antaifasy; (2) Antaimoro; (3) Antaisaka; (4) Antankarana; (5) Antambahoaka; (6) Antandroy; (7) Antanosy; (8) Bara; (9) Betsileo; (10) Betsimisaraka; (11) Bezanozano; (12) Mahafaly; (13) Merina; (14) Sakalava; (15) Sihanaka; (16) Tanala; (17) Tsimihety; and (18) Vezo.
Source: Tofanelli et al. 2009; GinkgoMaps-Project: www.ginkgomaps.com

any endemic species "heavier than a microwave oven" (D. Austin, pers. comm.), with some species disappearing as recently as 500 years BP (Crowley, 2010). These same issues continue to threaten Madagascar's modern fauna (see Section 7.3).

7.2.2 Climate

Generally, Madagascar experiences warm temperatures from October to April (austral winter), and cooler temperatures from May to September (austral summer). The island has a trend of increasing dryness from north to south, and from east to west (Crowley, 2010). This trend allows for its subdivision into three main climatic zones: the eastern rainforest zone, the central temperate zone, and the western dry zone (Wells, 2003; see Figure 7.1). Ocean currents and trade winds bring warm weather to the eastern coast. A chain of mountains running the length of the east coast of the island acts as a moisture barrier to the rest of the island, causing the discharge of air moisture as it is pressurised. In this way the mountains underlie the observed climatic divisions, which have led to the island's enormous diversity of habitat types (Wells, 2003).

7.2.3 Humans

Although humans appear to have arrived on Madagascar as early as 2500 years BP (Blench, 2007; Crowley, 2010), there is evidence to suggest the island was not properly settled until at least 1500 years BP (Blench, 2006; 2007; Cox et al., 2012). The genetic findings of Cox et al. (2012) combined with the linguistic findings of Serva (2012) support a single early colonisation event by a small group (approx. 30 women and an indeterminate number of men) of Indonesian people, with subsequent influence from African and other settlements and trade routes (Blench, 2006; Cox et al., 2012; Serva, 2012). Whether there were aboriginal people permanently inhabiting the island prior to this settlement event, whose own language was overpowered by that of the newcomers, remains unclear, but is a subject of on-going research (Serva, 2012).

Madagascar has been a genetic mixing pot for humans. Its people represent a mixture of South East Asian and African lineages, clear from both their morphology and language (Tofanelli et al., 2009; Serva, 2012). There are eighteen ethnic groups on the island (Tofanelli et al., 2009; Figure 7.2), which are classed broadly as either Highlanders or *Côtiers* (Tofanelli et al., 2009; Blench, 2006; 2007). These correspond also with the ethnic origins of the groups, the highlanders being of primarily Asian, and the côtiers of primarily African descent (Tofanelli et al., 2009; Blench, 2007). The customs of these people are also diverse, and are largely ethnically distinct.

Although Madagascar was a French colony from 1896 to 1960 and French remains listed as a national language, its usefulness decreases with greater distance from large cities. Malagasy pervades in rural Madagascar. It reflects strongly the South East Asian origins of the Malagasy people, sharing some 90% of its basic vocabulary with the Maanyan language of south-eastern Borneo (Adelaar, 1995; Serva, 2012). It has been influenced, however, by subsequent language influxes, particularly from the Bantu languages of the east coast of Africa (Blench, 2006). Although it was standardised for the purpose of writing, the Malagasy language exists as a broad range of dialects, reflecting both ethnic group and distribution. Despite the common core vocabulary that these dialects possess, they also have many significant variations, often impeding communication – particularly between non-neighbouring tribes (Blench, 2006).

7.3 Conservation

7.3.1 Threats to Madagascar's Biodiversity

The arrival humans on Madagascar put new and intense pressures on the island's natural habitats. These include (i) deforestation, (ii) exploitation and exportation of natural resources, and (iii) the introduction of invasive species. Together, these factors pose unprecedented threats to the island's natural biodiversity.

Deforestation is undoubtedly the primary cause of biodiversity loss in Madagascar. There are a variety of methods used in the clearing of forest, but perhaps the most widespread is slash-and-burn agriculture (*hatsake*). This involves the cutting of low vegetation, which is then set alight and left to burn itself out. The resulting layer of ash is allowed to dissipate in the rain, and then the cleared ground is used to plant crops, either for direct consumption or for livestock to graze (Jarosz, 1993). The cleared areas tend to have only short-lived fertility however, and farmers soon move on to clearing other areas. The threat that this practice poses has long been acknowledged, and it was outlawed as early as 1787 (Jarosz, 1993), and more recently also Madagascar's central government and the WWF (Clayton, 2011; Ferguson, 2011a). Nevertheless, it remains one of the major forms of agriculture across the island. It is important to note, however, that it is still unclear how much damage *hatsake* causes relative to other agricultural practices (van Vliet et al., 2012).

Deforestation of all kinds has been proceeding at an unprecedented rate in Madagascar; Harper et al. (2008) reported that 27% of the island's primary forest was left by the 1950s, and calculated that 40% of that forest had subsequently been cleared by the year 2000. There are several

consequences to this widespread deforestation. The soil, which is normally held together by the root systems of the overlying vegetation, is easily eroded and drained away in rivers, with significant economic implications for this country, whose economy depends on agriculture (Butler, 2009). Additionally, the disappearance of the forests is having dramatic consequences for the island's wildlife, more than 90% of which is restricted to forested areas (Dufils, 2003).

The exploitation and exportation of natural resources is a trend that is on the rise across the island. Exploitation of natural resources must have occurred from the days of the earliest settlers, who relied on the forest as a source of firewood and food (Harper et al., 2007), but the pressure on Madagascar's ecosystem has increased as its population has grown (van Vliet et al., 2012; Jarosz, 1993; Clayton, 2011). Golden et al. (2011) showed that the consumption of bushmeat is critical to the health of children in rural northern Madagascar, but is difficult to imagine the forests continuing to support Madagascar's growing population for long.

Increasingly, however, it is not the needs of the local people, but those of the international market that are driving the exploitation and exportation of natural resources. Mineral mines, including sapphire, ilmenite, and graphite, have sprung up across the island (Olsen et al., 2011; Vincelette et al., 2003); rosewood, ebony, and other hardwoods are harvested illegally from Madagascar's tropical forests to supply the international furniture and music instrument markets (Jarosz, 1993; Innes, 2010; Labat & Moat, 2003); and the international pet trade has driven illegal collection of protected species to dangerous levels (e.g. the radiated tortoise, *Astrochelys radiata*: see Section 13). Together, these factors have put dramatic pressure on already dwindling forests.

The introduction of invasive species presents a relatively low threat to the forests of Madagascar, but is still worth mentioning. Many species have been introduced, some on purpose, and others by accident. Bush pigs, for example, are thought to have been brought originally as livestock, but subsequently escaped and became wild (Glaw & Vences, 2007). The same is true of the prickly pear cactus, whose history has been unusually well documented (see Section 14.2.2). Rats and mice are likely accidental invaders, having arrived as stowaways on boats (Tollenaere et al., 2010). Their effects have been enormous however; rats are abundant in many of Madagascar's forests, and although they probably provide a valuable food source for Madagascar's endemic carnivores, they compete directly with its endemic insectivores, and are responsible for the persistence of the bubonic plague in Madagascar (Vogler et al., 2011). A full list of the known invasive species in

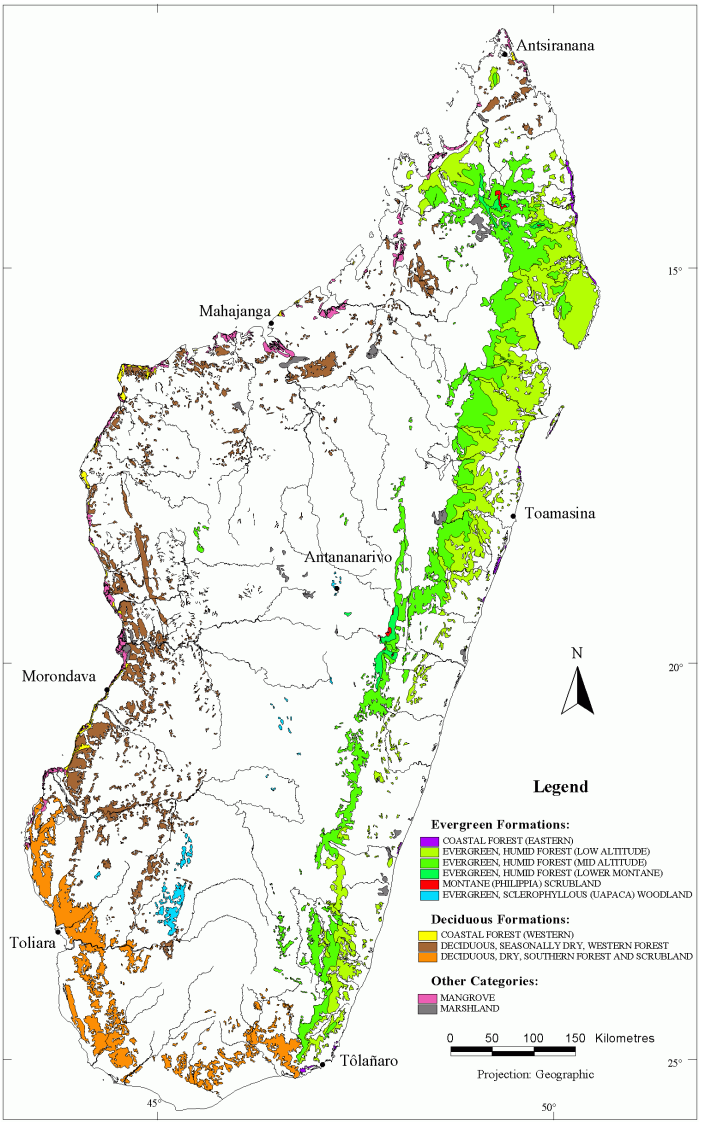


Figure 7.2 - Madagascar's Remaining Primary Vegetation. Source: Kew Gardens, 2012

Madagascar and some information relating to their effects on the endemic flora and fauna may be found on the Global Invasive Species Database at http://www.issg.org/database/.

7.3.2 Protecting Madagascar's Forests

Madagascar was one of the first countries to set up protected areas, beginning in 1927 with seven parcels of forest totalling 560,181 ha (Randrianandianina et al., 2003). Today, there is a large network of parks spread all across the island. Nonetheless, a large number of critically endangered species remain unprotected by conservation efforts (Glaw & Vences, 2007).

Despite the protection, the primary forest cover of the island plummeted by 85% between 1950 and 2003 (de Wit, 2003; see Figure 7.3). Conservation initiatives have encountered significant hurdles. Many forests are fragmented, and contain a diverse array of distinct microhabitats. Fragmentation and habitat heterogeneity inhibit the effective implementation of large-scale protected areas (Randrianandianina et al., 2003). Perhaps the largest issue facing conservation initiatives is the use *hatsake*, which has drastic outcomes on environmental conditions, contributing directly to climate change (reviewed in Holloway, 2003). Additionally, adverse social, economic and political conditions have impeded conservational progress (Erdmann, 2003). Until effective alternatives to detrimental practices can be determined, progress will be limited indeed (Holloway, 2003).

The "south" ecoregion (as specified by Randrianandianina et al., 2003; Fenn, 2003; and ANGAP, 2001) covers an area of 61,225.7 km^2 (ANGAP, 2001), and is made up primarily of spiny thicket (Fenn, 2003). This ecoregion contains, amongst other habitats, a sub-ecoregion of spiny and succulent thicket on volcanic and limestone substrates (see Figure 7.4). These heterogeneous forests are at particular risk due to the slow rate at which they regenerate, and this sub-ecoregion is highly fragmented (Fenn, 2003), with the Mandrare River Valley containing the best-preserved portion of forest (Erdmann, 2003). Until 2006, only approximately 3.2% of this area was protected (Fenn, 2003). Thereafter, the Durban Vision was implemented.

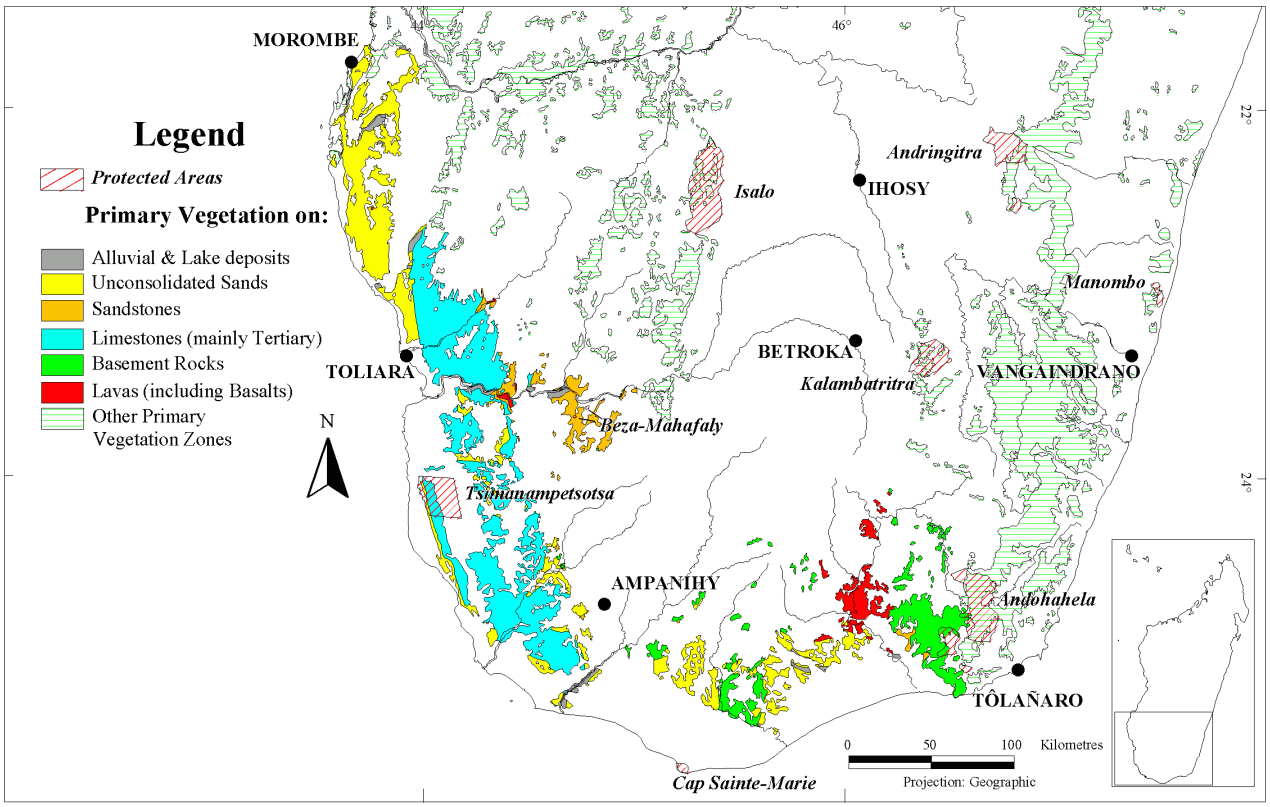


Figure 7.3 - Remaining primary vegetation in southern Madagascar, classified by underlying geology. Source: Kew Gardens, 2012b

Category	Designation
1	Extensive wilderness or ecosystem areas that are strictly protected
2	Ecosystem areas that also provide recreation, such as national parks
3	Areas that conserve specific features, such as natural monuments
4	Managed areas that maintain species and habitats
5	Protected landscapes with harmonious interaction between people and nature
6	Substantially natural areas managed for sustainable use of natural resources.

Table 7.1 – IUCN Conservation Categories. Source: Durbin, 2007

In 2003, former president Marc Ravalomanana pledged to triple Madagascar's protected area from 1.7 to 6 million hectares within five years (IRIN, 2006; Durbin, 2007; Ferguson, 2011b). This goal, coupled with the implementation of the System of Protected Areas of Madagascar (SAPM), which replaced the previous system, National Association for Protected Areas Management (ANGAP) with Madagascar National Parks (MNP), provided greater flexibility in implementation and structure in establishment of protected areas. This represented a large step towards sustainable protection (IRIN, 2006). The Durban Vision utilises the six categories established by the International Union for the Conservation of Nature (IUCN) for the classification of protected areas, which range from Category 1: strict protection of an extensive wilderness or ecosystem area; to Category 6: substantially natural areas managed for the sustainable utilisation of resources (Durbin, 2007; see Table 7.1). Under the Durban Vision, community-based associations (COBAs) are given the land rights to protected areas, with the understanding that they will manage the areas in accordance with conservation agendas (IRIN, 2006).

Identified as an important conservation priority by the WWF Spiny Forest Ecoregion Programme (WWF *Ala Maiky*) in 1997 (Ferguson, 2011a), the Mandrare River Valley was chosen as one of the new sites for protection, and the Ifotaka-North Protected Area was established (Figure 7.5). A participatory environmental monitoring scheme is being devised for this area, to understand the efficacy with which the protected area is being managed (Ferguson, 2011a). This

Figure 7.4 - Outline of the Ifotaka North Protected Area; Ifotaka and Kobokara are shown here for reference. Sources: Google Earth®, 2012; CEPF Madagascar, 2007, Ferguson, 2011a

represents cooperation between several NGOs, including the World Wildlife Fund for Nature (WWF) and Operation Wallacea (OpWall). Highlighted in this management scheme as chief priorities are, amongst others, radiated tortoises, high spiny thicket, and rare and unconfirmed species.

7.4 Southern Madagascar

7.4.1 The Spiny Forest

From the Cretaceous period until the Eocene, Madagascar sat abreast a line of high-pressure deserts at 30°S. This period was sufficiently long for nearly all non-drought-tolerant plants to be eliminated from the island. Subsequent northern drift has confined the remaining drought-tolerant vegetation to the southern end of Madagascar, and the xerophytic "spiny" scrub of the south is therefore the oldest biome present on the island (Wells, 2003). Approximately 50% of spiny forest flora is endemic at the genus level, and 95% at the species level (Wells, 2003). This ecoregion is characterised by four genera and twelve species of the endemic Didiereaceae, along with several *Euphorbia* species (Fenn, 2003). The plants are extremely well adapted to cope with precipitation levels as low as 500mm p.a. (Glaw & Vences, 2007; Fenn, 2003).

The spiny forest has been impacted greatly by the presence of humans on the island. The extinction of large herbivores may have led to an increase in leaf litter on the ground, contributing to the increase in the frequency, and severity, of forest fires following these extinctions (Crowley, 2010; Blench, 2007). Perhaps the single most devastating blow to this forest, however, was the introduction of the prickly pear cactus (genus *Opuntia*) around 250 years BP (Kaufmann, 2004; Binggeli, 2003). Although this cactus is today used in a broad range of applications, it was originally introduced as a defensive barrier in 1769, subsequently eradicated, and reintroduced as a food source in 1930 (Kaufmann, 2004; Binggeli, 2003; see Section 14.2.2). It has spread enormously, and today lines most roads in southern and central Madagascar, present also in disturbed and semi-disturbed areas of spiny forest (see Section 15). Despite its devastating impact on southern Madagascar's native flora (see Section 14), prickly pear plays a vital role as a famine food for the people of this area, both directly through its nutritious fruit, and indirectly by providing nourishment for their livestock (Kaufmann, 2008).

7.4.2 The Herpetofauna of Southern Madagascar

Madagascar is a hotspot for herpetofaunal diversity. Some 92% of its reptiles and 99% of its amphibians are endemic (Vieites et al., 2009; Glaw & Vences, 2007; Yoder & Nowak, 2006). There are over 370 species of reptiles and 250 species of amphibians currently described, and these numbers increase every year. Indeed, Vietes et al. (2009) predict there to be between 363 and 465 species of amphibians alone (roughly 4% of global amphibian biodiversity; Glaw and Vences, 2003). Approximately 6 species of amphibians and 46 species of reptiles are found in arid southern Madagascar (Glaw & Vences, 2007).

It is thought that Madagascar is the origin of the chameleon family (Raxworthy et al., 2002; see Section 7.2.1) Additionally, there are a host of peculiarities to the island's fauna that continue to puzzle zoogeographers and evolutionary biologists. Particularly the case of the boas (represented by the genera *Sanzinia* and *Acrantophis*) has been a hot topic of debate, as it hints to a South American connection (Glaw & Vences, 2007). Mainland Africa is home primarily to pythons (family Pythonidae), while boas (family Boidae) are typical of South America and other distant places (Noonan & Chippindale, 2006a). Thus, until recently, the presence of boas in Madagascar presented something of a conundrum. Noonan and Chippindale (2006a) revealed that the Malagasy boas were closely allied with a boid of mainland Africa, *Calabaria*, which had previously been placed amongst the pythons, and these three genera represent an ancient lineage of boids. They postulate that *Calabria* dispersed across the Mozambique Channel from Africa

(which was isolated from both Madagascar and South America by this point; Noonan & Chippindale 2006b) to Madagascar in the Late Cretaceous, giving rise to the modern Malagasy genera *Acrantophis* and *Sanzinia* (Noonan & Chippindale, 2006a). By this time, they argue, Madagascar was already isolated from an early land bridge connecting it to South America through India and Antarctica, hence the relatively distant relationship between the African boids and those of the New World and India (Noonan & Chippindale, 2006a). Thus, the boid enigma has been tentatively resolved.

Herpetofaunal absences are also noteworthy; Madagascar harbours none of the caecelians, the enigmatic worm-like amphibians found on mainland Africa (Glaw & Vences, 2007). Nor are there salamanders, though this is less surprising given global salamander distribution (Glaw & Vences, 2007; Yoder & Nowak, 2006). Furthermore, Madagascar lacks elapid snakes and varanid lizards, families prevalent on the African mainland (Yoder & Nowak, 2006). Thus, the diversity of herpetofauna remains an intriguing mystery (Glaw & Vences, 2007; Noonan & Chippindale, 2006b).

The herpetofauna is extremely important ecologically and interesting scientifically. Reptiles and amphibians make excellent bio-indicators due to their physiology (Glaw & Vences, 2007). Simply put, they are so dependent on environmental conditions that the slightest disturbances can have drastic consequences for their survival (Glaw & Vences, 2007; Gardner et al., 2007). They can broadly be classed as either disturbance-tolerant or -intolerant. While the former may be unaffected by, or even do better in, disturbed environments, the latter are rarely, if ever, found outside pristine forest. They are therefore important tools in the assessment of the state of a forest (Randrianandianina et al., 2003).

From a conservation perspective, the herpetofauna of Madagascar is high on the list of global priorities. A press report recently released by the International Union for the Conservation of Nature (IUCN) revealed that 40% of Madagascar's terrestrial reptiles are threatened, with 22 listed as Critically Endangered (IUCN, 2011a). In addition to the relatively low, but constant risk presented by the international pet trade (Raselimanana, 2003), Madagascar's reptiles are threatened by habitat loss and change (Gardner et al., 2007; Lehtinen et al., 2003; Scott et al., 2006), consumption as food (Randriamahazo et al., 2007), and climate change (Ballesteros-Barrera et al., 2007). The island's amphibians are faced by a greater potential threat than any of these, however. Madagascar is one of the last remaining amphibian biodiversity centres to lack the toxic *Batrachochytridium dendrobatidis* fungus, which has caused devastation in numerous other countries (Glaw and Vences, 2007; reviewed in Berger et al., 1998 and Weldon et al., 2004). Conservation efforts must therefore be undertaken in advance of the almost inevitable arrival of this fungus, to mitigate its potentially devastating effects.

7.4.3 The Radiated Tortoise

The Radiated Tortoise, *Astrochelys radiata*, formerly *Geochelone radiata*, is one of four chelonian species endemic to Madagascar (Pedrono & Smith, 2003). It is endemic to the semi-arid spiny forests of southern Madagascar (Glaw & Vences, 2007). It is known that hunting and the bushmeat, pet, and jewellery trades are major causes of the decline in its numbers (Lewis, 1995; Behler, 2002; O'Brien et al., 2003). Additionally *A. radiata* is under threat from the changing lifestyles of a growing human population, which has more than doubled in the past 36 years (CIA, 2012). In order to access fertile lands, people living in rural southern Madagascar have increased the practice of *hatsake*, which destroys the tortoise's natural habitat. This has, however, subsequently been banned in most areas by the WWF (Ferguson, 2011a; Clayton, 2011).

A. radiata is a priority conservation target. It is currently listed as Critically Endangered by the IUCN Red List of Threatened Species (IUCN, 2011b), and has also been listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

since 1975 (CITES, 2011). However, few studies have been carried out to determine population densities and/or fragmentation. Although the total population of *A. radiata* remaining in Madagascar has been estimated at 4.5 million individuals, which is extremely large for critically endangered species, it has been reported that 60,000 tortoises per year are being illegally harvested for sale in domestic and international markets (Randriamahazo et al., 2007).

7.5 Maps

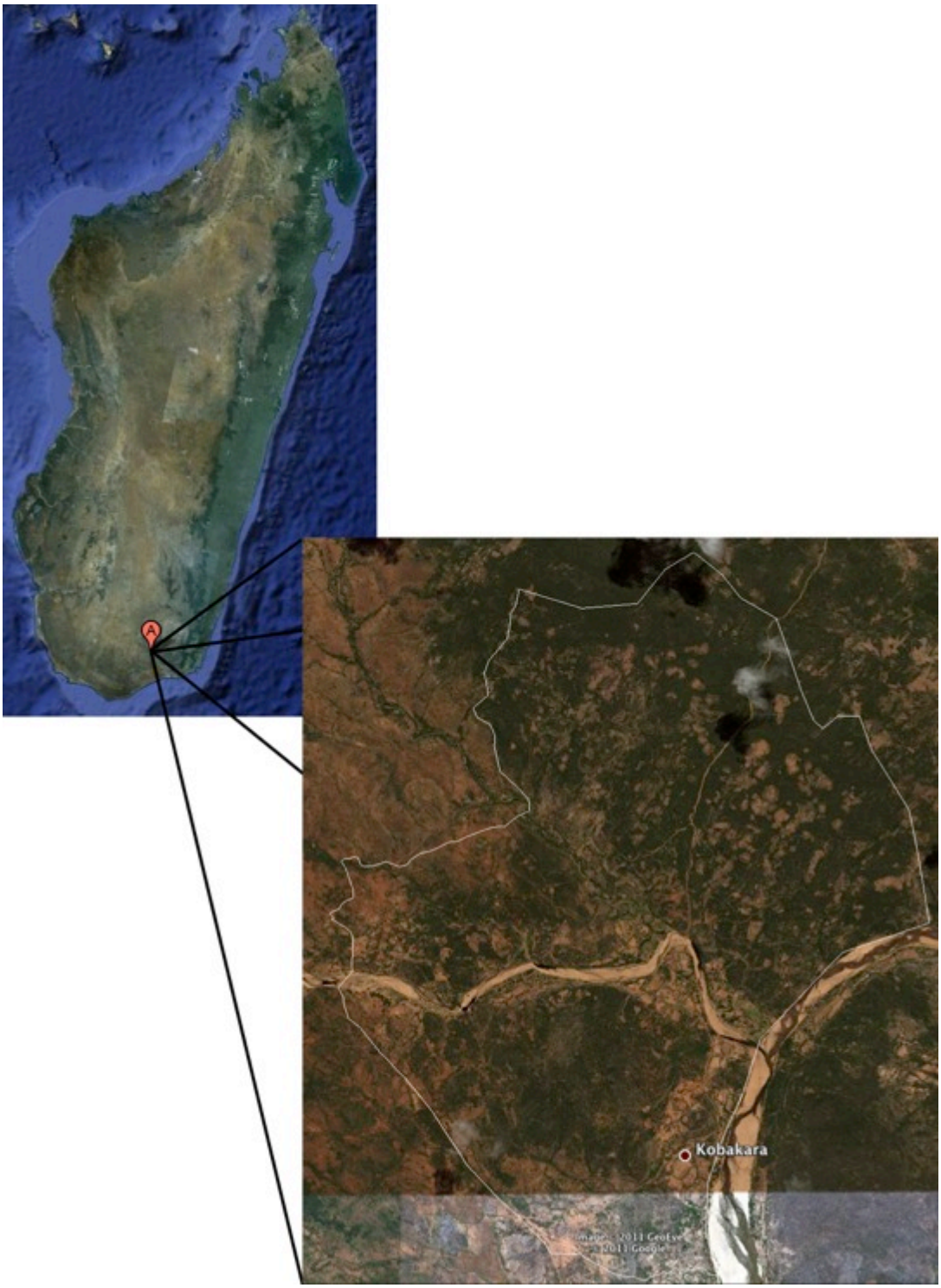


Figure 7.5 - Kobokara in the context of Madagascar. Source: Google Earth® 2012

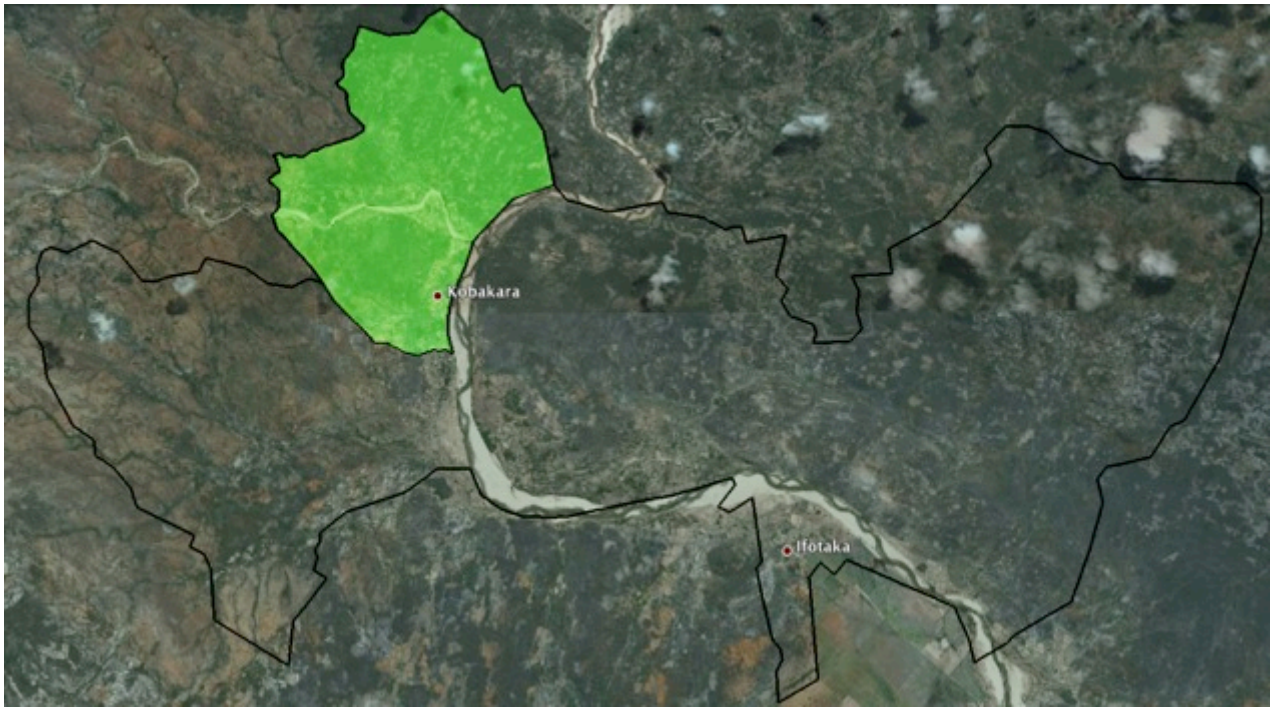
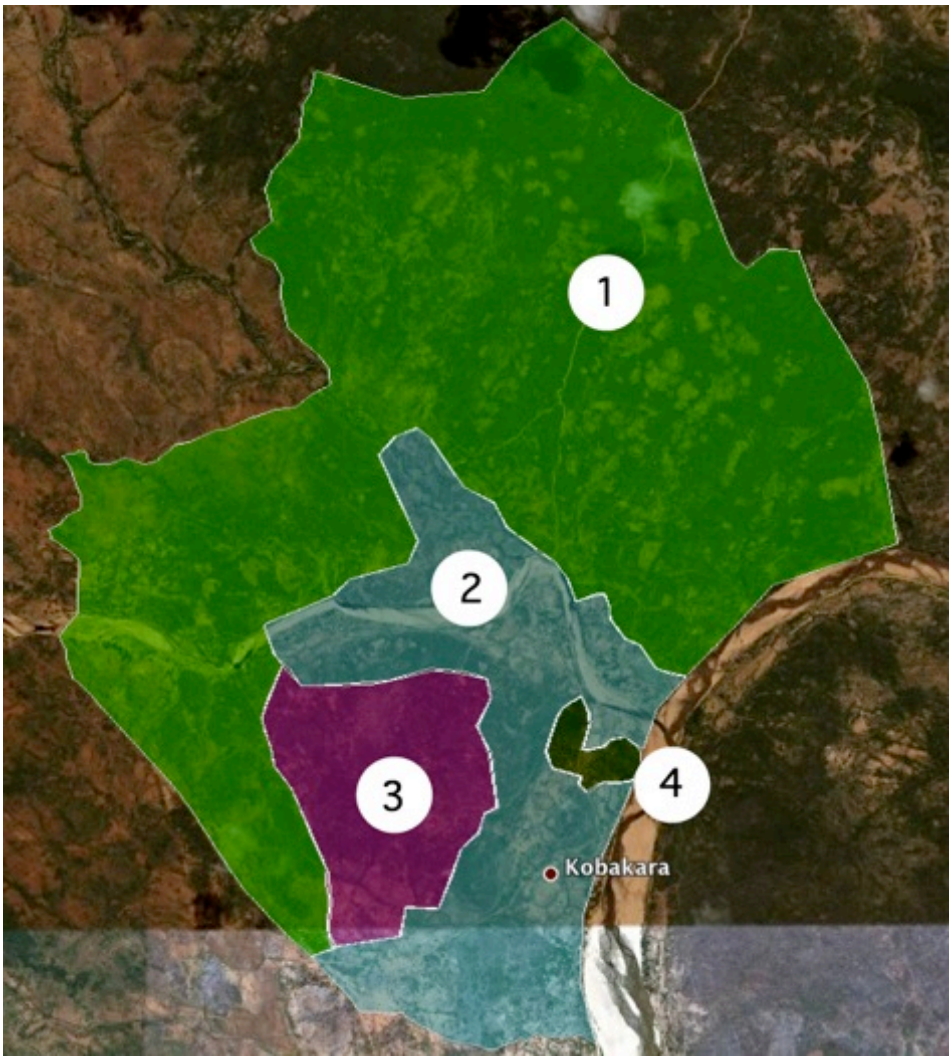


Figure 7.7 (above) – The Kobokara section of Ifotaka North Protected Area. Source: Google Earth® 2012

Figure 7.8 (below) – The Conservation Zonings of the Kobokara Region. (1) Conservation Zone (ZdC); (2) Restant; (3) Usage Rights Zone (CDU); (4) Total Protection Zone (*Ala faly*). Source: Google Earth® 2012; Ferguson, 2011a



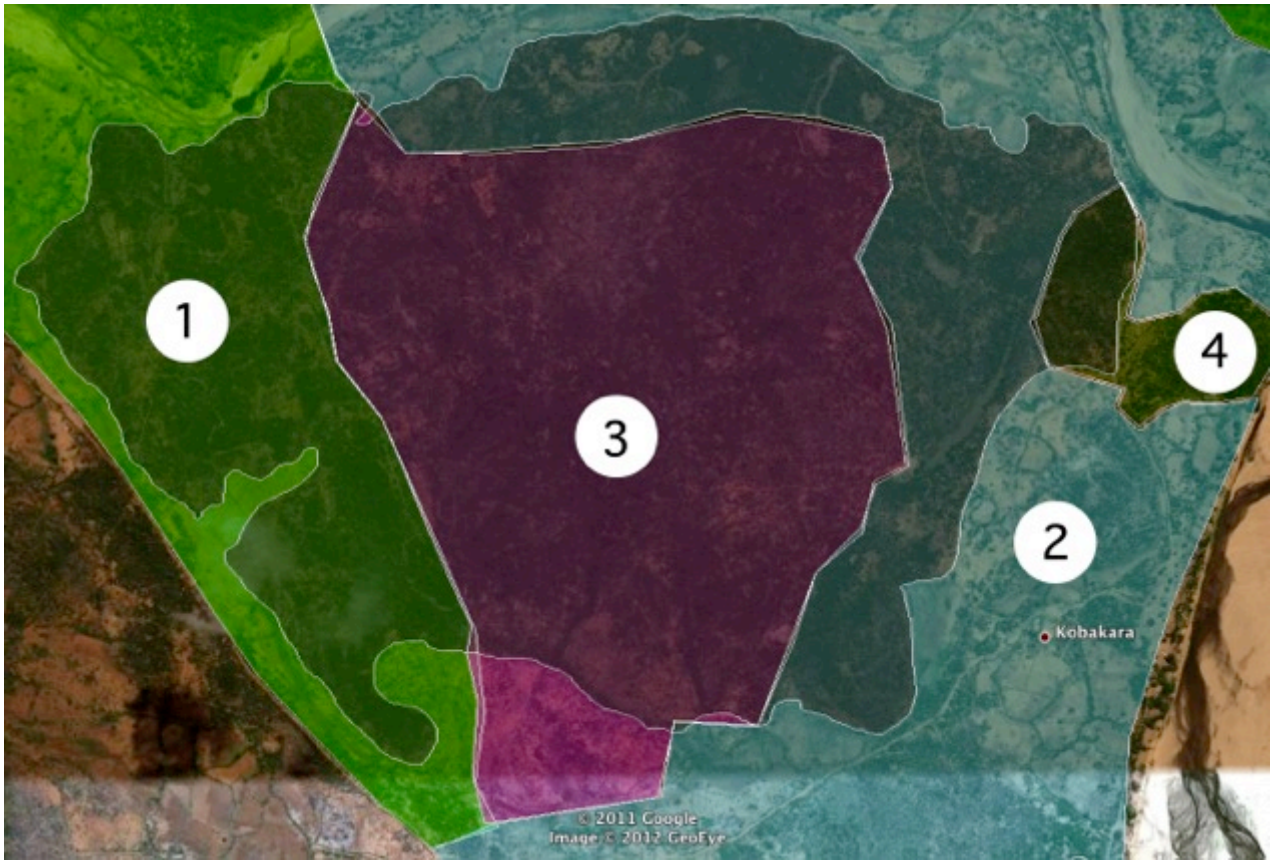


Figure 7.6 - Study forest in the context of conservation zonings, represented by darkened area. (1) Conservation Zone (ZdC); (2) Restant; (3) Usage Rights Zone (CDU); (4) Total Protection Zone (*Ala faly*). Source: Google Earth® 2012

8 STUDY AREA

The Ifotaka-North Protected Area is divided into five management zones in the current iteration of the management plan (Ferguson, 2011a): Ifotaka Central, Analamena, Matsandry, Bekiria, and Kobokara (Figure 7.7). Each of these management zones has further been subdivided by management type, as Zone de Conservation (Conservation Zone; ZdC), *Ala faly* (literally "taboo forest"; Total Protection Zone), Zone de Restoration (Restoration Zone; ZdR), Cantonnement de Droits d'Usage (Usage Rights Zone; CDU), and Restant (area designated for farming and habitation) (see Figure 7.8; Ferguson, 2011a). This expedition's camp was located at the north-east end of the village of Kobokara, within the Ifotaka North Protected Area (S 24° 45.319', E 46° 03.464'). To the west of this village is a 5.19 km^2 area of spiny forest, spread over an elevational range of between 78 and 128 metres above sea level (masl). This forest lies at the western border of the interior subregion of the spiny forest as defined by Fenn (2003). The majority of this forest falls under the CDU zoning, although some of it is designated for farming, and a very small amount for conservation (Ferguson, 2011a; see Figure 7.9).

8.1.1 Kobokara

The village of Kobokara is situated on the western bank of the Mandrare River. Founded approximately two generations ago by three brothers, it currently has a population of around 200 individuals. The surrounding hamlets bring the total population to about 400. The majority of villagers are, in some way, related, although men typically seek wives from outside the village. The people subsist on sweet potato (*bageda*), cassava (*balahazo*) and other drought-tolerant crops, farmed in the basin of the Mandrare and its tributary, the Ikonda (see Figure 8.1). A surprisingly

wide variety of plants can be grown in this fashion. Fish from the rivers, and wild birds such as the buttonquail (*kibo*) or the coua (*alìotse*), supplement this diet. As such, their livelihoods are at great risk from climate fluctuations. During drought, they consume tamarind and cactus fruit, and those who can afford to purchase other supplies on the market.

The market is held every Thursday in Fenoaivo; a village located 7 kilometres to the south of Kobokara. It fluctuates in size with the weather and season, but there is always a supply of rice, salt, some vegetables, sugarcane, and animals. Large market days include a vast array of clothing, trinkets, crockery, shoes, knives, sweets, and other non-essential items.

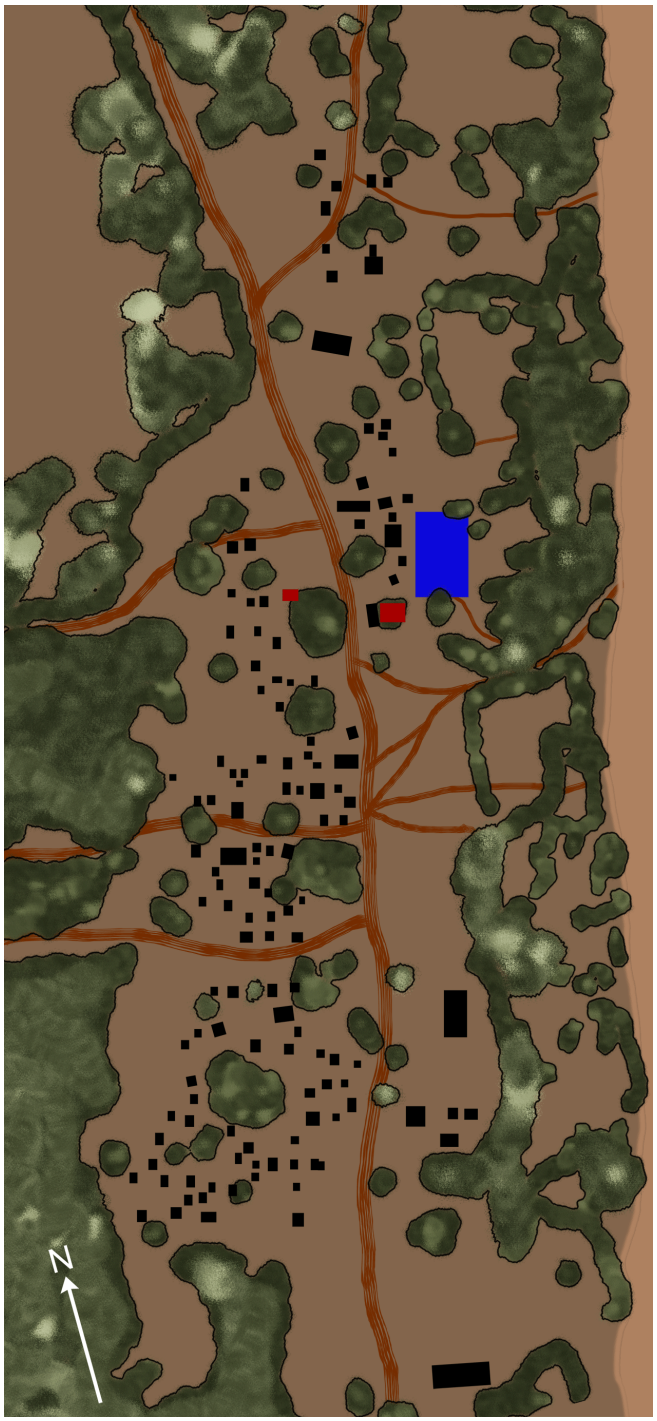


Figure 8.1 - The Village of Kobokara. Black: Buildings; Green: Trees and bushes; Brown lines: Roads; Blue: Our camp; Red: Fady zones. Based on imagery from Google Earth® 2012

Southern Madagascar is inhabited by three ethnic groups: Antandroy, Antanosy and the Mahafaly (see Figure 7.2). The people of Kobokara are primarily of the Antandroy ethnic group, known as "those of horns". These are a semi-nomadic group of cattle breeders (Tofanelli et al., 2009). Their wealth resides primarily in their cattle and goat herds, which they only rarely consume as food (Binggeli, 2003). The Antandroy language is the most distinct of all Malagasy dialects, representing a more significant deviation from the founding language than any other extant dialect (Serva, 2012).

Kobokara is presided over by a council, including a President, Vice President, Secretary, and other formal positions. This council is almost if not entirely subordinate to the WWF-run Community-based Forest Management Association (COBA), which takes responsibility for many decisions within the village beyond caring for it (see Sections 16 and 17). Traditionally, the village was run by elders and folk-law (*Dina*), and these still find their place in society. There is no clear boundary between roles and responsibilities, although the eldest of the elders can be expected to have the final say. Although the authority of the WWF is recognised, the elders' views are also important. This dichotomous governance based on both fear for the government and respect for the elders leads to sporadic law enforcement, but forceful implementation.

9 AIMS AND OBJECTIVES

- To create a baseline herpetofaunal inventory of a previously unstudied area of spiny forest
- To collect baseline disturbance information on an area of Usage Rights Forest, and investigate the way this is affecting herpetofaunal and botanical diversity
- To create a framework for on-going herpetofaunal data collection for the production of a comprehensive inventory
- To investigate the status of the critically endangered Radiated Tortoise, *Astrochelys radiata*, in the Kobokara area
- To understand the way NGOs are influencing life in remote areas of southern Madagascar
- To assess Kobokara's potential as a site for future ecotourism.
- To forge a connection between the school of Kobokara and Simpson's Primary School in Edinburgh

10 THE TEAM

Figure 10.1 - The Team. From left to right: Mark Scherz, Natalie Jane Smith, Miandanarivo Rakotomalaza, Morulla Tapiet Danvi, Herman Anicet Tsiafa, Junassye Rabemazaka, Justine Taylor, Matthew May

10.1 University of Edinburgh

MARK SCHERZ – TEAM LEADER, SCIENCE COORDINATOR, HERPETOLOGICAL AND DISTURBANCE RESEARCH

Age: 20
Nationality: American
Languages: English, German, French, Basic Malagasy
Experience:

- 3rd year BSc Biological Sciences with Honours (Zoology) at the University of Edinburgh
- Fellow of the Zoological Society of London
- 2009 Research on the herpetological biodiversity of Antsolipa, a dry deciduous forest in north Madagascar
- 2005-2006 Research on *Astrochelys yniphora, A. radiata, Pyxis planicauda*, and *P. arachnoides*; four critically endangered endemic tortoise species in Madagascar
- Experienced photographer

www.markscherz.com

Figure 10.2 - Mark Scherz

MATTHEW MAY – ASSISTANT TEAM LEADER, MEDICAL OFFICER, TORTOISE RESEARCH

Age: 23
Nationality: British
Languages: English, German, Basic French, Basic Swahili
Experience:

- MChem in Chemistry with Industrial Experience at the University of Edinburgh
- Fellow of the Royal Geographical Society
- 2010 Team Leader with First Aid Africa in Tanzania
- 2009 First Aid Instructor in Tanzania
- British Red Cross First Aid Instructor & Expedition First Aider
- Interest & Experience in Wilderness Survival
- Experienced photographer
  www.mjmayphotography.com

Figure 10.3 - Matthew May

JUSTINE TAYLOR – ANTHROPOLOGICAL RESEARCH

Age: 20
Nationality: British
Languages: English, Basic Malagasy
Experience:

- 3rd year MA Anthropology with Honours at the University of Edinburgh
- Experience working in primary schools
- Trained as a Peer Mentor

Figure 10.4 - Justine Taylor

NATALIE JANE SMITH – ORAL TESTIMONIES AND NGO IMPACTS

Age: 24
Nationality: British
Languages: English, Basic French
Experience:

- 2nd year MA Anthropology and Development with Honours at the University of Edinburgh
- 2008 Board member of GibMissionAfrica Rural Development Project, Ethiopia
- 2008 Development research project in Ethiopia

Figure 10.5 - Natalie Jane Smith

10.2 Centre Ecologique de Libanona

Herman Anicet Tsiafa – Herpetological Research
Age: 26
Nationality: Malagasy
Languages: Malagasy, French, English

Morulla Tapiet Danvi – Botanical Research
Age: 23
Nationality: Malagasy
Languages: Malagasy, French, Basic English

Miandanarivo Rakotomalaza – Tortoise Research
Age: 22
Nationality: Malagasy
Languages: Malagasy, French, Basic English

10.3 Other

Junassye Rabemazaka – Translator

Sama Zefania – Botanist and Academic Supervisor
Sama was brought on for a week to ensure that the Malagasy students' projects were being carried out correctly.

10.4 Local Staff

Our regular local staff included:
Bertrand – guide
Sabine – cook
Olive – cook
Jean-Louis – night guide and transport
Occasionally other individuals were brought on temporarily to help with events.

11 Pre-Fieldwork Phase

11.1 Team

This expedition was the brainchild of Ninette Rowland, who led an expedition to Angavo, in southern Madagascar, in 2010 (Rowland et al., 2010). She brought together a team of seven individuals, with three biologists including herself, one vet, and three anthropologists. As the field phase drew nearer, Ninette had to resign from the project for personal reasons. Two more team members chose to leave following this change, and another had to drop out for academic reasons. Mark was then appointed as Team Leader, and Matthew was brought onto the team to replace a lost biologist and team medic.

The participating students from the Centre Ecologique de Libanona (CEL) were selected by Barry Ferguson and Dr. Lalaoharisoa Raolinandrasana based on academic performance and interests. They each received bursaries for study, training, and fieldwork. The data gathered on this expedition has been used in their undergraduate dissertations (*License Professionelle*).

11.2 Training

Two of the team members who did not end up on the expedition received wilderness first aid training, and one of them also received orientation training. Fortunately, despite being brought onto the team very late, Matthew was able to take over the role of team medic. In the field, all team members were given instruction in orientation and GPS use by Matthew and Mark, and the option of being instructed in the correct method for handling snakes, lizards, and tortoises by Mark.

11.3 Permissions

Upon arrival in Madagascar's capital, Antananarivo, the team acquired three-month visas. Research permits were provided by the Department des Eaux et Forêts of the École Supérieure des Sciences Agronomiques (ESSA-Fôrets) at the Université d'Antananarivo (see Appendix I). In Fort Dauphin (Tolagnaro), meetings were held with the World Wildlife Fund's Project Officer for the Holistic Conservation of Forest, M Miharisoa Rakotomalala; and the Regional Director of Environment, Forest and Tourism for ESSA-Forêts, M Drouot Thomassien Ratsalahamanana, to explain the purpose of the expedition and its predicted outcomes. Additionally, we met with the Academic Director of CEL, Dr Lalaoharisoa Raolinandrasana, to discuss the dissertations of the three CEL students on the team. Barry Ferguson informed the village council of Kobokara of our arrival in advance. Upon arrival, meetings were held with the council and the Community-based Forest Management Association (COBA) to ensure we adhered to local practices and observed local regulations. A standard fee was paid to the COBA for permission to conduct research in the forest.

11.4 Pilot studies and Datasheets

A pilot study was carried out using one line of traps for the herpetofaunal and plant surveys (see Sections 12 and 14), and several pilot walks were carried out for the tortoise surveys (see Section 13).

Datasheets were produced for the convenient entering of data in the field. These are available from the expedition website (see Section 2). Contact Mark Scherz for more details.

12 HERPETOFAUNAL SURVEYS

MARK SCHERZ, HERMAN ANICET TSIAFA

12.1 Abstract

Madagascar harbours an almost unprecedented number of highly endemic reptile and amphibian species. Its dry southern domain has high levels of local endemism. Much of the forest in this area is under constant strain from human activity, yet there is only limited understanding of the effects that this disturbance is having on the local herpetofauna. We investigated the relationship between disturbance and species composition in an area of spiny forest in the Mandrare Valley. We recorded 22 species of reptiles over the survey period, including two chameleons, five geckos, one plated lizard, three iguanids, four skinks, one tortoise, and six snakes, one of which may be a previously undescribed species. We observed not only a species composition shift in relation to disturbance, but also a general trend of disturbance tolerance amongst reptiles as a whole. We highlight the need for more extensive fieldwork in this area, particularly during the wet season.

12.2 Introduction

Madagascar has extremely high herpetofaunal diversity levels. With endemism in 99% of its amphibians and 92% of its reptiles (Glaw & Vences, 2007; Vieites et al., 2009; Yoder & Nowak,

2006), it represents an extremely high conservation priority (IUCN, 2011a). Conservation initiatives must be, to a large extent, informed by research on the targeted species or communities (Fenn, 2003). In order for such conservation efforts to be effective however, it is crucial to know which species are found in the area. It is in this respect that the creation of species inventories contributes towards conservation initiatives (Raxworthy & Nussbaum, 1994; Jenkins et al., 2003).

Also significant in the ability to design and implement effective conservation measures is an understanding of the way in which taxa are influenced by anthropogenic changes to their environments (Irwin et al., 2010; Vačkář et al., 2012; Gardner et al., 2007), and the effect of disturbance at numerous taxonomic levels (Irwin et al., 2010; Jenkins et al., 2003). Furthermore, it is vital to address which factors are having the greatest impact on the studied taxa in order to formulate effective conservation initiatives (Irwin et al., 2010; Hecnar & M'Closkey, 1998). There is a dearth of case studies presenting the effects of disturbance on various taxa, although herpetofauna are perhaps amongst the best-studied groups (Irwin et al., 2010). Nonetheless, fairly few disturbance studies have been conducted in the arid spiny forest (Scott et al., 2006).

Reptiles and amphibians are particularly sensitive to small changes in their environments and anthropogenic disturbance has been noted generally to have negative impacts on herpetofauna (Irwin et al., 2010; Scott et al., 2006; D'Cruze & Kumar, 2011). Disturbance leads to changes in species composition, from forest-specialists to open-area-specialists and generalists (Irwin et al., 2010; Scott et al., 2006; D'Cruze & Kumar, 2011).

Reptiles are somewhat counter-intuitively influenced by anthropogenic activity, as their diversity has been noted to increase with increasing levels of disturbance (Irwin et al., 2010; Scott et al., 2006). This can perhaps be best explained by the ectothermic nature of their metabolism, the increased light radiation levels in deforested areas, and also the existence of numerous generalist species (Scott et al., 2006). This does not mean this class should be ignored when considering disturbance however; quite to the contrary, the specialist species are at extremely high risk of being overturned by generalist species (Irwin et al., 2010), and therefore represent a significant protection priority. These specialist species may be selected for use as bio-indicators, as their presence is indicative of relatively intact forest. Such indicators are vital in the continuous or selective diagnosis of ecological health (Randrianandianina et al., 2003; Hecnar & M'Closkey, 1998; D'Cruze & Kumar, 2011; Raxworthy & Nussbaum, 1994).

Habitat fragmentation and destruction are the most important factors influencing extinction in the herpetofauna (Andreone et al., 2005; Raxworthy, 2003). However, edge effects are also of significant concern, as they are directly correlated with extinction risk (Lehtinen et al., 2003). Encroaching edges repress the area of forest available to edge-avoiding species, and can therefore lead to the disappearance of a species without the obvious disappearance of its native habitat. However, this pattern appears to be less significant in herpetofauna than other taxa (Gardner et al., 2007), possibly due to a general trend of disturbance tolerance (Irwin et al., 2010; Scott et al., 2006). Irwin et al. (2010) noted that insects are the most strongly influenced of all taxa by anthropogenic disturbance, due to high levels of local endemism. The extinction of a locally endemic arthropod species may directly lead to a decrease in reptilian diversity, as reptiles are primarily insectivorous.

We created a preliminary species inventory for the CDU forest to the west of Kobokara, which will continue to be developed by future research initiatives in accordance with the Ifotaka North Monitoring and Management Plan (Ferguson, 2011a). Additionally, we investigated the relationship between disturbance level and reptilian species composition in a small area of spiny forest using a variety of assessment methods (Ryan et al., 2002), namely: (1) pitfall trapping at random sites in two different stratification levels: relatively disturbed (4-5 on the disturbance scale, see Section 15), and relatively undisturbed (2-3 on the disturbance scale); (2) time-constrained searches around the pitfall trap sites to account for sampling bias associated with

pitfall trapping; and (3) opportunistic searching across the full range of disturbance levels. Amphibians were not studied specifically as this expedition was conducted during the dry season, during which the regionally endemic species are difficult to find (Glaw & Vences, 2007).

Beginning in 2011, the Ifotaka North Protected Area will be the subject of an on-going monitoring program (Ferguson, 2011a). This research will be used to help inform the management and monitoring of this protected area.

12.3 Methods

Surveys were conducted in High Spiny Thicket (see Section 14), in areas of relatively low, and relatively high disturbance. Disturbance is here defined as activities such as slash-and-burn agriculture (*hatsake*), selective logging and grazing (see Section 15 for full disambiguation). Sites were further characterised by their botanical composition to confirm distinct stratification (see Section 14).

12.3.1 Survey methods

Sampling sites were selected at random from a master map of the area with numbered grid squares of 100 x 100m, after superficial stratification into low and high disturbance based on preliminary satellite-image-based forest assessment and extrapolation from a pilot study. Edge areas were excluded from the randomisation, following Gardner et al. (2007).

Pitfall traps were placed at the randomised sites, running from east to west along the northern edge of the selected grid square. Lines were relocated after 7-14 days. Six lines in total were placed over the period of the expedition, three in each stratification zone. Each line of traps consisted of 100 metres of plastic sheeting, with buckets placed along it every 10 metres (n=11; see Figure 12.1). A trench was dug along the line, and the bottom 5 centimetres of the plastic sheeting was buried in order to prevent animals from burrowing underneath it (Scott et al., 2006; Raxworthy & Nussbaum, 1994; Bennett, 1999). Rocks were placed at the bottom of buckets to provide shelter for trapped animals. This was a more convenient alternative to the litter used by Scott et al. (2006), given the general lack of leaf litter in the forest. Holes were also made in the buckets to prevent flooding from rain (Raxworthy & Nussbaum, 1994). Traps were checked once daily in the morning due to low capture rates.

Time-constrained searches were performed within 6000m^2 of trap lines, for 30 minutes (time taken to process individuals not included; Scott et al., 2006; D'Cruze & Kumar, 2011). Opportunistic searches were performed on a daily basis (Raxworthy & Nussbaum, 1994). They included searching cover objects such as dead or fallen trees, termite mounds, and rocks. Several nocturnal opportunistic searches were also performed.

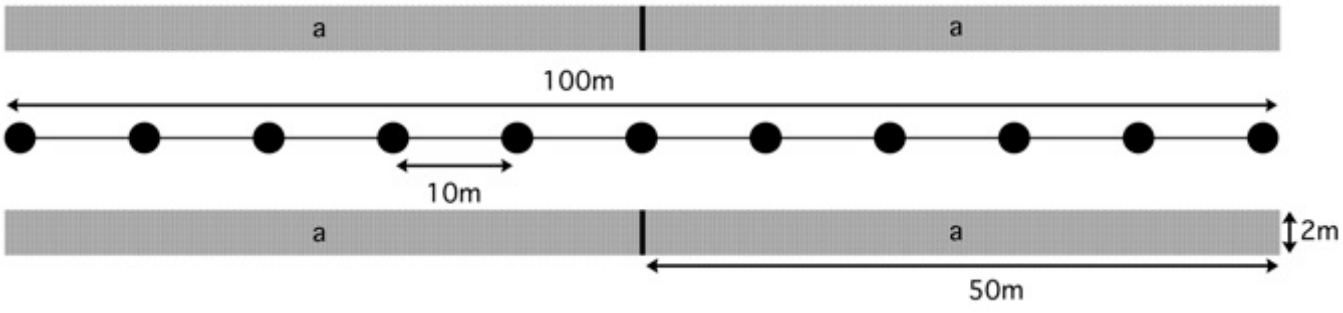


Figure 12.1 - Pitfall Trap Layout. Trap layout follows Raxworthy and Nussbaum, 1994; (a) botanical surveys

12.3.2 Disturbance classification

Disturbance was classified broadly according to apparent anthropogenic activity in the area, on a scale where 5 represents a completely deforested area (including inhabited areas), and 1 represents practically untouched forest (very occasional goat droppings, no tree stumps, no obvious paths). These categories do not account for unapparent human activity in the area, such as hunting or poaching. For a more detailed description of what is considered to constitute disturbance, see Section 15.3.

12.3.3 Specimen documentation

Reptiles caught were documented *in situ* where possible. Documentation recorded vital statistics (Snout-to-vent length [SVL], Tail Length [TaL], Total body length [TBL], Mass) and species identifiers (scale counts, after Glaw and Vences, 2007). Where identifications were unclear, photographs were taken for verification. All documented individuals were marked using non-toxic correction fluid to prevent record duplications, and immediately released within 10 metres of their capture points unless further documentation was required (D'Cruze & Kumar, 2011). Species identification followed Glaw and Vences (2007) with the exception of the Stenophis+Lycodryas clade, which followed Nagy et al. (2010).

12.3.4 Statistical analyses

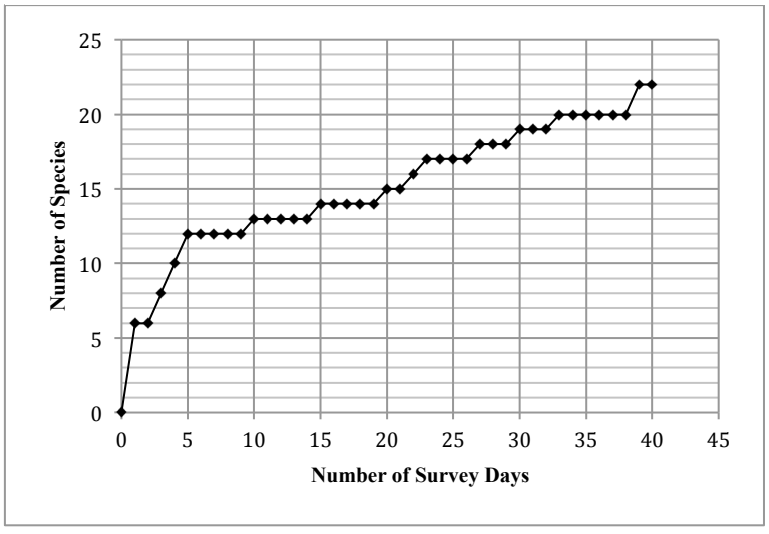
A species accumulation curve was plotted (Rakotondravony & Goodman, 2011) to show the efficiency of our research and its completion. We assessed the general abundance using a method similar to D'Cruze et al. (2006), which ranks species into the categories 'Abundant', 'Common', 'Infrequent' or 'Rare' based on observation frequency. Sample sizes were insufficiently large for statistical comparison of diversity indices (Fowler et al., 1998). Normality tests and statistical analyses were performed in Minitab® 16.

12.4 Results

12.4.1 Species composition

We recorded a total of 22 species of reptile (see Table 12.1) in the CDU forest to the west of Kobokara. A species accumulation curve (Figure 12.2) indicates that we failed to document all of the reptilian species present, as there is no indication of the trend reaching a plateau. We recorded two chameleons (9.1%), five geckos (22.7%), one plated lizard (4.5%), three iguanids (13.6%), four skinks (18.2%), one tortoise (4.5%), and six snakes (27.3%), one of which may be new to science (see Section 12.4.6). Additionally, we heard reports that *Crocodylus niloticus* is present in the Mandrare River during the wet season, and local people also reported having seen *Acrantophis dumerili* recently. Thus, at least 24 species of reptile are found in the area around Kobokara. This species inventory will be made available online (see Section 2), and continue to grow through future research (B. Ferguson, pers. comm.)

Figure 12.2 - Species Accumulation Curve



Species	Relative Abundance	Ecological Distribution	Disturbance Range	Endemic	CITES listing	IUCN Listing
Chameleonidae						
Furcifer lateralis	R*	AB	5	E	II	LC
Furcifer verrucosus	A	AB	3-5	E	II	
Gekkonidae						
Geckolepis typica	C	AB	2-5	E		LC
Hemidactylus mercatorius	C	AB	3-5	E		LC
Paroedura androyensis	I	T	2-4	RE		VU
Paroedura picta	I	T	3-5	E		LC
Phelsuma mutabilis	A	AB	2-5	E	II	LC
Gherrosauridae						
Trachyloptychus madagascariensis	A	T	3-5	RE		
Iguanidae						
Chalaradon madagascariensis	R	T	5	E		
Oplurus cyclurus	I	T	2-5	E		LC
Oplurus quadrimaculatus	R	T	3	E		LC
Scincidae						
Madascincus igneocaudatus	I	F	2-4	E		LC
Trachylepis aureopunctata	A	T	2-5	E		LC
Trachylepis elegans	C	T	3-5	E		LC
Trachylepis gravenhorstii	A	T	2-5	E		LC
Testudinidae						
Astrochelys radiata	I	T	1-4	RE	I	CR
Colubridae						
Dromicodryas berneiri	R	T	1-3	E		LC
Madagascarophis colubrinus	I	T	5	E		LC
Madagascarophis meridionalis	I	T	5	RE		LC
Mimophis mahafalensis	A	T	2-5	E		LC
Lycodryas pseudogranuliceps	R*	AB	5	E		LC
Typhlopidae						
Typhlops sp.	R*	F	2	?		

Table 12.1 - Species Inventory. Relative Abundance: A = Abundant; C = Common; I = Infrequent; R = Rare; * denotes species represented by single individuals. Ecological Distribution: AB = Arboreal; T = Terrestrial; F = Fossorial. Disturbance Range: 1 = Practically Undisturbed; 5 = Completely Disturbed; see DISTURBANCE. Endemic: E = Endemic to Madagascar; RE = Regionally Endemic to the arid south of Madagascar. IUCN Listing: LC = Least Concern; VU = Vulnerable; CR = Critically Endangered. Sources: IUCN, 2011b; CITES 2011, Glaw and Vences, 2006.

12.4.2 Conservation status

100% of the recorded species are endemic to Madagascar, and 18.2% are regionally endemic (see Table 12.1). Of the recorded species, 18 (81.8%) were listed on the 2011 iteration of the IUCN Red List of Threatened Species (IUCN, 2011b); 16 (72.7%) as Least Concern, one (4.5%) as Vulnerable, and one (4.5%) as Critically Endangered. Additionally, four (18.2%) of the recorded species are listed under the CITES Appendix II, and one is listed under Appendix I (CITES, 2011). Of the unconfirmed species, *Acrantophis dumerili* is listed by the IUCN as Least Concern, and CITES Appendix I, while *Crocodylus niloticus* is listed as Least Concern and CITES Appendix II (IUCN, 2011b; CITES, 2011).

Line	Disturbance	Habitat	Start Date	Finish Date	Days	Trap days	# specimens captured	Capture rate (%)
L00P	high	HST	25/07/2011	09/08/2011	14	154	5	3.25
L001	low	HST	03/08/2011	10/08/2011	7	77	6	7.79
L002	low	HST	10/08/2011	17/08/2011	7	77	2	2.60
L003	high	HST	13/08/2011	20/08/2011	7	77	8	10.39
L004	low	HST	23/08/2011	30/08/2011	7	77	9	11.69
L005	high	HST	26/08/2011	01/09/2011	6	66	2	3.03

Table 12.2 - Pitfall Trap Lines. HST = High Spiny Thicket

12.4.3 Relative abundance

Six (27.3%) of the recorded species were abundant, three (13.6%) were common, seven (31.8%) were infrequent, and nine (40.9%) were rare (see Table 12.1). Three of the rare species are known from a single specimen only. Two of these were not found outside the village of Kobokara, so their relative scarcity may be attributed to sampling bias, as we did not actively conduct searches within the village. The third is a fossorial snake, and is discussed in Section 12.4.6 below.

12.4.4 Ecological Distribution and Disturbance Ranges

Two (9.1%) of the recorded species are fossorial, fourteen (63.6%) are terrestrial, and six (27.3%) are arboreal. Sixteen (72.7%) of the recorded species were found in completely disturbed forest (category 5). Eleven (50%) species were found in relatively undisturbed forest (categories 1 and 2). Fifteen (68.2%) of the recorded species were found at more than one disturbance level. No fossorial species were found in completely disturbed forest.

12.4.5 Pitfall traps

Our pitfall traps are summarised in Table 12.2. Average capture rate was 6.46%. This was higher in relatively undisturbed forest than in disturbed forest (7.36% vs. 5.56%). Pitfalls captured a large number of invertebrates and several small mammals. All of the captured reptiles, with a single exception (see Section 12.4.6), were lizards. We postulate that the low capture rate may be due to the season during which this study was conducted (D'Cruze et al., 2006).

Traps were exceedingly difficult to set due to the thin soil and large number of rocks. This difficulty resulted in several lines being very poorly set, and this too is thought to have influenced our results.

12.4.6 Typhlops sp.

We found a single individual of a burrowing snake of the genus *Typhlops* in an area of undisturbed forest (category 2), at S 24° 44.493', E 046° 02.571'. It displays several characteristics that ally it most closely with *Typhlops arenarius* GRANDIDIER 1872 (Glaw &

Trait	***T. arenarius***	***T. boettgeri***	***T. sp.***
Parietals	oblique	transverse	oblique
Occipitals	absent	present	?
Color	uniformly pink, lacking pigmentation	beige above and pink below, dorsal rows faintly pigmented	anteriorly dark pink darkening posteriorly to dark mauve above, and transparent below, dorsal rows pigmented
Lingual Papillae	absent	present	?

Table 12.3 - Table comparing the differentiating traits between *Typhlops arenarius* and *T. boettgeri* as defined by Wallach and Glaw, 2009, with reference to the specimen here found

Vences, 2007) and the recently resurrected *T. boettgeri* MOCQUARD 1905 (Wallach & Glaw, 2009). For example, it possesses 22 scale rows at mid-body (20-22 in *T. arenarius* (Glaw & Vences, 2007) and 20-24 in *T. boettgeri* (Wallach & Glaw, 2009)). Although we were unable to assess its supralabial imbrication pattern (Wallach, 1993), we postulate that it possesses the T-V type which is common to both *T. arenarius* and *T. boettgeri* (Wallach & Glaw, 2009). It is difficult however for us to assign it to either of these species, as it possesses characteristics of both. The comparison of *T. sp.*, *T. arenarius*, and *T. boettgeri* presented in Table 12.3 best summarises these differences and similarities.

The colouration of *T. boettgeri* is not known from live specimens, and it is conceivable that its colouration was mauve prior to preservation, thereby lending more credence to the possibility that this specimen may represent an individual of this species (F. Glaw, pers. comm.). However, unpublished preliminary molecular results on this clade suggest the situation may be more complex (F. Glaw, pers. comm.). Thus, we are hesitant to assign this specimen to either species, and maintain that it may be an undescribed species. This highlights the need for a detailed island-wide molecular study on this clade of poorly known snakes.

Due to the lack of appropriate permits, we were not able to collect this specimen for further study. However, future work conducted in this area will attempt to recover more individuals and include specimen collection (B. Ferguson, pers. comm.).

12.5 Discussion

Anthropogenic disturbance has played a significant role in the distribution and abundance of herpetofauna in Madagascar over the last two millennia (D'Cruze et al., 2006; Vallan, 2003). We recorded greater species richness in relatively disturbed forest (category 5; n=16) compared to relatively undisturbed forest (categories 1 and 2; n=11). A regression analysis revealed there to be no significant correlation between species richness and disturbance level ($P > 0.05$, 4 degrees of freedom, $R^2 = 70.2\%$). However, the high R^2 value and frequent reports of positive correlations between reptilian species richness and disturbance (Irwin et al., 2010; Scott et al., 2006; Gardner et al., 2007) suggest that further study may substantiate this trend.

Analysis of simple species richness, however, does not take into account relative abundance. We noted a pattern similar to that reported by Irwin et al. (2010): we found there to be extremely low diversity in completely deforested areas, dominated by four or five core species: *Mimophis mahafalensis*, *Phelsuma mutabilis* (where trees were still standing), *Tracheloptychus madagascariensis*, *Trachylepis elegans* and *Trachylepis gravenhorstii*. All of these species appear to be generalists, as they were found at a broad range of disturbance levels. However, in disturbed but still identifiably forested areas (category 3 and 4, see Section 15), diversity was relatively high. The aforementioned "core" species were noted to increase in relative abundance with greater disturbance level, while other species became less common and eventually disappeared.

There is a high level of disturbance tolerance (evident by the occupation of a range of disturbance levels) in the species present in the forest. As a consequence, it is conceivable that some disturbance intolerant species may already have been out-competed as anthropogenic pressure has risen. Indeed, this theory is supported by the restriction of only two species to undisturbed forest, both with "Rare" abundance: *Typhlops sp.* and *Dromicodryas berneiri*. However, to validate this hypothesis, comparisons are needed with nearby forests of greater and lesser integrity. Furthermore, long-term and wet season studies are needed to reveal if this is a pattern caused by the forest degradation, habitat heterogeneity (Carignan & Villard, 2002), or naturally low abundances during the dry season; or, indeed, a consequence of sampling bias.

Chameleons and gherrosaurs were absent from areas of undisturbed forest (minimum category 3), although it is likely that chameleons in undisturbed forest were overlooked due to their cryptic nature, and also because no night searches were performed in undisturbed forest. Furthermore,

D'Cruze et al. (2009) report finding *Furcifer verrucosus* in aestivation, buried in shallow soil during the dry season. Such behaviour would influence the observation likelihood of these lizards, and once again stresses the necessity for surveys during the wet season. In contrast, skinks and geckos seem to show no preference for habitat integrity. This suggests that disturbance tolerance may be linked to physiology, morphology and/or diet. Determining which of these factors is most significant, however, will require further research.

Hecnar and M'Closkey (1998) revealed skink prevalence in a Canadian forest to be related to the availability of decaying shelter. By disassembling several decaying logs, we found numerous *Trachylepis* skinks, suggesting a similar effect may here be observed. Any naturally occurring logs lying near the edges of the CDU forest are used in construction or as firewood within the village, so refuges are lacking. Thus a decrease in skink abundance with greater disturbance may at least be explained directly by human activity. This effect is, however, limited to the skinks, and other distribution patterns require alternative explanations.

We consider deforestation for the purpose of construction and collecting fallen logs for firewood to be the most threatening on-going anthropogenic pressure on the forest (D'Cruze et al., 2009). Although the effect of this disturbance may be subtle and therefore not directly apparent from our restricted data, logging of the forest will eventually lead to its disappearance if it is not given time to recover. We consider this to be a greater threat to the herpetofauna than the practice of *hatsake* because it is sanctioned by conservation initiatives for use in CDU forest, while *hatsake* is outlawed (see Section 7.3; Ferguson, 2011a). Additionally, although relatively few spiny forest herpetofauna are targets for the international pet trade, the threat to *Astrochelys radiata* is still fairly high (see Section 13 for full discussion).

It is clear that anthropogenic changes to the forest are affecting species composition within it. Whether this activity is sufficiently detrimental to reptile populations to justify the further imposition of resource restrictions in this area, however, remains uncertain. The people of Kobokara and the surrounding hamlets rely on the CDU forest to sustain their livelihoods. Nonetheless, if this site represents the only remaining refuge for the potentially new *Typhlops sp.* reported here, it would be worth seeking alternatives, or imposing additional restrictions regarding land use. Thus, there is a need to survey the nearby forests, particularly those to the north of the Ikonda River, and to the east of the Mandrare River, for this and other potentially new species with highly limited distributions. Additionally, wet season studies are desperately needed in this area, as current information on the herpetofauna of the Mandrare River valley is derived almost exclusively from data collected during the dry season.

12.6 Changes to Methodology

Although we had originally planned to have a short (five day) deployment period of three simultaneous lines of pitfall traps (Scott et al., 2006), the difficulty involved in digging in each line meant that only two lines could be running at a time, and they had to be staggered in their deployment. They were therefore allowed to run for a longer period. This is not out of the ordinary for pitfall trapping however (Raxworthy & Nussbaum, 1994), and we do not therefore believe that it caused significant bias in our data.

The design of this research was performed outside the field, before we had experienced the forest. During the pilot phase, it quickly became apparent that stratifying by two different forest types (High Spiny Thicket and Low Spiny Thicket after Miller, 2008; see Section 14) was not possible, due to the contiguous nature of the forest, the absence of low spiny thicket, and the inability to distinguish habitat types from the satellite imagery available. Thus, stratification was limited to more and less disturbed based on the density of forest visible from satellite imagery. When we arrived at the randomly selected sites, we adjusted their location to more appropriate

forest for the stratification level and to avoid rocky terrain where it was impossible to dig. We acknowledge that this likely introduced some sampling bias, but it was nevertheless necessary.

During the design of this research, we proposed the use of foam covers on trees, following Bell (2009), to find sheltering geckos. We did not however utilise this method, despite having the required resources, as the time requirement was impractical. Also, the thorny nature of the trees does not lend itself to this study. Furthermore, this technique has been applied to a nearby area of forest, with limited success (O. Theisinger, pers. comm.; Morton et al., 2010). Nonetheless, in order to gain a more complete idea of the local herpetofauna, we suggest future monitoring efforts utilise this method.

Making holes in buckets presented several issues. Firstly, the unusually large amount of rain we received, and the poor absorption of the surrounding soil, meant that they were rapidly made redundant, and still were found full of water after one night. Secondly, the enthusiasm with which our guide made holes led to several buckets being destroyed. Thirdly, trapped fossorial lizards easily crawled through even small holes, and this undoubtedly led to several escapes. Thus, we advocate the use of a drill in making holes, and creating holes not just in the base of the bucket, but also in its side, to facilitate better drainage. The use of rocks instead of the leaf litter as proposed by Scott et al. (2006) further aids in this respect, as it provides an elevated point for trapped subjects to avoid drowning, and does not clog the holes.

Our proposed research included the use of funnel traps in conjunction with the pitfall traps, as advocated by several studies (e.g. Greenberg et al., 1994). However, we were unable to purchase appropriate material out of which to construct such traps in the field, and this plan was therefore abandoned.

12.7 Recommendations

Our greatest recommendation is that research be performed in this area during the wet season. The majority of research on the Mandrare Valley has been carried out during the dry season, as it coincides with northern hemisphere summer and therefore has inherent convenience for university expeditions and volunteering organisations (e.g. Morton et al., 2010; Rowland et al., 2010; Martin et al., 2001; Cain et al., 2003). This bias means, however, that current management schemes are based almost entirely on dry season data, which has only limited applicability to the wet season. Thus, wet season studies will have a much greater impact on management and conservation than further dry season studies.

Additionally, where possible, all herpetological researchers should strive to acquire collection permits. Although export permits can be difficult to acquire, collection permits at least permit the documentation and preservation of potentially undescribed species, thus allowing future work to investigate the findings. Future research efforts in this area will attempt to recover and collect a specimen of the *Typhlops* species found on this expedition, so that its identity can be confirmed.

We also recommend future initiatives to survey amphibian diversity within this area be conducted, during both the dry and wet seasons. Amphibians are widely considered to be more susceptible to environmental changes than reptiles (Irwin et al., 2010; Andreone et al., 2005), and therefore may be important bio-indicators in this region, particularly in gallery forest and other riparious habitats, where their vocalisations may be heard year-round. Several areas near Kobokara harbour permanent moisture, and therefore may be centres of diversity for this region.

In conjunction with the efforts to sample amphibians, we also suggest future researchers make a concerted effort to conduct more comprehensive searches at night. We were regrettably unable to conduct many night searches due to limited manpower and logistical complications, and several nocturnal species may therefore have been overlooked.

We propose further research efforts be focused in this area in order to add to the current inventory of species, and to better understand the effect disturbance is having on reptilian species

composition. Furthermore, we propose *Dromicodryas bernieri* be investigated for use as an indicator of habitat intactness, as this species appears to be restricted exclusively to undisturbed areas of this forest. However, our limited knowledge of their ecology at present does not make them ideal subjects (Carignan & Villard, 2002). Thus, we stress the need for further research, in the pursuit of a more suitable indicator, or greater knowledge on these seemingly elusive snakes.

Studies investigating the effects of a wider and more clearly defined range of disturbance parameters (e.g. size of disturbed area, time since disturbance, type of disturbance), and in the full range of local habitats, including riparious forest (D'Cruze et al., 2009; Scott et al., 2006), should be conducted to form a better picture of the specific effects of different practices in order to facilitate targeted conservation efforts (Scott et al., 2006). Furthermore, it is important that villagers be made aware of the impacts they are having on their local fauna, in an attempt to rationalise the conservation initiatives they are subject to (Scott et al., 2006).

Pitfall trapping is riddled with pitfalls (Enge, 2001), and their convenience should be weighed against their failings. They are ineffective at sampling range-restricted species, species with a high rate of trap avoidance, or species that are strongly linked to weather conditions (Crosswhite et al., 1999). Thus, it is important that they continue to be implemented in tandem with other monitoring methods.

There is a global demand for an effective method for the monitoring of fossorial herpetofauna. Although several studies have found raking to be effective where substrate is loose or sandy (Kuhnz et al., 2005), this is not possible in the spiny forest due to its thin and rock-ridden soil. Additionally, several studies have noted that the use of cover-boards (a commonly used alternative to raking) is an ineffective method for monitoring fossorial herpetofauna (Theisinger, pers. comm.; Kuhnz et al., 2005). Because of the prevalence of fossorial herpetofauna in spiny forest habitat, and the difficulty of studying them, progresses in this field may yield a large number of new species.

Finally, we recommend the implementation of funnel traps as described by Greenberg et al. (1994). We were unable to implement these traps on this expedition, but their usefulness has been well established in snake surveys, including fossorial species (Greenberg et al., 1994; Durso et al., 2011; Enge, 2001). Indeed, we noted that large snakes, in excess of 30cm in length, were able to enter and exit buckets at will, and were therefore un-sampled by the pitfall traps. It is therefore likely that funnel trapping will reveal species missed by our surveys.

13 TORTOISE SURVEY

MATTHEW MAY, MIANDANARIVO RAKOTOMALAZA, MARK SCHERZ

13.1 Abstract

Madagascar harbours four species of endemic and critically endangered tortoises. Amongst these is the charismatic Radiated Tortoise, *Astrochelys radiata*. The Ifotaka North Protected Area represents a significant step towards the conservation of this species at the northern extent of its range. However, in order to gain insight into its status within the region, monitoring efforts must be undertaken. We here report the first survey on the status of this tortoise in the Kobokara area of the Ifotaka North Protected Area. We recorded 35 individuals of the species *A. radiata* over 32 days of survey work. A total population of 55 tortoises was estimated for the 5.19 km^2 area, and continued threats to their survival were identified by conducting interviews with the local population. Unsuccessful attempts were made to identify the genetically distinct population by recording 39 morphometric measurements as pioneered by Rioux Paquette & Lapointe (2007). We highlight the need for improved understanding of the ecology of these tortoises, and make suggestions for future research, monitoring and conservation efforts within the area.

13.2 Introduction

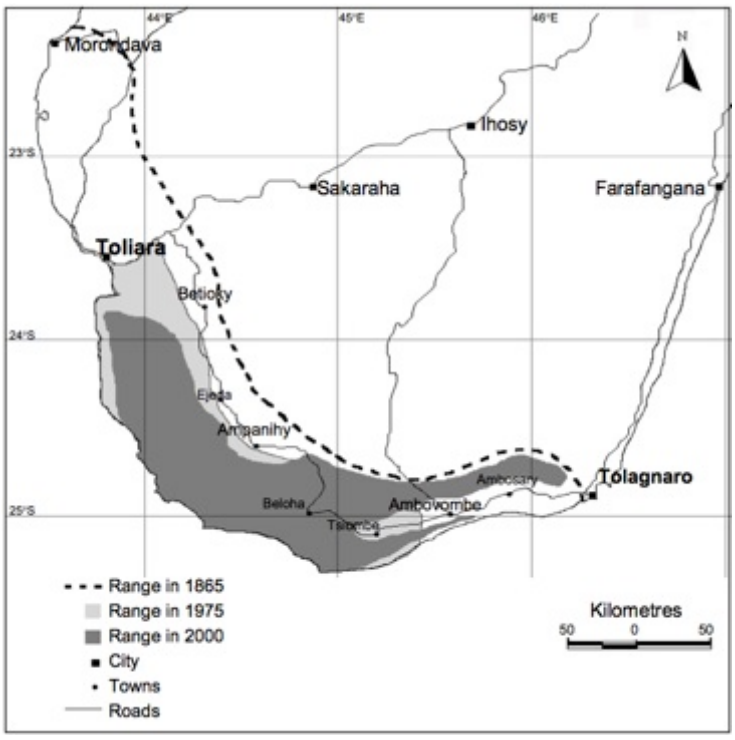
The radiated tortoise, *Astrochelys radiata*, formerly *Geochelone radiata* (Figure 13.1), is one of four chelonian species endemic to the island of Madagascar (Pedrono & Smith, 2003). First described in 1802 in southern Madagascar, *A. radiata* are predominately found in areas of dry spiny forest that are dominated by Didiereaceae and *Euphorbia* (Durrell et al., 1989; Pedrono & Smith, 2003), but they have been reported to be present on high inland plateaus and costal sandy dunes (Leuteritz et al., 2005; see Figure 13.2).

Figure 13.1 - ***Astrochelys radiata***

Tortoises are susceptible to disturbance, although this threat is secondary to the risk presented by exploitation (Irwin et al., 2010; Leuteritz et al., 2005). It is known that hunting and the trade in bushmeat and pets is a major source of the decline in numbers of *A. radiata* (Lewis, 1995; Behler, 2002; O'Brien et al., 2003). Additionally, *A.radiata* is under threat from the changing lifestyles of a growing human population, which has more than doubled in the past 36 years (CIA, 2012). In order to access further fertile lands, people living in rural southern Madagascar have increasingly been practicing *hatsake* (van Vliet et al., 2012), which causes wholesale destruction of tortoise habitat.

According to the International Union for Conservation of Nature (IUCN), available information indicates that this species has disappeared entirely from approximately 40% of its past range, from a combination of habitat loss and exploitation (Leuteritz & Rioux Paquette, 2008). Remaining populations continue to be exploited, predominantly for domestic consumption (O'Brien, 2002). An overall population reduction of 80% over two past and one future generation is a conservative estimate, thus qualifying the Radiated Tortoise as Critically Endangered under criterion A4d (Leuteritz & Rioux Paquette, 2008; IUCN, 2001). Population modelling indicates collapse and extinction in a period of on average 45 years into the future, thus meeting Critically Endangered under criterion E (Leuteritz & Rioux Paquette, 2008; IUCN, 2001). Habitat loss rates approach or exceed 80% over the three-generation period, so criterion A4c may also be met (Leuteritz & Rioux Paquette, 2008; IUCN, 2001)

Figure 13.2 - ***Astrochelys radiata*** **distribution.** Source: O'Brien, 2002



The status of *A. radiata* on the IUCN Red list was last assessed in 2008, resulting in its status being upgraded from

Vulnerable which it had held since 1982, probably due to a severe lack of studies in the wild until the late 1990s (Rioux Paquette et al., 2009). *A. radiata* is also listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since 1975. This makes it illegal to conduct any commercial trade with wild specimens, and very difficult to trade in captive-bred individuals (CITES, 2011).

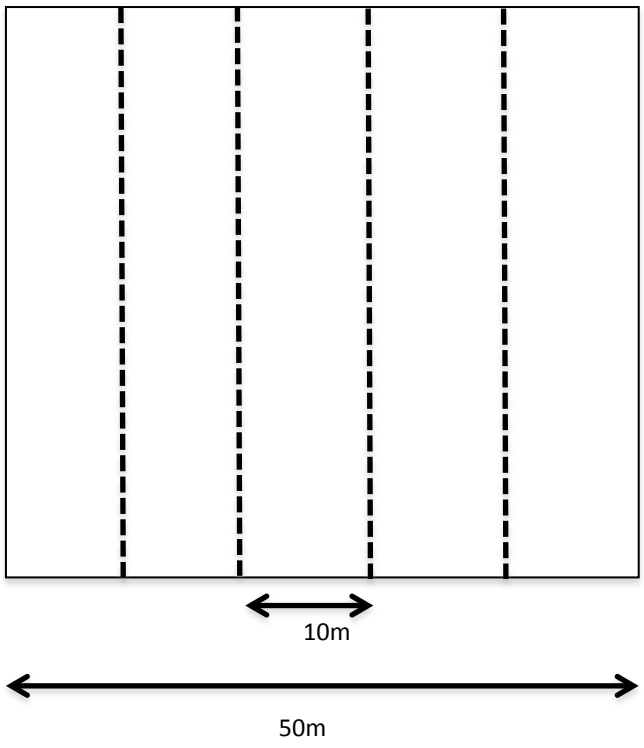
Although the total population of *A.radiata* remaining in Madagascar has been estimated at 4.5 million individuals, which is extremely large for a species classified as critically endangered, it has been reported that between 47,000-60,000 tortoises are being illegally harvested for sale in domestic and international markets (Randriamahazo et al., 2007; O'Brien et al., 2003; O'Brien, 2002). Despite IUCN Critically Endangered status, and being placed on Appendix 1 of CITES, there is still a large illegal market threatening the existence of *A. radiata*. Their international collection has been documented with Asian smugglers collecting tortoises for the pet trade and for their livers (Behler, 2002). Aside from use as food, the Malagasy people often keep the tortoises as pets and in pens with chickens and ducks as a means of warding off poultry diseases (Durrell et al., 1989; Leuteritz et al., 2005).

The establishment of the Ifotaka-North Protected Area is an important step in the conservation of the radiated tortoise at the north-eastern extent of its range. However, its status within the forests of the Mandrare River Valley is largely unknown (Ferguson, 2011a). We investigated the status of *A. radiata* within a 5.19km^2 area of CDU forest within the *fokontany* of Kobokara. We found a total of 35 tortoises in our short study, and conclude that the population within the forest is very small, likely comprising only approximately 55 individuals. We highlight the need for better understanding of the basic ecology of *A. radiata*, and make recommendations for future research, monitoring and conservation efforts in the area.

13.3 Methods

We generated a map using high-resolution satellite imagery available online from the geological surveys conducted of the region by mining companies. The map was divided into a grid of 100m x 100m cells, which were used to randomly select start points for walking transects. Transects were walked by groups of two or more people, separated by approximately 10m. Each transect was walked at a slow pace, taking time to look 5m to either side of each person's transect line, paying special attention to known hiding places of the *A. radiata*, in bushes, under fallen trees, and at the base of large trees (Figure 13.3)

Figure 13.3 - Tortoise Transects. Dotted lines represent the edges of the area searched by each individual.



GPS coordinates were recorded every 50m so that cells could be identified for analytical purposes. Upon discovery of an individual, the time, date, GPS coordinates, and altitude were noted. Each individual was examined and the sex (using the Anal Fork Ratio [fork width:fork depth], following O'Brien, 2002), age (estimated from the number of rings on the 2nd central scute), mass, surrounding habitat and 39 morphometric measurements were recorded as shown in Figure 13.4 (Rioux Paquette & Lapointe, 2007). Tortoises smaller than 270mm

in length were classified as juveniles (O'Brien, 2002).

After recording all required measurements for an individual, each was marked using a unique code created by filing notches in a combination of scutes on the left and right side (Cagle, 1939). Marked tortoises could then be individually recognised. In the event of recapture, the GPS coordinates, time and date would be noted, and this information would be used for Capture-Mark-Recapture (CMR) analysis.

Collected GPS data for captured individuals were used to estimate the populations of *A. radiata* in the forest to the east of Kobokara. By calculating the mean number of tortoise found per 100m x 100m grid cell searched, and then extrapolating to include the total area of the whole forest (5.19 km^2), we were able to attain an estimate of the number of tortoise which can be found in the forest. In order to generate an accurate estimate however, it was necessary to accommodate the detection rate of the tortoise (Durso et al., 2011).

For CMR analysis, we can use the Schnabel equation (Schnabel, 1938; Equation 1) to calculate the population density for the area searched, which can be taken as being the density of *A. radiata* found in the forest to the east of Kobokara.

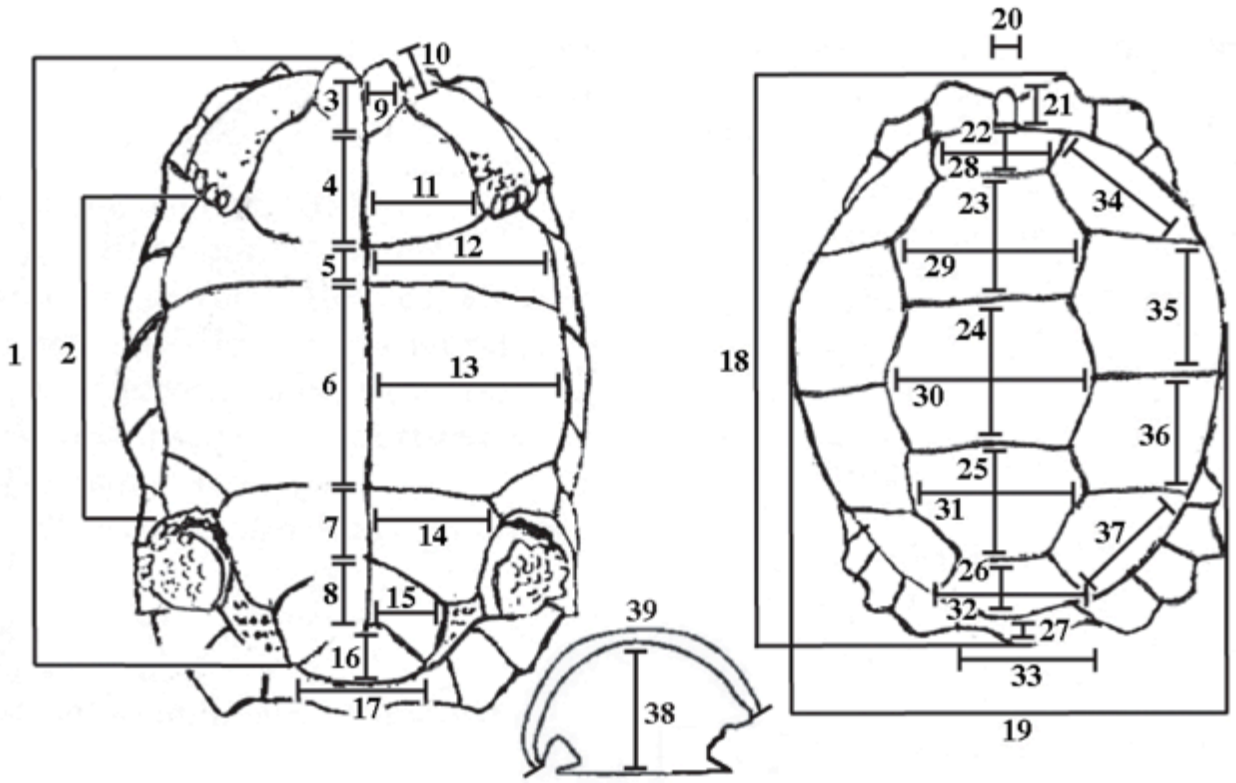
$$N = \frac{(M+1)(C+1)}{(R+1)} - 1$$

Equation 1 – The Schnabel Equation

Where N = number of individuals; M = number of individuals marked on first survey; C = number of individuals captured on second survey; and R = number of recaptures in C.

A selection of 12 people was interviewed from each of 3 villages in the area including Kobokara, across a diverse selection of the population, both men and women of different ages and professions, to find local opinions on the radiated tortoise.

Figure 13.4 - Morphometric measurements taken. For number key see Appendix II. Source: Rioux Paquette and Lapointe, 2007



13.4 Results & Analysis

13.4.1 Population Estimate

To estimate the population size, the total area of the forest to the east of Kobokara was calculated to be 5.19km^2. Transects searches covered an area of 3.29km^2, finding a total of 35 living individuals, and 4 deceased. If we assume a 100% detection rate and equal distribution, we may derive a population density of 10.638 tortoises per km^2, and therefore estimate a total population of approximately 55 individual tortoises in the 5.19km^2 study forest. However, it is highly unlikely that a 100% detection rate was achieved, so this number likely represents an underestimate. It is noteworthy that we found no individuals smaller than 153 mm in total length. This may indicate a detection bias towards larger tortoises, and may therefore contribute yet further to an underestimate of the tortoise population.

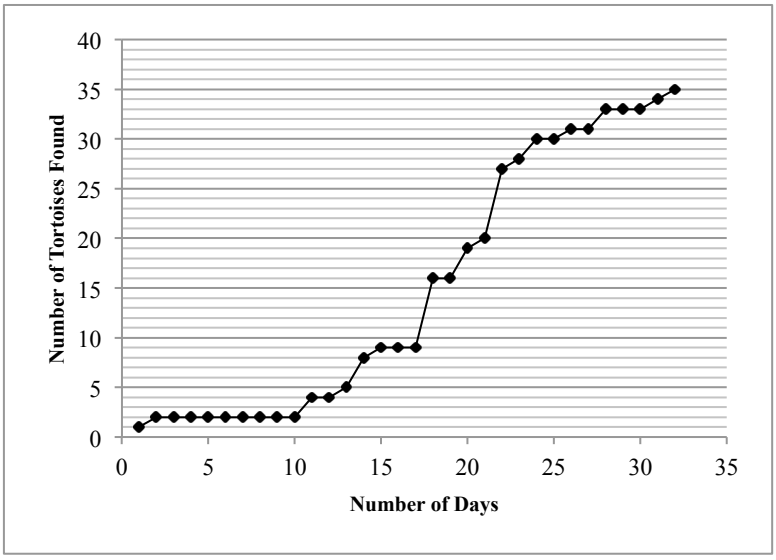


Figure 13.5 - Accumulation curve of tortoises found

We plotted an accumulation curve to find the completion of our survey (Figure 13.5). The accumulation curve clearly indicates that we continued to find many new individuals, even towards the end of the study period. As the majority of the population are recorded, fewer and fewer new individuals will be discovered despite an increasing time of study. This results in the curve plateauing once nearly all individuals have been found.

We recorded a total of 11 male and 6 female adult tortoises, and 14 juvenile tortoises, which cannot be sexed reliably (O'Brien, 2002). This ratio may be a result of sampling bias if there is a behavioural dimorphism between the sexes (Rioux Paquette et al., 2010), or an actual demographic difference. Although we cannot rule out the first of these difficulties, we consider the lattermost to be most likely, as our findings are corroborated by those of Rioux Paquette et al. (2009), who recorded a 2:1 male to female ratio.

13.4.2 Population Density

Unfortunately the length of the study was insufficient to complete a CMR program; only one individual was recorded for recapture, even though a further two were sighted. Miscommunication with other research groups on the project resulted in recapture locations not being recorded, and therefore in the inability to use the data for the study. Population density was therefore extracted by extrapolation, as explained above.

13.4.3 Morphometric Measurements

A table detailing all morphometric measurements collected for individuals can be found in Appendix II. Despite collecting morphometric measurements for 33 of our 35 individuals, we were unable to identify a genetic population for the area based on Rioux Paquette & Lapointe's work (Rioux Paquette & Lapointe, 2007). The data was processed using a complete algorithm provided alongside their paper, but our results prove to be insignificant. Indeed, even our own results were not consistent with each other, and it is impossible to draw any conclusions from the data. This may become possible by using a larger sample group.

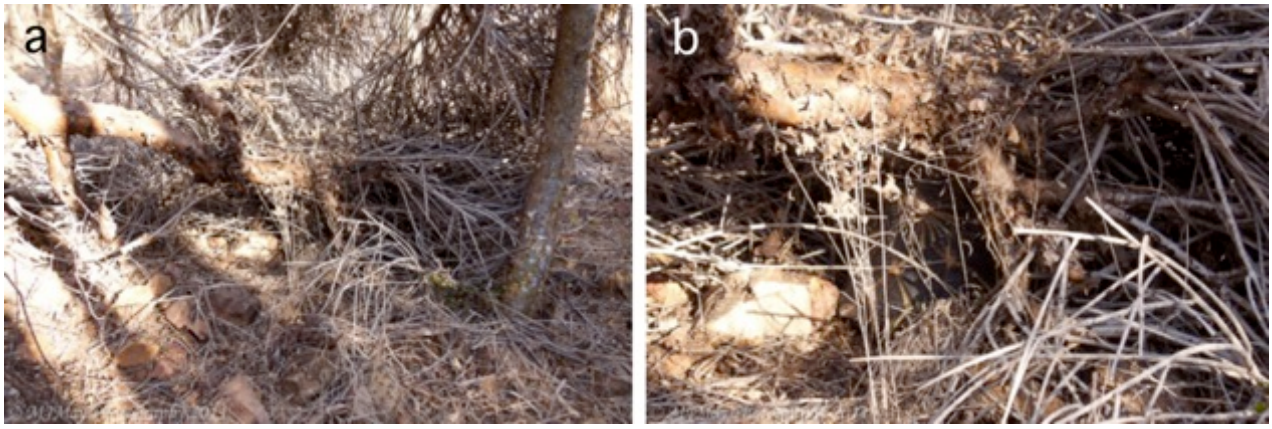


Figure 13.6 - Detection Difficulty. a: typical spotting distance; b: close-up of the detected tortoise. The detection difficulty varied by individual, but was generally high.

13.5 Discussion

Devaux (2010) summarised the available data on the historical distribution of these tortoises, highlighting the decrease in their range over time. Importantly, his summary suggests that the radiated tortoise's eastern range does not stretch as far north as Ifotaka. Additionally, Devaux conducted a study in 2009 that found radiated tortoises to the west of Amboasary to be at low densities, not exceeding 10 individuals per hectare. The furthest east population above 10 individuals per hectare was reported to be 25 km to the south-west of Tsiombe, approximately 110 km to the south-west of Kobokara (Devaux, 2010, p.69).

Our study revealed a population of very low density, with just 0.139 tortoises per hectare. Although this is not a good density, it nevertheless proves the existence of these tortoises, albeit at low concentration, significantly north of their assessed range. If they are found at similarly low densities over a considerable area, their overall population size may be significantly underestimated.

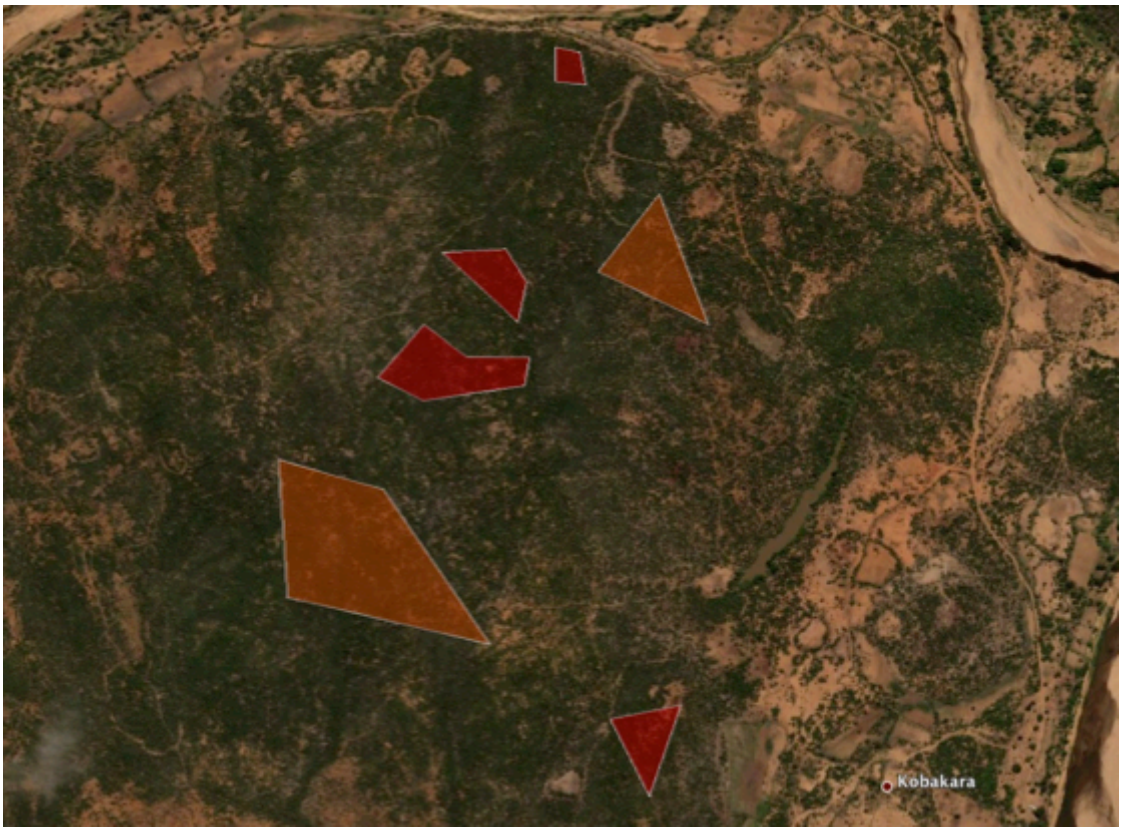


Figure 13.7 - Tortoise Density Polygons. Red = High density; Orange = Moderate density. Image Source = Google Earth® 2012

Although our predictions were that the high levels of disturbance found in the area would result in a low number of tortoises being found, we were surprised to discover that this was not the case. The capture of individuals was spread throughout completely undisturbed, semi-disturbed, and disturbed forest. However it should be noted that fewest tortoises were found in the undisturbed forest.

This may indicate that the tortoises are simply easier to detect in the semi- and disturbed forest, despite living predominantly in undisturbed forest. Indeed, we spent far less time in undisturbed (categories 1 and 2, see Section 15) than more disturbed forest, and sampling bias must therefore be considered to be prominent. Additionally, tortoises were very difficult to detect (see Figure 13.6). This means that we need to find an accurate estimate of our detection rate with which to modify the initially calculated results, to account for sampling bias and detection probability. It is difficult to generalise a grid over the whole area of study near Kobokara, when many different types of terrain were present. One would naturally expect some terrain to be a more suitable habitat for tortoises than others. Some indication of this is shown in Figure 13.7, which shows high-density areas of tortoises in red and areas of moderate density in orange. It is noteworthy to compare these density polygons with the disturbance distribution shown in Figure 15.1b. Those areas of highest density do in fact occur in the least disturbed areas of forest.

The observed 1.83:1 male to female sex ratio is concerning. If this ratio is not a result of sampling bias, it may suggest a limited recovery potential for the population at large. It is conceivable that the reason for this ratio may be a result of tortoise harvesting, for which the largest tortoises (females) are typically selected (Rioux Paquette et al., 2009; Leuteritz et al., 2005). Regardless of the cause, this observation is worthy of further investigation, as the pattern of male population dominance in *A. radiata* has, as yet, not been explained (Rioux Paquette et al., 2009). To address this curious observation, we advocate studies conducted in the middle or at the end of the wet season (January-March); during this period, the eggs of *A. radiata* hatch (Leuteritz & Ravolanaivo, 2005). Taking genetic samples from a significant hatchling sample, and thereby sexing them, may reveal whether the sex ratio is natural, or a result of negative selection on females, of natural or human cause.

Conducting wet season studies on hatchling demographics will determine whether this ratio is present in post-natal tortoises, but the underlying cause would still be unclear; if these tortoises, like almost all other chelonians (Bull, 1980), utilise environmental sex determination (e.g. Valenzuela & Janzen, 2001; Janzen & Paukstis, 1991; Spotila et al., 1994), the bias could be a direct outcome of environmental changes. Thus, the effect of environmental stimuli on sex ratio in *A. radiata* is in need of study, before results of hatchling studies may be thoroughly interpreted.

In addition to using transect searches to learn about the population of *A. radiata* in the Kobokara region, interviews were conducted with a diverse selection of the local communities. It is apparent from these interviews that the popular view is that the local population of radiated tortoises is on the decline. Despite the species having a protected status for many decades, they continue to be hunted to be eaten, their carapace used for jewellery, and more recently exported for the foreign pet trade, with a growing interest from East Asia. This species is in drastic need of some intervention to prevent its extinction; it took 3 weeks of transect searches in the field to find more individuals in the wild than had been seen in kitchens of various restaurants since our arrival in Madagascar. However, as with any nation, developing or more developed, people will only change their way of life if a better alternative is presented to them; it is not practical or even feasible to imprison tens or hundreds of thousands of people who do not respect laws imposed on them by their own or other governments, restricting practices that were previously acceptable and widely practiced. Education is needed, to teach the people why the tortoises are in need of conservation, and how they can help.

The future of *A. radiata* in this area is uncertain. Although the tortoises are protected from local consumption by *fady* (taboo), which dictates that they may not be eaten, they are still at threat from a variety of sources. The *fady* does not prevent the tortoises from being touched, so they are often hurled out of fields when they are found, resulting in shell fractures and ultimately death in many individuals (M. Scherz, pers. obs.). Furthermore, this *fady* is restricted to the Antandroy people, and the tortoises face an increasing threat from migrating individuals from neighbouring ethnic groups who consider tortoise flesh to be a delicacy (O'Brien, 2002).

The imposition of IUCN and CITES listings have only limited bearing in rural Madagascar. This is unsurprising, as the distance from power-bearing authority is significant. We were surprised, however, to learn that individuals (who shall remain anonymous) with ties to the WWF were fond of tortoise flesh, and oblivious to the illegality of its consumption. If rural people see the restrictions on consumption as a power play, restricting these delicacies to the lawmakers, the protection of these critically endangered tortoises will remain ineffective.

The status of the radiated tortoise in Kobokara is somewhat worrying. The Mandrare Valley lies at the north-eastern extent of its range (Figure 13.2; Rioux Paquette et al., 2010). At peak density, these tortoises are reported to exceed 1500 individuals per km^2 (O'Brien, 2002). A mere 10.6 per km^2 is, therefore, meagre. This area is under considerable anthropogenic pressure, and the CDU forest in which this research was conducted is rapidly declining in quality (see Section 15). Management schemes like those suggested in the Section 15.5 would doubtless be beneficial to the status of *A. radiata* in these forests. However, this area of forest represents only a very small portion of the Ifotaka-North Protected Area. Further studies on its status, particularly to the north of the Ikonda River in the ZdC, would be extremely beneficial in order to generate better informed management and conservation schemes.

13.6 Changes to Methodology

After our two-week pilot study yielded very few results, it was decided that in addition to scientific research into the population of the *A. radiata* in the region, a social study would also be adopted. This informal method of assessing the trend of tortoise populations was beneficial, and should be adopted by a larger number of studies, as it is unlikely that foreign teams can become as familiar with tortoise populations over a short study period as local people become over their whole lives, despite their obvious fondness for skewing reality.

Initial plans for the tortoise study suggested working as a team with the herpetology research team, so that we could assist in laying pit traps and we could have an increased manpower for tortoise surveys. However it soon became apparent that we needed to cover very large areas of the forest for our surveys and this was impractical given the amount of time required to be around the pitfall traps. This loss of manpower caused a significant decrease in our detection rate, which was unfortunately not consistent throughout the course of the study. Each day when a large number of tortoise were found, e.g. day 11 and day 16 when more than 5 new individuals were found, we had a work force of at least 4 people.

13.7 Recommendations for future studies

The lack of available manpower had a detrimental effect on this project, as such a small area was searched, and the area that was searched had a low rate of detection. Although in theory a 10m wide transect seemed very achievable, in practice it was far too much, especially in areas of little disturbance, but also in semi-disturbed areas. This could be solved in the future by employing local people to help search transects.

As previously mentioned, we advocate further studies, particularly to the north of the Ikonda River in the ZdC of the Kobokara section of the Ifotaka-North Protected Area. This large area of forest has not yet been subject to any tortoise surveys, but several individuals informed us that it

was a good area in which to search for tortoises. This forest is evidently also under increasing anthropogenic pressure, judging by circles of forest clearance that have appeared in the last five years on Google Earth®. However, its more protected status should mean that it might remain a refuge for these tortoises, even after the almost inevitable disappearance of the CDU forest, which was the subject of the present research.

Finally, the sex ratio conundrum remains unaddressed, despite the observations of Rioux Paquette et al. (2009). It is of particular interest however, and demands further study. It is surprising that this topic has, as yet, gone unstudied in a critically endangered species, for which several breeding initiatives, (e.g. Behler & Iaderosa, 1991), are in place. These studies would shed light on an important topic in the conservation biology of *A. radiata*.

14 BOTANICAL SURVEY

MARK SCHERZ, MORULLA TAPIET DANVI

14.1 Abstract

The oldest of Madagascar's many unique biomes is the spiny thicket of the south, which is dominated by a xerophytic flora that is 95% endemic. This forest is under an increasing amount of pressure from a growing human population. The effect of such disturbance on its species composition has, however, not been wholly established. We investigated the relationship between disturbance levels and dominant species composition to show that herpetological surveys were indeed stratified into different disturbance levels within the same habitat. We found this to be the case, and note also a species dominance shift related to disturbance. We therefore conclude that anthropogenic disturbance is altering forest composition, and thus infer that this shift may be related to the shift in faunal composition. Further research is, however, needed in this area. We propose a scheme of active replanting and cactus culls be introduced, as per Section 15.5, in order to mitigate further habitat destruction.

14.2 Introduction

The plants of Madagascar have an extremely high level of biodiversity (Gautier & Goodman, 2003). As has been discussed in Section 7.4.1 above, studies of the plate tectonics of Madagascar have given rise to the prevailing theory that the spiny forest of Madagascar's southern region are its most ancient flora (Wells, 2003). The unusually high level of endemism further supports this theory; with 95% endemism, this region contains the most unique array of Malagasy flora (Wells, 2003). With such high levels of endemism, it is unsurprising that this area represents a significant botanical conservation priority. In order to facilitate conservation efforts, there is a need for updated species lists and further research in this biome (Wells, 2003).

Du Puy and Moat (2003) have shown that substrate strongly influences the species composition of forest in Madagascar (see Figure 7.4). The Mandrare Valley contains ancient lava and basalt formations and harbours a specialised flora as a result (Du Puy & Moat, 1996; 1998; 2003; Ferguson, 2011b). Spiny forest is characterised by Wells (2003) as being composed primarily of plants of the Didiereaceae and Euphorbiaceae families. Fifteen of the plant species found in the Mandrare Valley appear on the IUCN Red List (Ferguson, 2011b; IUCN, 2011b).

The xerophytic succulents that dominate this habitat are well adapted to the harsh climate, maintaining a slow growth rate, and sporting only a limited number of leaves (Ferguson, 2011b). Although there are few species of large herbivores in Madagascar (Viljanen et al., 2010), the majority of these plants are covered in a startling array of spines. This may be attributed in part to their contribution to the diet of the locally endemic lemur species, the ring-tailed lemur (*Lemur catta*), Verreaux's Sifaka (*Propethicus verreauxi*), and the radiated tortoise, *Astrochelys radiata* (see Section 13). Additionally, they provide roosts for several birds and arboreal reptiles.

Livestock too are reliant on their leaves, and the local grasses, as sustenance. The plants also play a large role in traditional medicinal practices, and therefore have intrinsic value to the local people.

14.2.1 The Impact of Disturbance

Plants are directly subject to the anthropogenic disturbance discussed in Section 15 below. Disturbance occurs primarily through three processes: (1) livestock grazing (stratified deforestation); (2) selective deforestation; and (3) *hatsake* (wholesale deforestation). Aside from being extremely destructive to plant-life, all of these processes have secondary ramifications on fauna: livestock graze saplings and low lying foliage which is a main component of the diet of the radiated tortoise, *Astrochelys radiata* (see Section 13); selective deforestation removes integrity which is required for a number of disturbance-intolerant species, and directly removes the habitat of arboreal species, including lemurs, birds and reptiles (see Section 12); and *hatsake* kills or displaces everything in its path. Although *hatsake* presents the greatest threat to the forest, the ban imposed by the government and WWF on its performance has been met with widespread compliance, and it is no longer considered to be a significant risk to this CDU forest.

The wood harvested from the forest is put to a wide range of uses, as discussed in the Section 15.2. Most notable of these are construction and fuel. This pattern is not unique to Kobokara, but widespread across Madagascar (Schatz, 2001). Unfortunately, because of its slow regeneration rate, the spiny forest is at greater danger from human activity than most other biomes.

14.2.2 Prickly Pear and the South

The slow growth of the forest is capitalised upon by invasive species. The most widespread of these are the prickly pear cactuses, genus *Opuntia*, which quickly colonise cleared areas. These cacti are native to South, Central, and southern North America (Kaufmann, 2004), where they encounter similar climatic conditions to those of southern and south-central Madagascar. Indeed, they flourish in the Malagasy climate, despite the lack of their natural pollinators, being instead dispersed by humans (Binggeli, 2003; Kaufmann, 2004). These cacti have been cultivated in many countries across the world, for a variety of purposes (reviewed in Kaufmann, 2004).

Originally introduced as a natural barrier in 1769, *O. monacantha*, a particularly spiny species of prickly pear, was rapidly adopted by the people of southern Madagascar as fencing and cattle fodder (Binggeli, 2003; Kaufmann, 2004). It spread outward from Fort Dauphin, across Madagascar's southern domain, until eventually it represented nearly 50% of the vegetation cover (Binggeli, 2003). The ability of any broken off section, including the fruit, to take root, allowed these plants to spread at an incredible rate (Binggeli, 2003; Kaufmann, 2004).

By 1912, it was clear that something had to be done about the prevalence of this species, in exchange for *O. ficus-indica*, a less-spiny species. And so, in 1924, a scale insect (genus *Dactylopius*) was introduced to southern Madagascar, and within four years, *O. monacantha* had disappeared (Binggeli, 2003). Although this was doubtless an ecologically beneficial move (the dead cacti even providing compost for native species; Binggeli, 2003), it had serious ramifications for the people of the south, who had come to rely on these invasive plants for cattle fodder, and therefore wealth (Binggeli, 2003). Furthermore, the water storage facility of these cacti and their fruit, especially in the moister Androy region (including the Mandrare Valley), made them a valuable source of food and water in times of drought (Binggeli, 2003; Kaufmann, 2004). It was slowly substituted with *O. ficus-indica*, and today this species is dominant, especially along roads, in much of southern Madagascar.

It is uncommon for the history of an invasive species to be so well documented (see Binggeli, 2003, for a comprehensive review). Despite its past, however, there remains little in the way of management schemes and understanding of the modern role of the prickly pear in Madagascar.

Indeed, even Binggeli (2003), who presents what is undoubtedly the best synthesis of the natural history of *Opuntia* in southern Madagascar, fails to address the threat that the modern cactus levels pose to its forests.

14.2.3 Our Research

The botanical section of this expedition was dedicated to an analysis of the taxonomic composition of the areas into which the herpetological research (Section 12) was stratified. In this way, we gain not only an insight into the effect of disturbance on species composition, but also were able to ensure that stratifications used for the herpetological research were all given by relatively similar habitats.

We found a total of 66 species of plant, of which only five are not endemic to Madagascar. We conclude that, despite the lack of statistical support, stratification of herpetological research was sufficiently different to uphold a difference in botanical composition between disturbed and undisturbed areas within the CDU forest. We recommend the implementation of re-planting schemes within this forest to reverse, or at least slow, damage to this forest.

14.3 Methods

Study sites were located immediately around the randomised pitfall trap arrays set up for the herpetological research (n=6), which had been stratified into high and low disturbance, based on satellite-image analysis and preliminary field proofing. Four transects of 50 x 2 metres were studied per site (n=24; see Figure 12.1). All transects were spatially referenced. Data collected included vegetation type, disturbance level (see Section 15), elevation, aspect, slope, % rock cover, % canopy cover, vernacular and scientific name (where possible), height, branch height, and diameter at breast height (130cm).

We generated a list of the recorded species, including vernacular and scientific names, and assessed the most abundant species of plants in disturbed and undisturbed forest. Taxonomy follows the most recent publications, as found on the Catalogue of the Vascular Plants of Madagascar (Missouri Botanical Garden, 2012). We performed statistical analysis on the diversity data in Minitab® 16 to deduce whether the stratification used in the Section 12 was appropriate.

Analysis of the full data set is being conducted by M. T. Danvi, and will be published as a dissertation at CEL in 2012 (M. T. Danvi and B. Ferguson, pers. comm.).

Family	Scientific Name	Vernacular Name	Endemism
Anacardiaceae	*Operculicarya decaryi*	jabihy	E
Apocynaceae	*Pachypodium lamerei*	votanke	E
Asclepiadaceae	*Pentopetia sp*	kompitse	E
Bignoniaceae	*Rhigozum madagascariense*	hazonta	E
	Stereospermum nematocarpum	hiligne	E
Burseraceae	*Commiphora aprevalii*	daronomby	E
	Commiphora mahafaliensis	darosike	E
	Commiphora orbicularis	darotandroke	E
	Commiphora simplicifolia	daronomby	E
	Commiphora sp	darobe	E
Capparaceae	*Boscia longifolia*	somangipake	E
Combretaceae	*Combretum sp*	vahe	E
	Terminalia divaricata	taly tivoke	E
	Terminalia fatraea	fatra	E
	Terminalia neotaliala	taly hazobe	E
	Terminalia sp	kobay	E
Didieraceae	*Alluaudia dumosa*	rohondroho	E
	Alluaudia ascendens	sogno	E
	Alluaudia dumosa	rohondroho	E
	Alluaudia humberti	sognombarike	E
	Alluaudia procera	fantiolotse	E
Ebenaceae	*Diospyros humbertiana*	maintefo	E
	Diospyros humbertii	maintefo	E
Euphorbiaceae	*Croton barorum*	somoro	E
	Croton geayi	andriambolafotsy	E
	Croton sp	hazomby	?
	Euphorbia alluaudii	befoetre	E
	Euphorbia plagiantha	fihagne	E
	Euphorbia stenoclada	mozotse	E
	Euphorbia tirucalli	famata	NE
	Securinega capuronii	hazomena	E
Hernandiaceae	*Gyrocarpus americanus*	sirosiro	E
Leguminosae	*Albizia tulearensis*	mendoravy	E
	Bauhinia pervilleana	farohiosy	E
	Dichrostachys unijuga	ambilazo	E
	Vaughania cloiselii	hazombatango	E
	Mimosa delicatula	kirava	E
Meliaceae	*Malleastrum gracile*	mosesy	E
Passifloraceae	*Adenia sp*	hola	E
Ptaeroxylaceae	*Cedrelopsis grevei*	katrafae	E
Salvadoraceae	*Azima tetracantha*	filofilo	NE
	Salvadora angustifolia	sasavy	NE
	Salvadora sp.	sasavy	?
Sapindaceae	*Allophylus bojerianus*	kaleogne	E
Grewiaceae	*Grewia androyensis*	tabarike	E
	Grewia cloiselii	sely	E
	Grewia sp	taolankafotse	?
Urticaceae	*Obetia madagascariensis*	mia	E
Urticaceae	*Pouzolzia mandrarensis*	lahivozake	E
Verbenaceae	*Clerodendrum emirnense*	taikoakembato	E
Unknown	Unkown	fandreadambo	?
	Unkown	saresambo	?
	Unkown	bemangefo	?
	Unkown	famoegne	?
	Unkown	fandreandambo	?
	Unkown	fatikakoho	?
	Unkown	hafoja	?
	Unkown	harofy	?
	Unkown	lamotindolo	?
	Unkown	magnendrake	?
	Unkown	menateza	?
	Unkown	remote	?
	Unkown	somiandra	?
	Unkown	tsivoantolake	?

Table 14.1 - Plant Species Inventory E = Endemic; NE = Non-Endemic

14.4 Results

A total of 2258 plants, belonging to 64 species were recorded from the 24 transects (see Table 14.1). Two species of *Opuntia* cactus, *O. ficus-indica* and *O. stricta* were also observed, thus bringing the species number to 66. These represent 51.97% of the species known from the Mandrare Valley (n=127) according to Ferguson (2011b). The vernacular names of all species were noted, but we were unable to deduce the scientific names of 14 species. Overall, *Cedrelopsis grevei, Alluaudia ascendens, Commiphora mahafaliensis, A. procera,* and *Rhigozum madagascariense* were the most abundant species, in descending order.

Rank	Disturbed	Undisturbed
1	*Cedrelopsis grevei*	*Alluaudia ascendens*
2	*Alluaudia procera*	*Commiphora mahafaliensis*
3	*Alluaudia ascendens*	*Commiphora orbicularis*
4	*Euphorbia tirucalli*	*Cedrelopsis grevei*
5	*Rhigozum madagascariense & Commiphora mahafaliensis*	*Securinega capuronii*

Table 14.2 - Dominant Species in Disturbed and Undisturbed forest (Total Relative Abundance)

The most abundant five species in undisturbed and disturbed forest are listed in Table 14.2. Statistical analysis of the abundances of different species revealed there to be no significant difference between disturbed and undisturbed forest (Mann-Whitney U Test; $U_{14} = 119$; $Z = -0.25$; $P > 0.05$). The order of species dominance evident from Table 14.2 is, however, striking enough that we consider these categories to be sufficiently distinct for the purposes of the herpetofaunal study, yet sufficiently similar that they may be considered to be the same overall habitat.

14.5 Discussion

With over half of the known plant species of the Mandrare Valley present, the CDU forest at the edge of Kobokara has significant levels of plant diversity. Only three (6.38%) of the species we were able to identify taxonomically to species level on transects are not endemic to Madagascar, and only two species we recorded are certainly introduced (*Opuntia spp.*). Thus, despite the level of anthropogenic disturbance, this forest has thus far been somewhat resilient to human activity.

Nonetheless, a shift in species composition of the forest is noticeable from areas of undisturbed to areas of disturbed forest. The prevalence of specific species, such as *Cedrelopsis grevei* and *Alluaudia procera* increases dramatically, while *A. ascendens* decreases in prevalence, and *Commiphora mahafaliensis* and *C. orbicularis* nearly disappear. Such an overturn is likely to be linked with a shift in the availability of various resources, including shelter sites and insect food for reptiles, small mammals and birds, and therefore may well underlie the observed shift in herpetofaunal species composition. It is noteworthy that many species do not vanish from one disturbance level to another but rather shift in prevalence, as this pattern may explain the ranges of disturbance tolerance observed in many reptile species (see Section 12.5). This pattern has also been studied in other forests in southern Madagascar (Denton, 2003).

As has been mentioned in Section 12, the role of plants in the ecosystem of this forest does not cease once the plants die; the fallen husks of trees provide shelter for a great many forest-dwelling species, including the Critically Endangered *Astrochelys radiata*. Thus, permitting the removal of fallen logs may prove just as detrimental to the forest's ecology as permitting tree felling.

14.5.1 A Prickly Situation

The lack of prickly pear (*Opuntia spp.*) from transect data is a result of the stratification method used for the herpetological surveys, which ignored edges (see Section 12.3). Although these plants are prevalent in areas of human habitation, and at the edges of habitats, they were only observed to penetrate some 20-30 metres into the forest, and therefore were avoided by stratification. Thus, it

is evident that these cacti are not responsible for the loss of forest integrity; rather, they are amongst the first to capitalise on human disturbance. This pattern is, no doubt, helped by the role of these water-bearing plants in the diet of local livestock, particularly zebu, and their usefulness as a living fence.

The role of the prickly pear is a complex one. From a biological perspective, the *Opuntia* invasion represents a high level of danger to the natural environment. By out-competing endemic plants, it is preventing the passive regeneration of disturbed areas of forest. At the same time, human dependency on this extremely versatile and hardy plant is such that previous (successful) attempts at exterminating it had drastic consequences for the dependent populations (Kaufmann, 2004; 2008). Additionally, it now constitutes a large part of the diet of the radiated tortoise (M. Scherz, unpubl.), and may therefore have earned itself some ecological redemption. However, the cause-effect relationship of this dietary shift has not been studied, and should therefore be investigated, before any action is taken to manage this species.

14.5.2 Future Management

We must stress the need for further inventories and disturbance and habitat research before management schemes can be truly effective in the Ifotaka-North Protected Area. The CDU forest we studied is extremely heterogeneous, and the many microhabitats it possesses no doubt correlate with faunal distributions, which were beyond the scope of the research conducted on this expedition. Such a small area of forest may be best suited to carefully planned "fine-filter management" (Carignan & Villard, 2002), but our current understanding of its ecology is not sufficiently comprehensive to make this possible.

Despite the lack of comprehensive knowledge, we are still able to identify livestock grazing and selective deforestation as the most threatening human activities in this forest. This is to be expected, as the Usage Rights Zone is delimited for these activities. Nevertheless, grazing of zebu in the forest is doubtless correlated with the spread of *Opuntia spp.* into the interior of the forest. We therefore propose active replanting of the forest, coupled with *Opuntia* culls, ideally using the rotation scheme as outlined in Section 15.5.2, below. Volunteering organisations similar to OpWall could be extremely beneficial in this context, and provide a good source of enthusiastic labour.

14.6 Changes to Methodology

The changes to the botanical research occurred as a result of the changes that were made to the herpetological research. Most significant of these was the use of just six sampling sites, when our proposal had laid out twelve. Our dataset is thus of small size, and our interpretations of the effect of disturbance on species composition may therefore be affected by sampling bias.

15 DISTURBANCE SURVEY

MARK SCHERZ

15.1 Abstract

The people of rural Madagascar depend heavily on forest resources to sustain their livelihoods. This relationship has unfortunate ramifications for the forest in question, as it feels the strain of an increasing population's demand for more wood and livestock fodder. This relationship in the Antandroy region of southern Madagascar, where livestock represent wealth, is clearly evident, and yet the effect it is having on the forest is poorly understood. We conducted surveys on an area of spiny forest, which has been subjected to significant pressure from local people, to gain an insight into the distribution and cause of habitat degradation. We found a permeating, low level of disturbance in this forest, with a trend of decreasing disturbance levels towards its centre. By analysing satellite data, we reveal that the disturbance levels have increased significantly in the last seven years. We conclude that the edges of the forest are at greatest risk from anthropogenic disturbance, while the centre retains some nearly intact forest. We suggest a rotating management scheme, coupled with re-planting and cactus culls, be implemented to minimise further damage to this forest, and attempt to slowly restore its condition, so that it can continue to be utilised by local people.

15.2 Introduction

The people of Kobokara use a great deal of wood. It is used to construct their houses, cooking and storage huts; in their furniture; as fuel; and it is used in the construction of their carts for transportation. Their dependency on the forest as a source of wood cannot be refuted. And yet, as one might expect, they utilise this forest with little heed to its fate, thereby endangering their own long-term survival potential.

Human interactions with forests are historically destructive. It is to humans that we attribute the rapid disappearance of forest across most of the world. In Madagascar, this trend has been stronger than most, with 85% of the forest disappearing in the last half century (de Wit, 2003). The trend of forest destruction is of course correlated with the disappearance of forest-dwelling animals, especially those that are specialised to specific environments (see Sections 12 and 13). This threat is greater than that posed by climate change, which has received far greater attention in the media, but both are closely related, as the prevailing opinion retains that forest destruction is causing an increased rate of climate change (Corlett, In Press).

Even when forests are not completely eradicated, human activity has been noted to cause drastic changes in their biological composition (Sprugel, 1991). Disturbance of this nature can be subtle, leading to a simple overturn of a few key disturbance-intolerant species (e.g. Sprugel, 1991; Denton, 2003; Jenkins et al., 2003); or drastic, leading to a completely different faunal composition, the disappearance of multiple keystone species, and, in extreme cases, ecological collapse (e.g. Ellison & Farnsworth, 1996; see Sprugel, 1991). Secondary forest is of lower conservation priority than primary forest, but it is still important to conserve, if only because it retains some potential to be restored to pseudo-primary forest (Irwin et al., 2010).

Clearly there is a spectrum of disturbance, from subtle changes that have no noticeable effects, to areas that are no longer recognisable as forest. Despite the importance of an understanding of the way in which this occurs, there has been very little research conducted in this area (D'Cruze et al., 2009; Scott et al., 2006). Miller (2008) has perhaps captured the disturbance spectrum in spiny forest most accurately in her Index of Disturbance (see Table 15.1). This uses multiple measures (evidence of grazing, paths/roads and fences, selective logging and burning, invasive species, and forest quality) in an attempt to holistically assess human impacts on forests.

Evidence of Grazing	
Index	**Description**
1	No evidence of grazing
2	Minimal evidence of grazing
3	Increased to high levels of grazing
4	Extensive evidence of grazing

Paths/Roads and Fences	
Index	**Description**
1	No paths, roads or fences
2	1-2 small paths or fences, no roads
3	2-3 small paths or fences, possibly a road
4	More than three paths or fences and roads

Selective logging/burning	
Index	**Description**
1	No signs of logging or burning
2	Several signs of logging or burning
3	Lots of signs of logging or burning
4	Clear cut or burned areas

Invasive Species	
Index	**Description**
1	No species of cactus or sisal
2	Couple of species of cactus or sisal at low frequency
3	Increased population of cactus or sisal, but not dominant
4	Cactus or sisal dominate

Table 15.1 - Miller's (2008) Disturbance Indices

We used the categories of Miller (2008) to judge the disturbance level of a large area of the CDU forest to the west of Kobokara (see Table 15.1). We simplified these measures to create a 1-5 scale on which capture sites for the reptiles studied in Sections 12 and 13 were judged, 1 being undisturbed and 5 being disturbed (see Table 15.2). We present these findings as a spectrum map made in Google Earth Pro®. Using this map, we calculated the area of each disturbance band. We found the lowest area of the forest to be of category 1. Category 3 covers the largest area. There is 6.8 times more disturbed area (categories 4 and 5) than undisturbed area (categories 1 and 2).

We propose a management scheme of total protection rotation be implemented in this forest, to maximise its longevity, whilst maintaining utility for local practices. Additionally, we highlight the need for further, more intensive research in this area using long-term monitoring in order to better understand the effects of interactions between local people and spiny forest in arid Madagascar.

15.3 Methods

We spent a large portion of every day in the forest. We utilised the measures provided by Miller (2008; see Table 15.1), amalgamated into a holistic scale of 1-5 (see Table 15.2). Using these criteria, we assessed the disturbance level of the immediate habitat surrounding all herpetofauna captured and plant transects.

We incorporated these measures into an overview of disturbance based on satellite imagery from 2010 in Google Earth® to model the current levels of disturbance throughout the CDU forest. We then utilised this map to assess the area covered by each disturbance level, and compared these to judge which levels of disturbance are most common. We compared this map to

Table 15.2 - Index of Disturbance

Index	Description
1	Intact forest - no obvious paths, no traces of grazing, and no sign of logging
2	Forest almost intact - few unworn paths, no evidence of recent grazing, few stumps
3	Somewhat Disturbed forest - worn paths, evidence of recent grazing, several stumps
4	More disturbed forest - heavily worn paths, clear signs of recent grazing, multiple stumps, recently felled trees
5	Completely disturbed forest - invasive species present, very broad paths, fresh livestock droppings, clear-felled, or signs of recent burning

another created using the same technique on Google Earth® imagery from 2005 to assess the change in disturbance level throughout the forest in the last seven years.

15.4 Results

The majority of disturbance manifested as logging and the droppings of zebu and goats. Very few sites showed signs of recent burning. Paths were noticeable throughout the forest, though not always initially apparent. Often they were found to follow dry watershed routes, and are therefore likely insignificant in the degradation of the forest, save for the fact that they facilitate access to deep areas by livestock and their herders. Areas near villages were particularly affected by the presence of goats, as they left the ground completely desolate, scattered with hoof-marks and droppings.

The maps based on satellite imagery in Figure 15.1 show a pattern of encroaching disturbance from the edge of the forest. This pattern matches the activity of the local people, who minimise the effort involved in harvesting by taking wood from the most convenient place: the edges of the forest.

In the integrated active study and 2010 satellite footage, we found a pervading, low level of disturbance throughout the forest (see Table 15.3): 71.44% of the forest was given a disturbance rank in excess of 3, while 10.43% had a level of 2 or lower.

By comparing this data to that generated by analysing satellite imagery from 2005, we observe several significant changes. There is a clear increase in the level of disturbance, from just 45.62% of forest falling under categories 4 and 5 in 2005, to 71.44% in 2010. In contrast, the amount of relatively undisturbed (categories 1 and 2) forest has decreased by only 6.74% in the same time period. We note however that the satellite images from 2010 were taken in the middle of the wet season (25th February), while those from 2005 are dated to the 9th of August; the end of the dry season. Thus, it is possible that the amount of foliage on the plants has biased our analysis of the satellite imagery, leading to an underestimation of the prevailing disturbance in 2005.

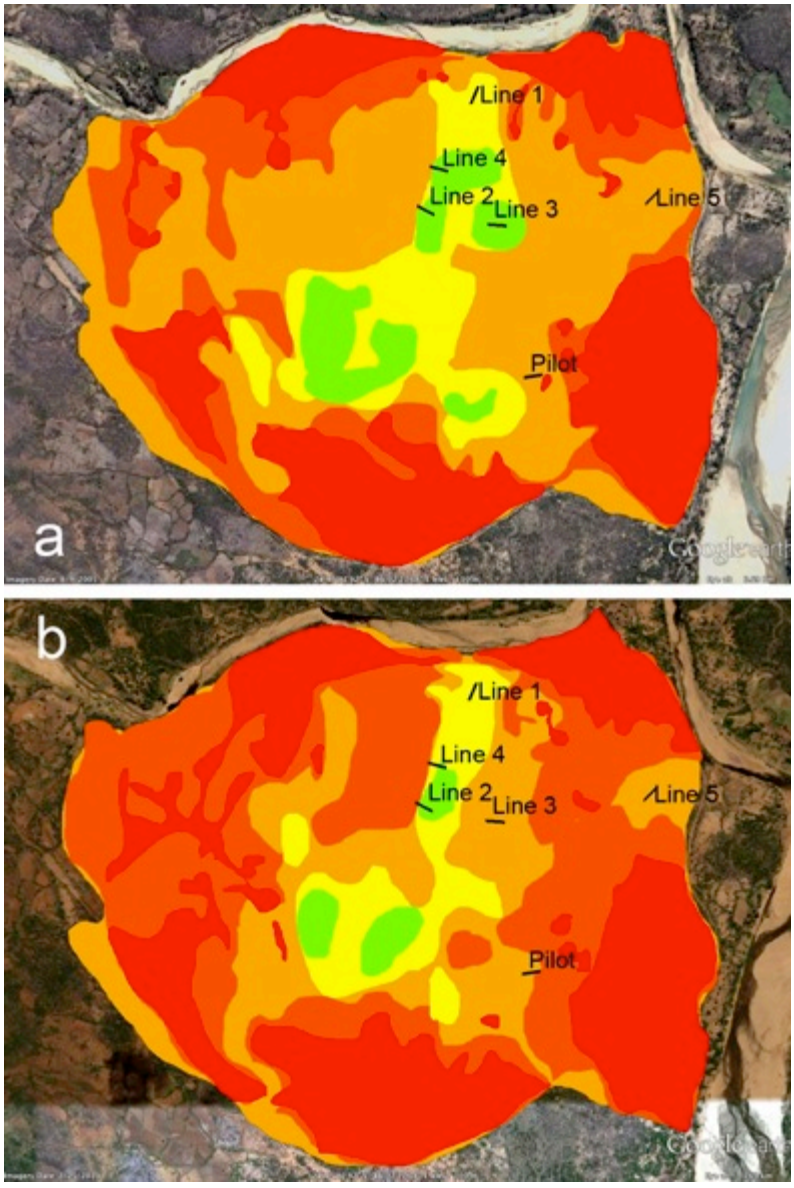


Figure 15.1 - Disturbance shift as evident from satellite imagery in (a) 2005 and (b) 2010. Red = 5, Green =1; 2010 ground-proofed using actual disturbance values. Source: Google Earth® 2012

	2005		2010	
Category	**Area (m^2)**	**Proportion of Area**	**Area (m^2)**	**Proportion of Area**
1	457927	6.05%	177944	2.45%
2	734692	9.70%	579568	7.98%
3	2926937	38.64%	1316162	18.13%
4	1223221	16.15%	2567230	35.36%
5	2232163	29.47%	2619279	36.08%

Table 15.3 - Disturbance Area Comparison

15.5 Discussion

It is clear from our findings that the area of CDU forest to the west of Kobokara is subject to an increasingly high level of anthropogenic deforestation. The increase in category 4 and 5 forest from 2005 to 2011 of 25.82% is concerning. Indeed, given the current trend, we postulate that this forest will be exclusively category 4 and 5 by the year 2040. We attribute the increase in disturbance primarily to the dependence of the local people on goats and zebu as a form of wealth; livestock constantly devour young plants, particularly saplings, preventing regeneration.

It is possible that some areas of this forest are beyond the scope of natural regeneration; the edges of cleared areas are liable to be colonised by *Acacia pervillei*, while the cleared space is often colonised by *Opuntia* cactuses. In these locations, active replanting coupled with *Opuntia* culls may be the only solution to the disappearing-forest problem.

15.5.1 Assessment

Our holistic scale of disturbance classification was not as extensive as that of Miller (2008), and though it was ample for our purpose, there is a need for a dedicated disturbance study in the CDU forests of the Ifotaka-North Protected Area, preferably spanning several years, in order to establish which threats are of greatest concern, and which areas of forest are subject to the most intensive practices. Although we recognise the particularly powerful impact of livestock grazing on disturbance levels, it is conceivable that this activity is only possible in the wake of low-level deforestation, allowing livestock to penetrate the thickest areas of forest.

15.5.2 Future Management

Although it has not been established whether spiny forest can recover from such a high level of disturbance, the slow growth rate of many of the plants (see Section 14) suggests that such recovery may be extremely difficult. We therefore propose further sub-zonation of this forest into quarters, rotating on a five-year basis. By permitting activity in two of these areas per five-year period, the other two are allowed to regenerate. Then rotation occurs, and one of the closed areas becomes open, while one of the open areas becomes closed. In this manner, each area receives ten years of total protection during which to initiate regeneration, and is then subjected to ten years of anthropogenic activity. This should give plants an opportunity to grow large enough to resist casual predation by goats, while at the same time retaining a large area of useable forest.

It is unlikely that a ten-year period of protection will be sufficient to allow for a great deal of growth of the endemic flora of these forests, and we conclude therefore that the protection should be coupled with replanting projects. Replanting of the forest by local people will not only teach them to value and understand their forests, but also encourage them to become more conscientious when considering their forests as a bountiful resource. This must be done carefully however; whilst we were conducting our expedition, an enormous shipment of sapling trees arrived in the village from the WWF. There was confusion as to how the project would benefit the whole community however, and ultimately the saplings went to waste (see Section 16.2). In order to avoid this kind of problem, careful education and supervision is required.

It is of course important to consider the costs and benefits of expending so much energy on the regeneration of the forest, in order to verify the need to do so. It could be argued that this forest has been degraded beyond the possible regeneration point, and should therefore continue to be exploited at its current rate. When this forest is gone however, the local people will turn to one of three options: (1) they may migrate to another area, and continue the destructive cycle elsewhere; (2) they may expand their wood-harvesting range, degrading other nearby forests in the same way as their own (although this would not be possible under the current Ifotaka-North zonation scheme); or (3) they may begin relying upon imports of wood and other forest resources, bush-meat notwithstanding, thereby putting increased pressure on more distant areas. By cultivating such an intimate relationship with the forest, the local people are at risk of running out of resources alternative management schemes are not put into place.

15.6 Changes to Methodology

The changes we made to the disturbance study were a result of the time-consuming nature of the other projects. Spending a large amount of time in the forest searching for reptiles was a slow and harrowing job, but the addition of detailed disturbance notes would have made it an insurmountable task. Instead, we resorted to basic assessment of the forest's status, thereby gaining sufficient data on which to base the maps we created, whilst not jeopardising the success of the parallel projects.

16 Oral Testimonies and NGO Impacts

Natalie Jane Smith

16.1 Methods

16.1.1 Integration

Justine and I were constantly walking around the village making an effort to meet members of the community and share our life stories and pictures from home with them. There were two deaths in the village while we were there, which provided an excellent opportunity for us to integrate with the local community. Justine and I encouraged other expedition members to attend the remembrance ceremonies, and in accordance with local custom, dance and sing for the family of the deceased. Additionally, every Saturday expedition members took turns to teach English to the community of Kobokara, and every Wednesday and Sunday at 16:00h we had a football match, where team members played alongside people from Kobokara. Before leaving we had a party for the whole village with music, dancing, food and drinks. We also organised a raffle to distribute some of the belongings and equipment we did not need to take with us, in an attempt to share it among local people.

16.1.2 Documentaries and Oral Testimony

I interviewed team members, Non-Governmental Organisation (NGO) workers and villagers from Ifotaka, Bekiria, Besely and Fenoaivo, both individually and in groups. In order to document these interviews, I wrote notes, or recorded them using a sound recorder or video camera. The participatory rural appraisal method was used initially when gathering data from the local villagers (Ferguson et al., 1999). This method employs semi-structured interviews to provide qualitative information. Pseudo-random individuals were chosen to avoid biases that may have arisen from selecting particular social groups or genders. I also spoke to the guide we hired about the themes I was interested in, and he recommended people that could be of potential interest for various topics of discussion.

Before beginning any interviews, subjects were briefed on the purpose and background of our research as a team. Permission was sought initially from the local Vice-President to carry out

interviews and to record within the *fokontany* (village). Permission was also sought from participating individuals: to record interviews on the dictaphone, take photographs and to film during interviews. Afterwards, subjects were welcomed to talk about whatever they wished, or ask questions – both on and off the record – and given the option for their data to remain anonymous on any subsequent presentations. The interviews were then reviewed, translated, and transcribed.

The interviews took place outdoors, in either the subjects' houses, the church, or the local school building. As I became more confident and inspired by oral testimony and participatory video techniques (Slim & Thompson, 1993), I abandoned preparing lengthy set questions and maintained little structure in the interview. I would merely explain who I was and that I was interested in the way of life in Kobokara. I requested people talk to my camera about various issues I suggested and anything else they wanted to, giving them an opportunity to express what they wished to the outside world.

"Oral testimonies are vivid, personal and direct; they challenge the generalisations of development literature and explain to planners and policy makers about what it feels like to be at the sharp end of development." (Warrington, 2006)

16.1.3 Digital Storytelling

Twenty-one individuals – males and females – between the ages of 10 and 65, were given a disposable camera, a piece of paper, and a pencil, with the task of taking five pictures of things that either represented Kobokara, or were important to them. They were to put a star next to the picture they wanted me to send back to them as a small token of our appreciation for participating in the project. I tried to approach a wide range of people, both those with whom I was familiar, and those who I did not know well. I tried to balance the number of young and mature individuals.

16.2 Findings

I decided to focus on development work while I was in Kobokara, since there are many organisations working there, but few reports of progress in the last few decades. The WWF has set up COBAs and banned *hatsake,* which is regarded an unsustainable livelihood practise. The WWF and ASOS (Action Socio-Sanitaire Organisation Secours) had previously managed projects in the four *fokontany* (villages) I visited, and had on-going projects in Kobokara, Ifotaka and Fenoaivo. I attended the meetings they held in Kobokara and Ifotaka, and was impressed to find that the local people are allowed to provide input into development project planning and management. Since the ban of *hatsake*, the WWF had been trying to create new livelihoods for the people, such as bee keeping and turkey breeding projects in Kobokara, as well as sending tree seedlings for reforestation. They established a COBA to manage the protected area of forest, and prevent the practise of *hatsake*, which is known to be unsustainable. ASOS were doing a chicken-breeding project in Kobokara. Care International (CI) had managed the installation of a local road and well, giving the local people food in exchange for their labour, and had set up an irrigation system in one of the fields in Kobokara for communal use. Despite this, the local people explained that their lifestyles had not been greatly improved by the presence of such NGOs. They said that they appreciated the road and employment opportunities during its construction, and that, during drought, NGOs had brought them food and supported them, preventing starvation. However, there was a lack of progress within the village, and confusion about the intentions and function of various projects, as well as several individuals expressing that only a select few of them would benefit from the initiatives. The projects in Kobokara were often unsuccessful or had been abandoned before completion. A boy of twelve told me that Madagascar was poor, but Kobokara was very poor.

There was frustration in Besely because they never had a COBA, and every village I visited needed greater assistance with education and medical services, which they felt were not being

addressed by NGOs. During an interview, an employee of the WWF explained that the COBA ideology they are trying to implement was flawed in hindsight, but explained there was nothing that could be done. He also indicated that replacing *hatsake* with new job opportunities was a challenge, since it was previously their main livelihood, and people could not easily be convinced to change their farming methods. However, he assured me they were trying their best, and had more ideas for the future. He agreed that people preferred to work individually instead of as collectives, which also made development very difficult. Indeed, within Kobokara many chickens had been stolen or neglected, instead of breeding successfully. They had been given 74 hens and 10 cockerels, but the numbers had fallen drastically, leaving 33 chickens and little enthusiasm for the ASOS project. There was a lack of solidarity and trust between the village people, who found it hard to work together, especially since some chickens had been stolen. Furthermore, chickens are taboo for the people of Kobokara to eat, and the nearest market is seven kilometres away in Fenoaivo and only happens one day per week. This made us question the chicken project's ability to help the community.

In an interview in Fenoaivo with the President of the COBA and the President of the *fokontany*, a boy who was listening said that the WWF had given his community no choice but to steal and become robbers since banning *hatsake*. I explained that we were interested in local people's opinions on the subject, and subsequently the president arranged for us to have a meeting the following week and invited members of his town. During another interview with someone from Kobokara, I was told that the community would continue using *hatsake*. This was because it was, in his opinion, necessary, and no one owned the land and should tell people what to do with it. He said they will do it responsibly, and require no approval from any organisations or intellectuals who may try to betray them. This informant told me the villagers are still doing *hatsake,* because they do not have enough land to farm on otherwise. He explained that it is also valuable in local society, and money can be made from it by producing surplus harvests.

Another informant, one of the forest police in Kobokara, told me that he could not easily report the occurrence of *hatsake* to his COBA as his position required him to, since it was his friends and family who were performing *hatsake*. This same individual took me out of the village to show me a well CI had constructed. He explained that, when the Mandrare River is flooded and polluted, they had hoped to rely on it for their water consumption and other related uses. However, he informed me that people in Kobokara are currently unable to use it because it does not have an adequate supply of water. It had been in this state for several years and there seemed to be no plans to finish it. There was also an irrigation pump set up in the village by CI that did not work. CI employees refused to partake in an interview with me when I met them working nearby in Bekiria.

In the days before I left the field, a delivery of thousands of plant seedlings arrived in Kobokara from the WWF. In an interview, I was informed that they had arrived unexpectedly, with no prior communication. These included mango, papaya and orange trees that were each worth 3000 Ariary (approximately £1). The people in Kobokara felt they were ill equipped to plant them, so they were left for a few days in a house out of the sun. Eventually it was decided they were better in the care of the COBA president, and local children were given the unpaid responsibility, of taking turns to water them. Two local people had received training on reforestation techniques, but there seemed to be a communication breakdown, as the rest of the villagers said that the project was not for the community, and were suspicious that only the two trained individuals would benefit from the project. They therefore wanted to send the seedlings back to the WWF.

In interviews people approved of us being there since they said we could help to bring wealth to the town, through our exploration of the forest in the form of ecotourism. They were also glad to meet us, and amused by some of our customs, especially the men's ability to cook. Finally, they were very keen for us to teach their children English because this would benefit them in the future.

In development work, there needs to be greater acknowledgement and priority to take holistic approaches which include a greater consideration and analysis of the local peoples own ideas, customs and traditions. Although it is fantastic that the NGOs are trying to provide some autonomy to the local community about which projects they can do, they then appear to steer their management in unfamiliar directions, as with the COBA and collective chicken breeding. This was failing because people are accustomed to working within their individual households, and are distrusting of group projects, so perhaps they require more training and team building activities. Again, although the WWF have done great work in attempting to prevent *hatsake*, this is clearly embedded deeply within the culture, and, if anything, the alternative livelihood projects must first be successful before the local people are going to trust the WWF fully. There definitely could be greater communication with NGOs and the local people, as incidents such as the seedlings and the unfinished well have caused confusion and loss of trust towards these organisations. Through oral testimony and gathering direct opinions, the local people can explain their true feelings and experiences, which can inform policy makers and give them a better understanding of how they can assist and develop communities.

16.3 Outcomes

16.3.1 Documentaries

I made four short documentaries from the footage I collected presenting my findings.

- A day in Kobokara
- Madagascar's biodiversity and local resource use patterns
- Project Kobokara
- NGOs in Ifotaka

These can be viewed at www.projectkobokara.org.

16.3.2 A day in Kobokara

This documentary creates an opportunity to allow the people of Kobokara, whose lives are almost incomprehensibly removed from our own, to share things about their daily living within their small village of a few hundred. It features photos taken by the local people of what they considered important to them or to represents life in this village. It also includes footage of them speaking about anything they wanted to express, which mainly consists of stories about their work, school, how they feel about foreigners in their village and how they feel about development efforts by NGOs. It also features interviews with the Vice President of the village, teachers, other adults and children describing what they do in their daily lives and their dreams for the future. One elder focuses on polygamy, and how having many children is an important role to fulfil in married life. Another describes his adversity to the WWF banning *hatsake*.

We see people in the village at work, and children at play. We see photos of people at work in their fields (*tonda*) and Kamara, a farmer, and Gnatty, a fisherwoman, describing how they work. Misikare, the local *tromba* (healer), prepares and describes one of his medical concoctions, and there is footage of one of his ceremonies and a *Kokolampo* (another spiritual healer) ceremony. Children are shown dancing in traditional ways, playing football and working. Footage is presented from two funerals where people are dancing and singing to a recently bereaved family. One of the songs is about how the lady was killed by witchcraft, and has been translated and is accompanied by subtitles. Footage and stills then document the transition from the funeral party, to the conclusion at the burial.

16.3.3 Madagascar's biodiversity and resource use patterns

This documentary shows some of the wonderful fauna and flora that exist in the Andasibe rainforest region, which we visited while waiting for our visas to arrive. A guide explains what the

plants are and their uses. There is also footage and pictures of lemurs, reptiles, birds and spiny forest growth from the expedition's fieldwork. Pictures and footage follow this, exemplifying how wood is put to practical use, and the dangers posed to the island's flora and fauna. We see a Critically Endangered radiated tortoise in a restaurant waiting to be eaten. Elsewhere villagers chop down the endemic trees for various uses. An informant from Antananarivo tells us how the once green country is now brown from deforestation and erosion. We hear about how this problem is being managed by the government and mediating organisations. We then have the argument presented that such destruction of natural habitats when compared to the developed world's destruction for use and consumption is minimal and out of balance.

16.3.4 Project Kobokara

This documentary consists of a series of interviews with each of the expedition members from the University of Edinburgh and those from the CEL. It presents their expectations of their fieldwork and the progress of their research. They are pictured at work both in footage filmed and stills captured. We get an insight into their diet, transport and accommodation in the field, and see what time they had to get up in the morning! This documentary also shows how they interacted with the local people through the English lessons, football matches and work organised together. It also documents interactions in more natural situations that came about in the field, such as washing clothes together, assisting with work in the local villagers' fields or with the researchers' projects, and attending spiritual and religious ceremonies.

16.3.5 NGOs in Ifotaka-North

The final documentary shows footage from a WWF meeting in Ifotaka, where local people split up and discussed their concerns about *hatsake* being banned, and also the benefits they perceive from this restriction. There are summaries of how NGOs have worked in the surrounding areas in the form of interviews and written summaries. There is also footage and photos of the work carried out by NGOs in Kobokara, and villagers' accounts of this work in their communities. Again this focuses on Kobokara. We hear of problematic breeding projects encouraging the locals to work collectively against their traditional family methods. There is footage of a vast well that was constructed on the outskirts of the village and irrigation system in the village provided by Care International, and a local villager explains how neither of these functions as was hoped. We also hear about the road that was sponsored by NGOs which has been of great benefit, creating a route for safe travel to the market on foot or by zebu cart.

16.3.6 Digital Story Telling

Table 16.1 - The Data; Who took which pictures and why? *** Beatrice's data was unfortunately lost

Name	Age	Sex	Pic 1	Pic 2	Pic 3	Pic 4	Pic 5	Star pic
Louisette	15	F`	Flower because I Like it	Mother because she's my mum	Tsilanimamy my youngest brother	Big house it's my dad's	Sheep the represent wealth	Pic 1
Tahierey	17	F	Kily (tamarind) tree because it gives shade	Church for praying	brother he's family	Hatsake in the past because it is for crops	Mango it is because edible	Pic 3
Maritiazee	13	F	My grandfather	Sheep	Lohatihie my mother (aunt)	Voantandro my mother	Fiatoae her father	Pic 5
Fanjara	10	F	House for sleeping	Cactus because it is edible	Family	Chicken breeding	Kily (tamarind) for shade	Pic 3
Bertrice***	50	F						
Lohathie	Late 50s	F	Tafisena my child	Havasoa my child	Tsiareke my child	Damy their father	Church for praying	Pic 2
Sabine	27	F	House	My husband he's always on my mind	My mother	My husband again	Zebu as they can bring the wood	Pic 2
Olive	20	F	Ber Dunes my daughter	Ber Tous my son	Fantiolotse it makes me happy to look at it	House because I sleep there	Mother she looks after me	Pic 1
Kamara	65	F	Peeling potatoes	Church	Shade in the village	Zebu carrying sugar cane	People in market	Pic 4
Zotsomarea	45	F	Masindia my husband with his zebu cart	Chicken because I breed them	Tree for shade	Tahimbelo they bring food	House we sleep there	Pic 1
Masakare	60	M	Gnatie his sons wife	Zotsomaree my child	Vinale his child	House we sleep there	Blank	No star
Longasoa	30-40	M	Sanorina because I love my daughter	Mahareta he brings the chickens	Oliva my daughter	Sambeto my child	Maree my mother	Pic 4
Fidisoa	30	M	my friends because I love them	Sheep because it is Malagasy custom to breed them	House live there and sleep with my children	Church there everyone can show their believes	My dad and paternal grandmother	Pic 5
Damy	26	M	Berthin my son	House I sleep there	Corn I eat it	Church for praying	Hoanie my wife	Pic 5
Mara	18	M	Gastine she's my friend	Sambeaze because she is my mother	House because I sleep there	Zebu because they are valuable	Goat because it is valuable	Pic 2
Naheritsoa	20	M	Tsimandeftse because he's family	Sheep because they are valuable	Mimy tree because it gives shade	Church because i like to pray	Mandrare it is the river where I wash	Pic 1
Kambisoa	29	M	Marizety his child	Vola his older sister	Votondre his mother	Kambisoa his house	Mimy tree for shade	Pic 5
Kaka	16	M	Grandparents (guardians) because they are looking after me	Ombiasa Fiandria because he heals the sick	Zebu because it can help you when required	Dog because they are gaurds that protect us	Chicken because you can breed them	Pic 1
Beaupen	12	M	School because I like to learn	Motorbike because it can travel so far	Church as I like to pray	Ndabolie my godmother who looks after me	Zebu because they are our wealth and can help us	Pic 4
Rembesoa	16	M	House because I sleep there	Bake tree for shade	Rembesoa I love him	Casava I eat it	Church for praying	No star

Which Subjects had the Highest Incidence

Table 16.2 - Subjects with the highest incidence. *: not representative, as not all participants are of child-bearing age and some took more than one picture of their children; **: Lohathie took a picture of her ex-husband, the father of her children, and Sabine took multiple pictures of her husband.

Picture	Frequency of appearance
Church	8/19
Flower/Cactus	1/19
Mother	7/19
Father	2/19
Siblings	4/19
House	11/19
sheep	4/19
Zebu	6/19
Chicken	3/19
Children	12/19*
food	6/19
Tree / shade	7/19
Himself	1/19
godmother	1/19
motorbike	1/19
School	1/19
Dog	1/19
Ombiasa (Plant healer)	1/19
Parents/Guardian	1/19
River	1/19
Goat	1/19
Friends	1/19
Husband**	4/19
Wife	1/19
Grandparents	2/19
Market/produce	2/19
Daughter – in - law	1/19
Other family	1/19
Aunt	1/19
Hatsake (slash and burn)	1/19

17 ANTHROPOLOGICAL RESEARCH

KOBOKARA'S ECOTOURISM POTENTIAL: BALANCING CULTURAL RESPECT, ECONOMIC STABILITY, AND ENVIRONMENTAL PRESERVATION

JUSTINE TAYLOR

17.1 Introduction

In this work I aim to explore the different ways in which Kobokara is changing due to outside influences, and suggest ecotourism as a strategy that advocates people's rights to protect a traditional way of life whilst also allowing indigenous people gain economic empowerment. The protection of local culture is a sensitive issue, which is taken into account by the numerous NGOs working in the area. Nonetheless I would like to offer these observations exploring ecotourism as a contemporary way to empower the community in taking the next steps whilst preserving society, culture and the fragile surrounding ecosystem. I do this with emphasis on recognising the importance of three interwoven aspects of life in Kobokara. There are already evident conflicts of interests between traditional social roles or cultural formalities and the intentions of NGOs, and therefore an insensitive ethnocentric imposing of an ecotourism project may exacerbate existing controversies. This criticism of 'cultural insensitivity' to be made of existing projects by charitable givers may be avoided when the interaction of indigenous culture and outside influences is explored by an anthropological and emic approach. However, in creating a new analysis of aid programmes in Kobokara - that highlight the merits of thinking locally - I hope to avoid romanticising the idyllic village life in the way that Sahlins arguably did by portraying his depiction of the 'original affluent society' (Sahlins, 1968). Thus, even if ecotourism is a viable option in terms of natural resources and (although tenuously) existing infrastructure, my work led me to see suffering and poverty as well as tranquillity that Sahlins experienced within a village, and as a result of this, my research aims to point out the vulnerabilities of village life and highlights how essential it is not to take the concept of ecotourism at face value.

In this document I will firstly outline what makes Kobokara an ideal place for ecotourism, focusing upon the natural assents that are available to the village. Included here, is a section dedicated to analysing the work of NGOs, which is useful in the wider discussion about ecotourism due to the massive influence that NGOs have within the village. Furthermore, this section is highly relevant due to the way in which NGOs have such a great influence in village life, and also because this interaction is a good way to understand how villagers relate to the outside world. I will follow this section by exploring the wider context of ecotourism to understand the possible consequences of ecotourism in Kobokara. The experience of the whole group of researchers on project Kobokara was a very valuable resource when discovering what was needed in terms of foreigner/local interaction and therefore I have written a section of what we experienced to show the stepping stones to ecotourism overall in the context of Kobokara. The final part of this report consists of a section of suggestions, based upon what is explained throughout the whole chapter in order to aid in the establishment of ecotourism in Kobokara that has the potential to benefit the community as a whole.

17.2 Scenic beginnings

For someone unfamiliar to the Spiny Forest region in Madagascar, the landscape was completely alien. I had grown used to homogenous green being the milieu of scenery if I ventured into the English countryside. The Ifotaka region presented me with views of spiny forests that couldn't have been more different: the dusty shades of red or beige soil punctured intermittently by lush green plants, but more frequently scrubbed with a thicket of grey spiny trees. This wild and prickly forest gave way to gorgeous groves of fertile land that was cultivated near the

riverbed. Although Kobokara may not be unique in its peacefulness, set upon the bank of the Mandrare River along with the sprinkling of other similarly idyllic Antandroy villages; Kobokara's gentle pace of life is furthered by the coextension of family and village boundary. This tradition of openness, due to kinship, eliminates the wooden fences and division of resources that typify familial divisions represented within other villages in the surrounding area. Gestures of caring are extended among the people in Kobokara. Even when an outsider becomes aware of the existing households and closer family ties indicated, usually arranged by proximity of housing, the flow of possessions around the village seems to be indiscriminate of who lives within each familial cluster.

At the time we were staying in Kobokara it was the dry season. The village was situated a short walk from the river which was still deep enough to swim in most of our time there; it was apparent that in the wet season the water filled the floodplain almost meeting with the village. The dry season did not completely parch the landscape, creating a stunning ecosystem succulent green aloes and Euphorbias juxtaposing shrivelled looking spiny plants growing out of the orange dust of the earth. Kobokara is an easy sell in terms of the cultural and natural aesthetic basics for ecotourism, yet it is this shallow analysis of Antandroy villages at face value that has been generating problems for NGOs in the attention grabbing debate that is discrediting charitable organisations for poorly implemented work. Yet without the need to fabricate natural beauty, ecotourism is an excellent chance for Kobokara to gain from its strengths in a sustainable way.

The fragmented implementation of existing NGO strategies in Kobokara and the surrounding villages have the potential to be reconciled by encouraging ecotourism in Kobokara; ecotourism can be a celebration of the work done by all organisations instead of an egocentric celebration of what an individual tourist or tourism organisation might achieve. There were multiple accounts of confusing and poorly implemented NGO projects within the Kobokara Fokotany. Raising the profile of such cases, as in Kobokara by placing the village in the international eye offers a chance to demonstrate whether accountability is taken by NGOs. The current eco-political discourse surrounding Kobokara is not unusual in developing villages where NGOs operate, yet the clashes of international verses local agendas result in issues far too abstract from the local interest. For example, the WWF use carrot and stick approach to 'protect' nature from the traditional land use models. The WWF's claim is that when deforestation stops, rain will finally come. Unfortunately Kobokara's traditional land use patterns are 'logical' land use models according to villagers. The WWF's new description of nature as a vulnerable creature creates a discourse that is alien to villagers, yet still obediently implemented all the same.

17.3 Method

Research in Kobokara took the form of inductive research, although both my research partner and I had plenty of bookish knowledge about anthropology in similar situations, it was essential to avoid superimposing this circumstantial knowledge onto the real people encountered. We did direct pilot research by pursuing the most high profile NGOs in the area and attempting to interview as many people as possible including those who we were informed had decision making power, such as elders and the village vice president.

In the field observation and participant observation allowed us to research through joining in with daily life activity. Although it was initially important to test our hypothesis about the roles of NGOs in the village by having semi-structured interviews, we found it was not possible to understand the way in which people in Kobokara interacted with and felt about NGOs simply through interviews. This was because village members thought we were in the village to confirm that NGOs were good, as this was the kind of attention that outsiders were typically in pursuit of.

During my time in the field my research defined itself; eco-tourism was simply a theme that I wished to explore. Whilst living in Kobokara, and visiting the ecotourism site at Ifotaka, as well as

witnessing the love that village members had for outsiders, ecotourism 's relevance and suitability became even more apparent. Many people in Kobokara were not looking for, and did not ask me specifically for, empowerment. However, women were much more likely to acknowledge disempowerment, and ask us foreigners for help. Despite this, men were much more represented within the traditional decision-making structures, which we initially resorted to researching. It was only through interviewing a wider range of people in the villager, and truly getting to know the spectrum of relative wealth and poverty that we learned that in Kobokara there was still suffering and need for aid. Yet throughout our time in the village, Natalie and I felt frustration on behalf of the villagers that disillusionment and disenfranchisement seemed to have become a norm when people lived at the mercy of the whims of NGOs. In this way, Natalie's and my research developed separate yet parallel approaches.

This work on ecotourism is part of a larger article where I collected data on many different parts of life in Kobokara, by exploring ecotourism, I found a way to contextualise the information I learned about the culture in Kobokara whilst offering a way in which people in the village could be empowered against the silence that is the nature of the give-and-receive relationship between NGOs and the government and villagers.

17.4 Results

17.4.1 The essence of Kobokara as a potential tourist destination

Kobokara is in a stunning location, and during our stay there, the whole team felt both safe and welcome among the people we lived with. The village is an ideal place to develop ecotourism, certainly from the point of view of whether local people are 'accommodating' enough. In this section I explore the ways in which community in Kobokara, and the lifestyle in Kobokara may be attractive to ecotourism.

There is a mix of factors about Kobokara that might make the village a future honey pot for ecotourism. In terms of fulfilling entertainment for eco tourists, the way of life, from the musical culture to the lively traditional medical practices that have continued to exist alongside the introduction of outside influences; the village is a spectacular kaleidoscope of experiences for anyone's cultural palate. In some ways villagers in Kobokara are aware of their uniqueness, in being the only village with a population trusting enough to not surround their houses with hostile *fantihoulitse* (cactus) fences. The whole village is descended from three brothers, a piece of vernacular history that adults in the village are proudly aware of. Thus, the village is also a more picturesque place than other destinations in the Ifotaka-North area. The walks to the beautiful, lush crop fields are magical, lined by such a diversity of landscapes, offering stunning views of both the Mandrare and the Ikonda rivers, emerging to cross at a paradise-like green confluence, before finally reaching fields of tall sugar canes and lush mango trees. Although it is some distance to the most undisturbed parts of the forest, it is only a five-minute stride across the river to Benolo's fields[1], where there forest it thick enough to exhibit a greater amount of biodiversity, including sifaka and chameleons. One of Kobokara's greatest assets is its proximity to attractive sites, and walks to take whilst spending time with guides who might be any one of the open and friendly people from the village. When we went for a walk we could accompany or be accompanied by almost anybody if we so whished, people were more than accommodating and eager to assist us. For Natalie and myself, young boys and women were more likely to invite us, but in the fields anybody was glad for our company, inviting us to help out and eat fresh vegetables with them.

For those seeking to experience the daily culture of Tandroy people, life is lived mostly outside houses in the shade of a tamarind tree, or on *tihy* (a woven mat) in the shade of their houses. Daily

[1] Benolo's land is a sort of mystery to me, as he lives on it.

life in Kobokara is open, interfamilial, between houses; down by the river and on the edges of crop fields. This means that it is much easier to meet people and join in with everything going on outside. It is also easy to relax and observe. The music and dancing is flamboyant, and very much about showing off, so villagers are almost guaranteed to put on a good show. From the young girls, to the *Rangahe*, (the respectful term for old man) people in Kobokara never seem to run out of energy, which adds to the welcoming atmosphere; no one is ever too exhausted to spontaneously have a chat.

One of the most rewarding aspects of time spent in Kobokara is the relationship one forms with the people, yet this is probably not on the agenda of most tourists. Ifotaka already has nature walks and guided trails through the sacred forest, which could be replicated in Kobokara. Despite the general 'sightseeing' agenda of tourists, if there were a need for places for longer-term visitors, Kobokara would be a most welcoming place. Small-scale tourism that allows tourists to really form bonds with people in Kobokara and really explore the culture on an intimate level would be the most appropriate way of introducing the industry. People in Kobokara are very open to sharing their lives with newcomers; there are no hostilities between villagers and visitors.

17.4.2 The complexities of fragmented NGO project implementation in Kobokara

The sum of all the research gathered illustrates that the biggest influence upon Kobokara from outside of the region is that of NGOs, many of which carry out proxy governmental work. The people working closely with village members are generally Malagasy men, which has the potential to allow NGOs to deal more sensitively with the relationship between NGOs and villagers. However, these men appear wealthier than villagers; wearing logo clothing that is not torn, and travelling around in cars or on motorbikes. Thus the ways in which NGO's representatives are able to empathise with villagers is perhaps limited due to these socio-economic factors that mark NGO employees as different. NGOs have had a great influence in Kobokara; much of the impacts are positive and NGOs endeavour to democratically include people from the village in decision-making. Despite these efforts, people in the village are filled with both gratitude but also a sense of bemusement. NGO run schemes are not always compatible with local culture, or local climate and when a plan fails people become disillusioned. Action Socio-sanitaire Organisation Secours (ASOS) is one of the NGOs that attempt to encourage people in Kobokara to choose development projects, but as we witnessed this does not ensure success. An example of this is the Beehive Scheme. Sabine, the sister of our host Bertrand, often attended NGO discussion meetings. She explained that the beehives were 'nonsense' to people in the village; she understood that villagers had chosen the beehives, but people hadn't really understood what they were choosing. Sabine also described how poorly managed the chicken-breeding project had been, which ultimately resulted in Sabine stepping down from her position in the committee.

Sabine's concerns represented a more analytical and moral disenchantment at the ways in which NGO projects were carried out. Damy, a village appointed Forest Policeman expressed financial self-awareness in relationship to ASOS projects. His issue with regard to the chicken project was that the chickens were not useful to him whilst 'owned' collectively by the community. Given the choice, he would have sold his share of the chickens; having preferred the money to help himself with immediate problems. He felt it a more costly struggle to keep the project going.

There were many open ASOS meetings in the village; the NGO had attempted here to create a cooperative approach to farming chickens. In theory, this would mean that in the long run everyone would be better off. In the cooperative chickens could breed and be sold. However, this structure of working cooperatively wasn't compatible with local trading and sharing structures. It seemed that ASOS had misinterpreted the village's sharing structures among families. even though items are shared within the village, traditionally livestock is private. As people in

Kobokara cannot eat chickens due to the *fady* (taboo), there was now the burden of this depleting stock of chickens that had been taken on single headedly by *Rangahe* Misikare. The *Rangahe* had elected himself to care for the chickens until ASOS or the village could decide what to do next. Although it is understandable that NGOs are likely to come up against certain complications throughout the implementation of projects, these teething problems had already been experienced by the WWF who had attempted to carry out the same project but with turkeys; similar to the chickens, the turkeys starved to death, were diseased or had been stolen. Only two *Rangahe*, Soandro and Misikare maintained their turkey supply.

As explained above, this shows that cooperative based projects are incompatible with local structures, especially in the case of livestock. Sabine stepping down from her position emphasises the friction between NGO visions of ideal structures, and the actual relations between villagers. With this in mind, it is visible that the WWF appointed COBA is well structured as it represents families within the village and is formed from a number of *Rangahe* and *Rakemba* as well as other younger representatives. The people in the COBA elect its members, and Damy became a part of the COBA as the 'man of his family' following the death of his father.

Interestingly, after interviewing a diverse sample of people within the village it seemed that the project that made the most positive impact to people in the village was the basic medical training received by women. Although this training was not as tangible as crop fields, the distribution of knowledge was done so that most women in the village had some medical knowledge. The response to these projects was very positive, as unlike material driven or wage driven projects; no single family or individual could gain monopoly of the outcome. Material things such as crop fields and tools tend to become the property of people with a higher position in social hierarchy, not necessarily the possessions of elders. *Rangahe* Soandro explained to me that he had no interest in gaining form these projects as he had plenty to be happy with; he became rich enough by his own work in his lifetime to be satisfied. Younger, NGO appointed members of authority sometimes misinterpreted their position, and gained disproportionately from projects. This misinterpretation was more supported than challenged by villagers.

Another issue that has reduced the successful distribution of revenue from NGO projects is the way NGOs find a comfort zone of employees and then return to these trusted few: the WWF is known to only employ the same few villagers that they trust for the majority of their projects. The two men that were employed by the WWF to do tree planting projects were also two of the three forest policemen, Damy and Tsereke. When asked if they thought this was fair distribution of work and wages, Damy and Tsereke seemed amused by the question; the money was theirs because they earned it, the boys didn't really think about the ways in which other villagers were excluded from earning money. Being part of two different 'family clusters', Damy and Tsereke were likely to distribute their money around their immediate family; so two families potentially received money from these projects. Due to their involvement with the WWF, it was no coincidence that Damy and Tsereke became such close friends of the team – they had become accustom to interacting with *vazaha* due to their position of 'forest police' and therefore were used as guides for outsiders, their grasp of English and understanding of what foreigners needed put them in an advantageous position when forming bonds. Thus development projects benefitted some families more than others in the village. People that I spoke with in Kobokara admitted that they felt disenfranchised as the village's natural resources are being continually more restricted in accessibility and development projects rarely reach their potential and benefits could be casually shifted to different families without justification from charities.

17.4.3 Contextualising ecotourism in Kobokara: a broader view

Ecotourism is favoured for have fewer ethical implications than the usual, exploitative 'tourism'. Thus, before I discuss ecotourism, I will illustrate the ethical issues that are associated

with the industry. Although ecotourism is not as aggressive as typical tourism, different kinds of concerns about this industry threaten to outweigh the benefits of encouraging ecotourism; if it comes at the price of the well being of people in Kobokara it would be a mistake to try to introduce it in this village.

We should begin by deconstructing the illusion of a 'highly beneficial' industry of ecotourism, which has emerged. Although ecotourism comes in many forms on a great spectrum of benefits, the neoliberal western romanticisation of 'the wild' entices consumers to believe that there are ideal and pristine places in the world that are flawless and therefore only these, in comparison to other 'natures', are worthy of protecting. West and Carrier (2004) argue that this has been taken to extremes for the sake of ecotourism; where real issues are pushed aside to support the western neoliberal image of nature and what native people 'should be like' overrides the existing nature and population. They illustrate that ecotourism is a new way to appeal to the vanity of the neoliberal conscientiousness. Brooks (2005) utilises the case study of Hluhluwe game reserve, where local people have had to be removed from the landscape, as they corrupt the pristine image of wild nature. These case studies show that the economic benefits of creating the image of 'pristine nature' are such that local people's needs are not considered.

There are points of entry into the industry through which indigenous or local people can gain revenue, such as becoming 'part of the attraction', showcasing parts of a culture, which can be acceptably exhibited to a neoliberal audience. Although this can be done in a positive and educational way, Edward Said's (1995) 'Orientalism' is a depiction of the way in which dominant culture consumes the less powerful subordinate culture in an exploitative way, yet the way that Orientalism has been applied to the paternalistic approach to conservation efforts legitimates use of this theory in ecotourism where culture is suppressed and moulded into something lovely for wealthy people to explore. In this interpretation of the industry ecotourism is paradoxically unethical, and anthropological work set up to aid ecotourism in discovering the details to pick out and amplify, such as traditional dances and unusual healing practices is even more unethical. Therefore, it must be understood that being 'part of the exhibit' does not count as being 'part of ecotourism'. Demonstrating this is the familiar tale of Massai Mara tours in Kenya which has become the archetypal depiction of how nomadic people are forced to settle, and token few have been given permission to remain within the reserve to collect little revenue from tourism; most money from this 'exhibition' of people is still kept by the reserve and safari guides. Highlighting this recurring tale of marginalisation, Guah (1997) points out the way in which the small amount of environmental impact of traditional practices is vastly eclipsed by the damage done by modern industry, yet subsistence farmers and hunters are most likely to be demonised for their unsophisticated, unsustainable practice, and this is done at the whims of certain superpower NGOs and unquestioned by the neo-liberal consumers depicted (West & Carrier, 2004). The friction between what ecotourists want to see according to West and Carrier (2004) and the existing way of life of those who have historical claim to land demonstrates the most worrying disconnection between ecotourism as an industry and the ecotourism ideal.

Kiss (2004) explains the strategy of Community Based Ecotourism (CBET); a form of ecotourism that promotes caring for the environment to a wider community living in a potential tourist spot. CBET allows people from the local area to become actively involved in tourism. Kiss (2004) points out that one of the difficulties of CBET is encouraging a culture of caring and respect for nature, yet she promotes nature in the sense that West and Carrier (2004) define as the self gratifying 'western' image of 'communalism' (Kiss, 2004). In contrast to this, as Palsson (1996) points out, the communalistic way of living within nature is an integral part of many indigenous cultures. Therefore, it can be regarded as the challenge of the ecotourism industry in Kobokara to seek out the communalistic aspects of life in Kobokara instead of fabrication of something that is not part of this culture. In terms of living sustainably within nature, the work of

the WWF means that this consciousness has been established in Kobokara by the presence of another organisation, encouraging people to respect the spiny forest. Kiss (2004) highlights how sustainability of ecotourism is based upon the availability of donors. Kobokara, with its existing infrastructure, and a population that is used to complying with the idea of preserving the neoliberal standard of what nature 'should be', has a head start on the road towards becoming a formidable ecotourist destination. Donors need only look at the sustainability of Ifotaka to predict the success of a CBET in Kobokara: only a few short hours zebu cart ride away is the idyllic ecotourism spot of Ifotaka. Ifotaka village is much more accessible by public transport than Kobokara is and in order to arrive in Kobokara one must travel through Ifotaka. Ifotaka has amenities, such as shops, a hotel, restaurants and safe drinking water ('sweet water', *rano mamy*) that can be used by tourists.

When juxtaposing these two locations, the proposal to make Kobokara a place for ecotourism highlights the facilities it lacks; working toilets, private washing facilities, and money for goods exchange system that tourists can rely upon. Such things are important when trying to attract the less-rugged ecotourists. Indeed, Scheberger (2008) argues that the existing facilities in Ifotaka require improvement to enhance the ecotourism experience. Requirements and expectations of facilities may of course vary, based on the kinds of tourists that intend to visit the area, but this may mean that creating facilities is nonetheless a worthwhile investment to increase the numbers and kinds of tourists that visit the village. Tourism requires infrastructure and amenities that the people in Kobokara can do without, so the basics do not yet exist. Thus, this kind of work would have to start from scratch. Our team dug a long-drop, which we intended to fill in at the end of the expedition, but we were asked not to fill it in, so that our host family could continue to use it, showing that people in Kobokara are open to the idea of *vazaha* facilities in their village.

Although there are aspects of the way in which Antandroy people live that may aggravate what Guah (1997) calls the 'juggernaut of conservation', Kobokara is already heavily regulated by NGOs, with WWF policy being integrated into Dina, (law) making Kobokara a 'safer' place for ecotourism. For example as it is taboo for people to eat radiated tortoise, it is unlikely that villagers will aggravate NGOs that place the welfare of wildlife over that of people.

Some infrastructure that would allow the forest to be explored by tourists is also already in place, such as the road built by Care International. The 'Forest Policemen', Damy, Tesereke and Benefice, act as guides for science teams that come to do research in the forest. With this knowledge structure in place, it would be beneficial to the WWF's strategy if ecotourism brought in the increased revenue that members of the COBA expect to receive from research teams. Kobokara has the bonus that the known ecotourism destination, Ifotaka, already has the necessary amenities to satisfy a tourist's need for creature comforts whilst bringing in a flow of clientele.

Scherburger (2008) evaluates the facilities in Ifotaka, where ecotourism is already established, showing the reality of the successes of ecotourism when it is established. Yet, Scherburger also highlights the issues of the lack of clearly defined roles for guides and guardians for places to stay, which results in confusion over what tourism can offer versus ecotourism as a burden. Furthermore, Scherburger pointed out that she was unsure of who or where to pay for her stay. During our stay in Kobokara, my team was made aware that we also had to pay a fee for doing research, without knowing how much, or who to pay, and this issue was not resolved until we were about to leave. As both my team and Scherburger suffered this issue independently, the need for clarity of fees is something that matters to visitors, and should be addressed in a transparent matter. The fee-paying issue was amongst many issues that emerged during Scherburger's research, all of which stem from a lack of clarty as illustrated in her SWOT analysis (Scherberger, 2008, pp.44-47).

17.4.4 Learning from our experiences and mistakes

It is extremely telling about the nature of people in Kobokara that all misunderstandings between team members and villagers were received with good humour. However these misunderstandings need not occur when there is a flow of more people visiting Kobokara.

The following section outlines issues that we came across and resolved. This might offer an understanding of the kinds of things that future implementation of ecotourism would have to consider. If a person familiar to the region is implementing ecotourism, none of these issues will be new, and therefore will be much simpler to negotiate. However we were strangers to the region. It is definitely one of Kobokara's merits that all issues were resolved without conflict between the team and the wider village.

This section covers four main sections:

- Elders
- The COBA
- Dina and Fady
- Cultural nuances

The morning after arriving in Kobokara, we were not entirely sure what exactly the procedures for getting 'permission' to carry out our respective research projects might be. On request, Bertrand, our host, arranged a meeting with Fidisoa, village vice-president, and a meeting with the head of the COBA, *Rangahe* Misikare. Only Mark, Matt and Junassye were introduced to Misikare. As a team, we were polite as we thought we should be, and assumed that we had met with all the relevant people. However, as I conducted interviews trying to explore the 'power relationships' and 'voices of authority' in Kobokara, I began to understand the approach we took was not the approach that was expected. In not following this protocol some people were slightly bemused, though it never caused anyone to treat us with any hostility.

17.4.4.1 Elders

We were not introduced to the president of the *fokontany*, as the oldest *Rangahe* in the village, *Rangahe* Remaninga, a family member of the president, was very ill. This may also explain why we were not introduced to the oldest elder. This however, was our first mistake, though we were unaware of it. We should also have met with *Rangahe* Tsigado the only person in the village who always wore traditional dress, which was not unlike a loincloth, matched with a 1980's ski jacket and a sombrero.

I always worked with Junassye when talking to *Rangahe* Soandro as I felt it was more respectful to avoid misunderstandings when talking to people of such high social standing, and through this connection we managed to reconcile *Rangahe* Soandro's misgivings about our presence in the village without event. Natalie and I went on a walk out of the village without a guide and upon seeing us in his crop field, *Rangahe* Soandro brought us sugar cane to suck on whilst we worked under a mango tree. This gesture illustrated that we had been forgiven for neglecting the formality of addressing an elder.

When interviewing the wife of the vice president, Vontsira, she explained that the president and vice president's roles in the village were only effective as far as the elders allowed. Ex-president *Rangahe* Jean Louis explained that the role of the president was simply to assure the presence of the government within the village, but of course, it was advantageous to be an elder and a president if one really wanted to have any decision making authority. In recognition of this, the WWF's COBA included a large number of elders.

17.4.4.2 The COBA

The COBA is a body of people collect by the WWF but members are nominated by people in Kobokara to regulate the relationship between people and the New Protected Area[2]

Failing to meet with the whole of the COBA was a faux pas of which we were completely unaware until the very end of my stay in the village, when I happened to interview forest policeman Benefice. Natalie and I knew a lot about the role of the COBA as a regulatory body, yet it did not occur to us that we should have met with all twelve of its members to announce our presence formally. The COBA is a WWF initiative, making forest management of the New Protected Area (NPA) part of the responsibility of people in Kobokara. This was a responsibility that was taken seriously by those bequeathed with the task. That is not to say that there was no resistance to this WWF-imposed organisation, but the members of Project Kobokara were still expected to respect COBA procedures, and it caused some issue when we did not. Unlike addressing the elders of Kobokara, there were tangible bureaucratic rules that we did not deal with when failing to meet with the COBA. Benefice illustrated these rules to us:

- We did not make ourselves known to the COBA in Kobokara
- We did not pay the fee that the COBA demands of all researchers in the NPA
- We did not employ guides or forest policemen.

After setting up a meeting with the COBA to address these issues, agree payment, and apologise, we were forgiven.

The meeting with the COBA took three days to arrange; all of its members had to be present, to ensure fairness. This was the format of democracy that was developing in Kobokara; the members of the COBA represented different interest groups in the village, not just elders. This illustrated the way in which the village of Kobokara, despite its ancient hierarchical system, was flexible enough to engage with structures from the outside world.

17.4.4.3 Dina and Fady

There is a difference between *fady* (taboo) and *Dina* laws in Kobokara. The *Dina* traditional law, and '*fady'* or '*faly'* acted as the taboo; the two are fairly easy to differentiate between. As outsiders we did not have many interactions with the *Dina*. *Dina* is more dynamic than *fady*, and can be altered with time.

Fady are the rules for which the reasoning may be somewhat incomprehensible to an outsider. Formed by stories that are rooted in the ways of ancestors, *fady* have a role in maintaining order in the village. *Fady* prevents people from handling foodstuffs with their feet or shoes for the sake of hygiene. *Fady*, too, ensures that people do not use the place they wash as a place to defecate, and encourages people to treat an individual's final resting place with respect. Sometimes *fady* might come across as more random: people in Kobokara cannot eat chicken; no one may speak about an old person's body parts by the same name that you would talk of a young person's body parts. The ruling of *fady* seems to be entirely set in stone. *Fady* is impervious to any change by outside influences, and are seemingly taken for granted by people living within Kobokara.

Dina changes based on needs; most recently, the *Dina* has been stretched to accommodate rules that the WWF has imposed upon the village. In separate interviews with Justine and Vontsira, both women explained how everyone decided on the *Dina*. Vontsira took time to mention that elders had most clout upon defining *Dina*, but both women made clear that the *Dina* was not static. During our stay, a *Dina* meeting was held, when a man stole chickens from his own brother.

[2] The New Protected Area is an area of forest that the WWF has assigned to be part of the forest where it has become illegal to engage in practices that are harmful to wildlife, such as *hatsake-* (slash and burn) or other forms of deforestation such as commercial logging

The oldest *Rangahe* in the family presided over this meeting, which explored why the robbery had taken place, and what the appropriate course of action would be. This hearing was fairly flexible, as it was held by family members, and the decision was ultimately down to the jurisdiction of the elders.

17.4.4.4 Cultural nuances

Vazaha unannounced:

We witnessed what happened to *vazaha* that appeared in Kobokara without going through the proper procedures some weeks after our arrival, when a group of researchers came looking for a previously undescribed species of aloe. Despite claiming to come from an academic institution, which justified their presence to us, this explanation was meaningless to people from Kobokara, who became very afraid of these newcomers. The villagers held a meeting under the tree outside *Rangahe* Jean Louis' house. It did not last long, but there was a great deal of concern about these newcomers. Nonetheless, only Olive expressed to us that there may be something amiss, by miming about a lynching, to illustrate to us the seriousness of the situation.

Days after this, interviews were punctuated with anxious enquiries, and the need for reassurance that we were not going to turf Kobokara's people out to the 'mystery *vazaha*'. Although this does not directly address the hierarchical structure of the Kobokara of past or present, I feel it would be negligent to not observe the way in which people react when there is a blatant disregard for formalities. *Vazaha* will be treated like kings in most settings in Madagascar, but this should not be used as an excuse to forget that one is a guest.

Sharing:

We learned much later in our trip, from Bertrand himself that other villagers had become frustrated that his family alone benefitted from our presences, on our first morning we had asked Bertrand who we would employ to do certain jobs for us such as cooking or collecting wood, we took Bertrand's advice and thought nothing of it. However, we later discovered that everyone employed were part of Bertrand's close family. Although this was the way things would naturally run, Bertrand's family now had a disproportionate income for the period that we were visiting. This highlights the need for more efforts to ensure as fair as possible distribution of the benefiting among people in Kobokara, especially as villagers are aware of lack of equality, failing to implement as egalitarian form of ecotourism would be potentially insulting to people in Kobokara.

17.5 Proposals for Introducing Ecotourism

17.5.1 Ecotourist experience:

In order to enhance the experience of people visiting Kobokara, this is an eclectic selection of small things that became apparent as points to be aware of when setting up ecotourism in Kobokara.

Firstly, it would be exceedingly pleasant to have documented Kobokara's tale of three brothers in a narrative form for tourists to enjoy knowing the context of Kobokara's roots. We learned the story from two elders, and this was a pleasant way to gain this knowledge as it conformed to our preconception about the 'timelessness' and wisdom of elders, something that tourists might appreciate. We came across the story purely by chance and for village members to know that this would be something interesting for tourists might encourage communication with outsiders. Although there is no lack of willingness to communicate, knowing the kinds of things that foreigners are interested in may encourage the more shy villagers to come forth.

It may also encourage villagers to know that tourists are curious about local traditions, especially the musical culture in the village. There are currently no inhibitions about inviting foreigners to funerals, weddings and medical ceremonies. Ecotourism should be respectful of this

highly advantageous position, and should not exploit these traditions. Although it would be convenient to have villagers performing on cue, meaningful ceremonies shouldn't become consumable. There are people within the village who are skilled at singing and playing their instruments who told me that they were already paid to perform at ceremonies. With this knowledge that certain parts of culture can be bought and certain parts are spontaneous, ecotourists should accept the privilege of being able to attend a wedding ceremony if such an event is going to take place.

Although Junassye, our translator, advised us to dress modestly, we found that failing to do so only elicited a small amount of extra attention from villagers who eventually became accustomed to it. For the sake of defusing divisions between tourists and local people however, it could be seen as more appropriate to encourage modest dressing as a subtlety.

It is possible to pre-emptively create a list of locations that are likely to be most useful for ecotourism without these locations having to be adapted too much from their original state. From my time in Kobokara I found the following places to have a diverse number of appealing attributes to make them recommendable for ecotourists to enjoy:

Crop fields are an aesthetically pleasing exhibition the tranquil daily life of villagers, which ecotourists can appreciate by following the well-worn dusty paths through sugarcane groves and around vegetable patches without being invasive.

The confluence of the Ikonda and the Mandrare is a wonderful deep and clear watered place to bathe in during the dry season surrounded by sandy banks and much more luscious plants than those around Kobokara.

Benolo's land across the river is not as undisturbed as the sacred forest, but is home to Sifaka lemurs and has greater botanical diversity than anything as close to the village.

Sacred forest is further from the village but is much less disturbed than anywhere else and demonstrates what the spiny forest is like without human intervention.

Fenoaivo market is a vibrant and friendly atmosphere to experience trading as well as picking up locally produced souvenirs.

By travelling to and exploring WWF sites ecotourists are enabled to directly witness the process through which conservation projects develop.

Care International project sites at varying degrees of completion offer a great visual representation of the scale of projects in Kobokara and the surrounding area (these sites may require explanations as to what the procedures; CI seem to have an absent yet ubiquitous presence in Kobokara that villagers simply accept and respect.)

There are many sites that embody Kobokara's traditional way of life, for example: enclosures for livestock with separate little fenced areas for baby animals or the places where many graves stand, people decorate their own final resting place with bright paints depicting significant features upon one's own life and protect the area with octopus-tree groves.

One of the loveliest ways to spend a day is to spend time with women, especially during the time when they wash their clothes by the river. Although men were not usually part of this, our team leader Mark was never unwelcome by the river, meaning that when done respectfully foreign men are not prohibited from also enjoying this aspect of village life.

17.5.2 Maximising benefits for people in Kobokara, NGOs and the ecotourism industry in the Ifotaka area

By coordinating NGO projects it may be possible to see which ones would benefit people in Kobokara. This would also enable tourists to see where the holes in the fabric of the 'aid' network are, and where more funding and direct donations are needed. Allowing for tourists to see what exactly needs funding, and allowing visitors to innovate and oversee projects, allows for a more

personal and trust based approach, thus connecting charitable givers and people in Kobokara, instead of having interaction on paternalistic abstract levels that currently typify NGO projects. Allowing tourists to be part of their own projects demonstrates a level of community between donators and receivers.

A way to demonstrate this would be to make exploring the reach of NGOs as an active part of the eco-tourism experience such as a 'WWF tour', part of the overall project to demonstrate:

- The importance of the WWF's projects in sustaining the Spiny forest
- The importance of acknowledging these projects as more than just 'for vasaha' but also important for the village
- Encourage the proper maintenance of projects, by both the WWF and by villagers

The reason to focus on the WWF is because WWF has had the most restrictive effect upon the village in order to protect the surrounding nature and also because the WWF is a charity that has a well known global profile. Being a charity with so much clout and so much wealth, it is important to hold this charity accountable to itself.

To understand NGO projects that are still active, and which projects are most beneficial, meetings with the committees for NGO projects within Kobokara as well as 'lists of charities' allow for a quantitative approach. There are projects that are no longer active, leaving out-of-use relics behind. By understanding the stories behind these facilities there may be ways in which materials can be put to use, but this is something that requires interaction from the villagers, as in Kobokara, even after the intended reason for a thing is spent, objects gain new uses. There should be a good relationship between the ecotourism facilitators from outside Kobokara and the individuals within Kobokara who are part of the implementation process of current projects. This might seem like a lot of work but as people in Kobokara are part of a cohesive and attentive society, a well-communicated project is unlikely to be poorly comprehended – groundwork just needs to be thorough.

It is essential to acknowledge the nature of people in Kobokara and their expectations of others. The example of our being informed about our own negligence to follow the rules in Benefice's frank approach demonstrates the way in which people in Kobokara have a clear comprehension of justice and fairness. From my time in Kobokara and the negotiations that I had to enter into between one team member that didn't learn Malagasy and our friends in the village I learned that people in Kobokara will try to arrange things to increase mutual fairness and widest benefit; people in Kobokara were conflict resolvers, and not antagonistic in their nature. If someone is seen to achieve something upon their own merit then it is rarely disputed that it is their 'right' to retain fruits of their labour, which is what results in 'rich' and 'poor' families, even within such a cohesive society. It is essential that tourists be therefore provided with a means to distribute the money and other resources that they bring as effectively as possible whilst respecting the pre-existing mechanisms of Kobokara's social organisations. For example: there are Six *Rangahe* in the village representing the oldest elder in each of the six main families, thus wealth could be at least spent six ways.

Ways in which to make a fair division of resources and roles within Kobokara's eco-tourism project should be explored thoroughly, instead of following the current example set by the WWF where few of the same men are given first choice of carrying out work. One way in which wealth could be partially spread in a new way is to construct a market for poorer women to sell goods as competitively as better off women are able to, for example making woven mats which is a popular pastime for many women in Kobokara. Wealthy women had access to better materials making their woven mats a better commodity. This shouldn't be the case if women are all competing for a limited number of foreign buyers, therefore poorer women should be encouraged to sell mats that they weave and have access to equally high quality resources. Although this is difficult to

achieve, starting the ecotourism industry with as fresh a canvas as Kobokara village means that those implementing ecotourism should strive for equality as much as possible.

It might be worth investing in a means for longer-term tourists to farm. This suggestion emerges from the fact that every time we were to stray from the village and into crop fields, we would return inundated with gifts of fresh vegetables, sugarcane and peanuts. If this was to happen to a larger number of tourists, instead of just to Natalie and me, then perhaps the tradition of giving gifts might become unsustainable. In order to return the balance, there should be a non-commodifying means by which tourists can return this kind of gift. Olive called these things 'gifts'. If ecotourism is not expecting a particularly large number of people then the 'tourist' crop field might become another unnecessary burden upon the people of Kobokara to tend and distribute among villagers. Therefore this suggestion is only relevant when ecotourism reaches the point at which people of Kobokara are giving too much to ecotourists in the form of spontaneous gifts, as they seem so bound by culture to be so generous.

Finally, and perhaps most importantly for the distribution of wealth and transparency there must be a centralised way in which to manage fees, such as the 'forest tax', 'camping tax', clarity in how much to pay, and who money should go to. There should also be more general advice to visitors about how to spend and distribute money in daily life whilst living in Kobokara.

Ecotourism in Kobokara should be mindful and respectful of what NGOs in Kobokara aim to achieve, but if ecotourism does become established here, the most important suggestion I would make would be to keep an ear turned to the people. So much good work goes on in Kobokara it is essential to ensure that this work has maximum positive impact.

17.6 Conclusion

In Kobokara, the warmness of its people that makes it such a unique and attractive place could be threatened by an influx of wealth that may not be accessible to everyone in the village. Seeing this village the way that we saw it- Kobokara had a distribution system that was adapted to the existing availability of resources. Although equality is not absolute, within each of the six extended family units there was enough of a system of support mechanism that distribution was not presented to me as a strident village discourse. Yet, during our stay in Kobokara, we became aware of the fact that our money was only circulating among the families in closest proximity to where we were sleeping. Meaning that we had accidently created a new set of inequalities. Once we were aware of this, we attempted to shop around the village for fresh items, such as eggs, and we donated generously to events that we attended in other parts of the village, such as the two funerals. However, we continually found that it was easier to establish links with individuals that were already privileged: young people who attended school outside of Kobokara, and people farming enough to produce delicious-looking items to sell to us. Through English lessons, and walking the village to meet new people, we did establish relationship with a wider circle of people. Nonetheless, it seemed that there is a process of 'self selection' that marginalises individuals who do not feel they have the means to establish relationships with *vazaha*. This model was also the case for individuals working with NGOs, as our friends proudly told me one day that NGOs always chose certain villagers because NGOs 'trusted' them.

The people of Kobokara are extremely fortunate; they live in a place of natural beauty, and have such a dynamic culture that their village is an ideal location for ecotourism. The existing infrastructure and community's commitment to conservation projects that are established in the area also make Kobokara an ideal site for community-based ecotourism.

If ecotourism is established in this village, tourists can expect to enjoy diverse natural features and become familiar with the work of NGOs acting in the area. Particularly the temperament of people in the village is one of the greatest assets of the area; no one can feel unwelcome. The kindness with which we were treated was wonderful; I can only hope this does not become jaded

by tourism. Spending time in Ifotaka, where ecotourism has already been established, I did not find this to be the case: villagers there were extremely accommodating and resourceful; the village would adapt well to tourism. During an interview with *Rangahe* Jean Louis, I discovered that one family had even attempted to build *vazaha* style latrines, seeing this as a positive western adaptation. With openness to new ideas, and a love for the presence of *vazaha* in their village, Kobokara is likely to benefit from tourism. At the very least, the people of Kobokara will enjoy observing the follies of new *vazaha* in the future.

This leads me to finally recommend ecotourism as an appropriate way to empower villagers in Kobokara within the national economy; ecotourism should allow for the village to both modernise by offering a perspective on globalisation and also demonstrates the value of protecting traditions. Furthermore ecotourism encourages care for surrounding natural habitats, meaning that there is a chance for synthesis between the culture centred and biodiversity centred NGO projects. Based upon the evidence that I saw for the way in which Kobokara's people are vulnerable to outside influences, it is of the utmost importance that ecotourism is implemented by a person, or body of people, who are willing to become familiar (if not already familiar) with the cultural needs of Antandroy people, and perhaps more specifically even, the needs of people within the village itself. Ecotourism is a tool that can be beneficial to a great number of people when implemented correctly. I have no doubts that Kobokara is the right place for sensitively implemented ecotourism.

18 Notes and Recommendations on Kobokara

Mark Scherz

It is important that we make a few concluding notes on the area around Kobokara for the benefit of future researchers and NGOs working in this area.

18.1 Bushmeat

The consumption of bushmeat can be quite unsettling for some of the more reserved explorers. We were repeatedly offered various animals from the forest, including lesser hedgehog tenrecs (*Echinops telfairi*), couas (genus *Coua*), and buttonquail (*Turnix nigricollis*). These animals are a significant and important part of the diet of the local people, and studies have shown that their consumption greatly benefits the health, particularly in children (Golden et al., 2011). This is perhaps unsurprising, as these people rarely consume meat, their livestock serving more as a statement of wealth than a source of food.

From a conservation perspective, it is difficult to justify the consumption of many of these animals. However, it is important to observe local practices when attempting to integrate. Refusing food laid out before you, unless you think there is a high likelihood of it actually causing irrevocable damage, is never a good idea. At the same time, sustainability should be maintained when bushmeat is being consumed. We were very glad to consume buttonquail whenever it was presented to us, as these birds are found in significant numbers in the forest. Other animals, with the exception of fish, were refused. Larger expeditions should exercise restraint when consuming bushmeat, as over-exploitation could rapidly lead to stock depletion.

There may be some difficulty in conducting studies on small mammals in the forests around Kobokara. Tenrecs trapped in pitfall arrays are quickly snatched up and eaten by local staff. It would be difficult, I think, to convey a desire to keep tenrecs alive long enough to get an idea of their numbers.

18.2 Local Health, Risks and Malaria

Parasite incidence in the human population appeared low, though no investigations were made into the presence of dormant parasites. Giardia is certainly prevalent in the area, though our team was fortunate enough to escape it.

Several goats, sacrificed for our leaving feast, were found to have blowfly larvae living inside their skulls. We are unsure whether this species of fly ever lays its eggs in humans, but care should still be taken to avoid these parasites where possible. Finding them in goats was quite unsettling enough.

We observed at least two cases of malaria, including one in an extremely young child. The drugs to treat malaria (e.g. chloroquine) are apparently fairly easy to come by, and many local people have been trained in their administration. Nonetheless, it is likely that malaria is responsible for a significant number of deaths in the area every year.

There are several individuals in the village who have disabilities, including Down syndrome and epilepsy. The girl with epilepsy is having it managed through drugs, but still has regular attacks, and is ill-treated by her fellow villagers. Managing in such a harsh environment with such disabilities must be incredibly difficult, and was sobering for the entire team. It is unlikely that better treatment will be available in the area for some time. This situation highlights the need for medical facilities available locally, and would be an ideal target for related NGOs.

Scorpions are of considerable risk, although we were able to avoid being stung. A UV torch was brought with us into the field. On night walks, I would shine this while turning over stones. Nearly all of the stones turned were home to at least one scorpion. With such prevalence, and the lack of substantial footwear available for local people, I imagine there are relatively large numbers of stings per year. These species are probably not life threatening, but severe anaphylaxis would result in almost certain death. All expeditions to this area should bring an EpiPen or vials of adrenaline for emergency administration.

The need for medical education has been weakly addressed by recent efforts in the area. Although condoms are available on the market, it is unlikely that their use is widespread. Nevertheless, the HIV and AIDS have not yet spread to more remote villages, and prophylactic education in the use of, and need for, contraceptives could mitigate potential crises, while at the same time reducing population growth rate – an important step towards reducing pressures on local forests.

18.3 Architecture and Education

The buildings of Kobokara are constructed primarily from wood. More wealthy individuals are able to afford larger, more elaborate huts, and a few of these are constructed from brick. The main school in the village has collapsed somewhat, and is in dire need of renovation. The Vice President told us that he was ashamed of the level of English speaking in the village, and that he wanted to improve this, but before it would be possible, the school would have to be rebuilt.

The value of education to this community cannot be overstated, and it is clearly desired. Literacy levels were surprisingly high in the younger generation, showing a marked improvement over the older generations. Reading and arithmetic lessons for both young and old individuals would be of great help to the local community, and important in encouraging ecotourism as discussed in Section 17, above. Again, these projects would be ideal for future NGO efforts.

18.4 Faunal Research Possibilities

There are a great many species, which we did not study, but noticed while conducting our fieldwork. I feel it would be beneficial to relate which are of significant interest, for the benefit of future expeditions and research.

The mammals of the CDU forest were difficult to observe. Large lemurs were rarely seen, but extremely tolerant of human activity. Our guide told me that they have no fear of people, because they feel protected amongst the spines of the *Alluaudia*, within which they hide. Mouse lemurs, genus *Microcebus*, were commonly observed at night, both in the forest and around the village. We trapped only three species of small mammal in our pitfalls: *Mus musculus*, *Microgale brevicaudata*, and *Echinops telfairi*. Further research would reveal if these are the only species present in the area, but the diversity does not appear to be great. Bats appear to be abundant in the area, though we were not able to identify any of those we observed.

The birds of this forest are certainly diverse, and worthy of investigation. Although it is unlikely that this forest harbours new species, the *Coua* has been highlighted as a conservation priority in the Ifotaka-North Protected Area (Ferguson, 2011a), and its status in this forest should therefore be assessed.

There is considerable research potential for the well-trained entomologist in this area. Although we cannot assume to know a great deal of entomology, Matthew and I were able to identify at least twenty-five species of butterfly. Studies on the arthropods of the area would be of particular interest, as they may give insight as to the effect of the shift in reptile and plant species composition we observed in response to disturbance.

19 LOGISTICS REPORT

19.1 Pre-expedition

19.1.1 Fundraising

Fundraising was a continual process, which started before the team was even assembled. All UK team members made donations of £200 to get the project started. A wide variety of grants and scholarships were then applied for. Ninette's previous experience meant that she was able to supervise fundraising.

We packed bags at a grocery store, and were thereby able to raise £200 in one afternoon for the project. Natalie organised a band night, titled "Mada-musi-car", which also raised a significant amount of money

Emergency funding was pursued at the end of the pre-field phase, as several grants had not yet been delivered. This funding was, however, unnecessary, and was subsequently returned. In the field, additional funds were also procured from Barry Ferguson, but were subsequently returned when they too were found to be unnecessary.

19.1.2 Science Equipment

A large portion of the science equipment used on this expedition was sourced from the University of Edinburgh and has been returned. Equipment that could not be sourced from the university was purchased using expedition money, and donated to CEL, OpWall, or kept for use on subsequent expeditions.

19.1.3 Medical Kit

Medical equipment was acquired by Elise Bardsley, or donated by Matthew May (for the full medical kit list, see Section 21.1). Items with restricted use, including those that had expired, were destroyed upon returning from the field.

19.1.4 Flights

Flights to Madagascar were booked through Air France. Flights from Antananarivo to Fort Dauphin were booked in Antananarivo once our permits had been collected. Flights from Fort

Dauphin to Antananarivo were purchased at the Air Madagascar office. The expedition covered the expense of flights from Edinburgh to Fort Dauphin and back.

19.1.5 Satellite Phone

A second-hand Iridium® satellite phone was purchased for the purpose of this expedition, loaded with 75 minutes of talking time, to be used up over three months. Due to misunderstandings that arose, it became necessary to top-up the phone whilst we were in the field. However, for the majority of our time there, the phone was un-usable.

19.2 During the expedition

All equipment, both scientific and personal, was carried by the team as hand and hold luggage on their domestic and international flights to Madagascar. Plastic sheeting and maps of the region were sourced in Antananarivo. Due to luggage restriction, the majority of the expedition equipment had to be transported as excess luggage on the domestic Madagascar flights at the cost of €1 per kilogram.

All cooking & digging equipment was sourced at Tanambao market in Fort Dauphin. Additionally, drawing and painting supplies were sourced from shops in Fort Dauphin. Basic seasoning and cooking ingredients, such as oil & salt were bought from a supermarket in Fort Dauphin.

Trap-making equipment, such as chicken wire, was sourced from a hardware store in Fort-Dauphin.

Transport into the field was in a large converted cattle truck cooperatively hired with Barry Ferguson, who was transporting supplies to roughly the same area as us. A basic supply of fruit, vegetables, other foodstuffs, and non-perishables, was bought at markets en route to Kobokara.

Whilst the team was in the field, water was procured from the Mandrare River by digging holes in the flood plains and filtering the water that diffused into the holes using a 1-micron filter bag. The water was then chemically treated using “Sur Eau”, a USAID chlorine solution readily available in Malagasy cities.

Vegetables and rice were bought once a week from the weekly market at Fenoaivo, a village 1-2 hours walk from Kobokara. Meat, in the form of *Kibo* (Button Quail), Beef, or Goat was bought from villagers in Kobokara. Where possible, vegetables and fruit were bought from Kobokara or Besely.

To leave the field, 5 members of the team took an oxcart to Ifotaka and then a scheduled taxi-brousse to Amboasary, where they took a further regular taxi-brousse to Fort Dauphin, taking only a day bag with them. The remaining 3 members of the team returned to Fort Dauphin by chartered 4x4 with all of the equipment and remaining bags.

Cooking and trap making materials were donated to the village of Kobokara and CEL for use on future expeditions. A personal tent and miscellaneous equipment was donated to OpWall.

Team members carried remaining equipment as luggage on domestic and international flights back to Europe.

20 FINANCIAL REPORT

Income	
From	**Amount**
Royal Geographical Society	£ 1'250.00
Weir Fund	£ 4'000.00
Anonymous Grant	£ 300.00
Zoological Society London	£ 1'800.00
Mohamed bin Zayed Species	£ 3'190.00
Davis Fund	£ 2'100.00
Barnson Bequest	£ 250.00
Albert Rickett	£ 750.00
Fundraising	£ 553.28
Personal Contribution	£ 1‘400.00
Total	**£ 15‘593.28**

Expenses - Preparation	
From	**Amount**
Research Permits	£ 400.00
Administration Costs	£ 108.01
Wilderness Medicine Training	£ 400.00
Flights	£ 5’934.86
Visas	£ 280.00
UK Transport to Training	£ 65.00
Student Bursaries	£ 450.00
Satellite Phone	£ 1‘070.00
Camp Equipment	£ 668.68
Medical Kit	£ 612.37
Scientific Equipment	£ 704.22
Insurance	£ 337.00
Total	**£ 11’030.14**

Expenses – In Country	
From	**Amount**
Food	£ 343.67
Accommodation	£ 199.39
Maps	£ 32.78
Local Transport	£ 398.11
Local Help (Translator, Guide, Cook)	£ 1‘102.50
Miscellaneous	£ 104.57
Medical Kit	£ 512.37
Scientific Equipment	£ 1‘102.50
Total	**£ 3‘795.89**

Expenses – Post-Expedition	
From	**Amount**
Travel RGS-IBG Explore 2011	£ 257.35
Travel ZSL Conference	£ 200
Travel Anglo-Malagasy Society Talk	£ 80
Administration	£ 263.93
Total	**£ 801.28**

Total Income	Total Expenditure
£ 15‘593.28	£ 15‘627.31

21 MEDICAL AND SAFETY REPORT

21.1 Medical Arrangements:

Matthew May replaced Elise Bardsley as Medical Officer when she was forced to drop out of the expedition due to unforeseen circumstances. Matthew has a background in event and expedition First Aid, including significant experience teaching and using First Aid in remote African environments, and was therefore suited to the position.

Between departure and entry into the field Matthew provided the team with basic First Aid training.

A Satellite phone was available throughout the expedition, and all team members were familiar with its use.

Full medical insurance was taken, including emergency evacuation back to UK by air (AON Insurance) and Campbell Irvine insurance. All team members were made aware of the repatriation facility covered by the expedition insurance, and emergency contact details.

Before leaving for the field, all members of the team were briefed on the risk assessment and where it could be found.

In the field, all team members were made aware of the location of the medical kits and manuals/handbooks

21.2 Medical Kit Supplies:

21.2.1 Expedition Medical Kit Contents

The following is a comprehensive list of the expedition medical kit.

Table 21.1 - Comprehensive Medical Kitlist

Item	Quantity	Item	Quantity
10ml syringe	15	Jelonet	
2ml syringe	13	Large crêpe bandages	6
4ml syringe	1	Large plain wound dressings	2
5ml syringe	5	Large sterile dressing	1
Absorbent cotton wool rolls	2	Lidocaine	10
Adhesive dressing	20	Low adhreant dressing pads	5
Adrenaline	5	Meloline wound dressing	15
Alcotip swabs		Metronidazole	
Assorted Plasters		Micro-porus tape	8
Assorted Scalpels	12	Moist cleansing wipes	40
Bactroban		Orange needles	10
Blue Canula	6	Otoscope	
Blue Needles		Paracetamol	120
Buccastem tablets		Pink Canula	3
Chlormephamine	5	powder free latex gloves	
Ciprofloxacine-Mepha	10	Ranitidine tabs	
Clarithromycin		Rehydration Powder	
Clotrimazole		Reli-strip	2
Co-amoxi-mepha 100	20	Rusch sterile pack	2
Co-amoxiclav	30	Safety pins	12
Co-codamol	40	Skin cleansing swabs	
Compressed dressings	3	Standard suture pack	5
Cotton Wool		Steri-strip	1
Cottong gauze swabs	10	Sterile surgical kit	2
Doxycycline	30	Sterile swabs	3
Eye-pad dressing		Sting and bite cream	
Fluorescein sodium strips		Suture	
Green Needles	18	Tetracaine	
Grey Canula	3	Thermometer	
Guedel Airway	6	Thin microporous tape	
Harmann's fluid	1	Tramadol	5
Hydrocortazone cream	2	Transfusion set	
Hydrocortozone		Triagular calico bandage	1
Ibuprofine	140	Wound closure strips	2
Ice Pack	2	Zinc oxide self-adhesive plaster roll	
Immodium	14	Zirtec	80

21.2.2 Personal Medical Kit Contents

Plasters

Blister pads or Moleskin, mole foam, Compeed

Antiseptic wipes

Antibacterial handwash

Rehydration sachets (e.g Diarolyte)

Sunscreen

Insect Repellent

Bite Cream/Gel/Spray

Mosquito net

Basic anti-inflammatory/pain relief (Ibuprofen, Paracetamol)

Throat Lozenges (e.g strepsils)

Immunization card with Yellow Fever Certificate

Antidiarrhoea Medication (e.g Immodium)

Any personal medication

21.3 Preventative Medicines and Inoculations

All UK expedition participants undertook a course of anti-malarial prophylaxis in the form of Mefloquine, Malarone, or Doxycyclin.

All European participants were up to date with the following inoculations: Hepatitis A; Hepatitis B; Meningitis C; Polio; Rabies; Typhoid; Tetanus; and Yellow Fever.

21.4 Management of Emergencies and Evacuation

There was regular transport from the local village of Ifotaka, which was approximately 2-3 hours by oxcart from Kobokara. In the event of an emergency, Matthew would take charge of the situation and organise a plan of action for Mark to implement. In the event of the casualty requiring extraction from the field, casualties would be transported by oxcart to Ifotaka. In the event of a life-threatening condition, a 4x4 vehicle would be summoned by Satellite Phone to meet the casualty and medic in Ifotaka and bring them to a hospital in Fort-Dauphin.

In the event of serious injuries or other life-threatening conditions, the possibility of evacuation by air would be considered but not at the expense of the casualty waiting. Their insurance provider would be notified. The casualty would subsequently be transferred to a European standard hospital in Reunion, South Africa, or Kenya. Repatriation through their insurance provider would have been called upon in the case of casualties requiring specialist care e.g. surgery.

Such evacuation and repatriation procedures were fully covered by the medical insurance taken out by the team. The team was fortunate enough to not have to put into use any of these arrangements. The effectiveness of such arrangements cannot therefore be commented upon.

21.5 Risk Assessment

A thorough risk assessment was compiled before leaving Edinburgh. This was discussed with CEL students before entering the field. It was reviewed regularly and modified according to conditions, and always through discussion between two or more team members.

21.6 Medical incidents and issues raised

Two instances of dehydration occurred and were treated successfully and without the need for evacuation. However, both cases were avoidable and resulted from a break down in team dynamics and organisation, as well as poor judgment on the part of an individual.

Two avoidable cases of gastronomic upsets occurred, both from the poor judgment of individuals by consuming pieces of unidentified plants.

One member of the team suffered from mild fever, exhaustion and constipation. They were evacuated to Fort-Dauphin by 4x4 and spent 3 days recovering after seeking medical examination and receiving a negative result on a malaria test. A course of Coartem® was administered as a precautionary measure.

There were no known incidences of infection by water-associated disease.

There was one occurrence of a suspected chest infection in an asthma sufferer. This was successfully treated with a course of antibiotics.

A few cases of traveller's diarrhoea were experienced, most likely contracted from contaminated food or related to malaria prophylaxis.

Whilst it was relatively easy to control the contamination risk to water (by careful cleaning of the water filter and apparatus, and by allowing each individual to be responsible for their own water), it was more difficult to maintain checks on food, which was purchased on local markets and prepared by cooks, who were hired locally.

Numerous wounds from the spiny forest occurred, particularly among the scientists. These were disinfecting with Melfen, and where necessary the offending spines were removed.

Sunburn was occasionally a problem due to not wearing appropriate clothing. Burnt areas were cooled and later moisturised with aloe-vera gel or after-sun.

One team member suffered a gastrointestinal infection at the end of the trip, which continued for 5 weeks after returning to Europe.

21.7 Preventative, hygienic and environmentally sensitive practices adopted

Drinking water was collected from holes dug by the side of the river, and filtered using 1 micron filter bags, before being chemically treated with "Sur Eau", a chorine solution obtainable locally and subsidised by USAID.

Food was stored in an allocated tent, and efforts were made to keep insects and other pests out, although on two occasions mice got into the tent and were dealt with.

Food hygiene was overseen by a designated member of the team, but the employed cooks were responsible for food preparation. At the start of the expedition, efforts were made to communicate food hygiene to all members of the team. No serious instances of food poisoning occurred.

Firewood consisted of dead wood bought from the village. Due to the dry, hot climate, appropriate wood was fairly abundant.

During the expedition a 2m x 2m x 2m latrine was dug to the west of Kobokara in the designated "toilet area". The medical officer treated the latrine each week with bleach to reduce the insect infestation. Upon leaving the village, it was requested that the latrine remain open for use by villagers.

Great care was taken to check for scorpions when moving personal possessions or equipment at the campsite. There were considerable numbers of small scorpions under the rocks around the village; these rocks were left alone so as not to disturb them.

When travelling to the field, paths were used wherever possible. Careful progression through the forest meant that machetes were not required. No clearing of vegetation occurred for research

during the expedition. Appropriate clothing was worn, and plants known to cause skin irritations were treated with caution.

At the end of each week rubbish and medical waste (except needles) were disposed of by burning them in a fire pit away from camp. Needles and scalpel blades were deposited into a Sharps Bin that was brought from the UK, and disposed of upon our return.

The Medical procedures employed during the expedition were adopted and modified through the acquired knowledge of the medical officer, local knowledge and the common sense of all team members. Practices were discussed by the team regularly, and modified as more experience was gained.

22 ITINERARIES

22.1 Overall Itinerary

Day	July	August	September
1		Fieldwork	End of Fieldwork
2			Final arrangements, meetings and packing
3			
4			
5			Travel to Fort Dauphin
6			Meetings, Data-processing, Presentation at CEL, Translation
7			
8			
9			Flight to Antananarivo
10			Translations, Data-processing
11	Flight to Antananarivo		
12	Permit and equipment acquisition		
13			Flight to Edinburgh
14			
15			
16	Flight to Fort Dauphin		
17	Meetings with Students, Barry, WWF, and ESSA-Fôrets, equipment acquisition.		
18			
19	Travel to Kobokara		
20	Fieldwork		
21			
22			
23			
24			
25			
26			
27			
28			
29			
30/31			

22.2 Pitfall Traps

Day	July	August		September
1		Pilot	L001 Setup	L005
2		Pilot	L001 Setup	
3		Pilot	L001	
4		Pilot	L001	
5		Pilot	L001	
6		Pilot	L001	
7		Pilot	L001	
8		Pilot	L001	
9		L002 Setup	L001	
10		L002 Setup	L001	
11		L002		
12		L002	L003 Setup	
13		L002	L003 Setup	
14		L002	L003	
15		L002	L003	
16		L002	L003	
17		L002	L003	
18			L003	
19			L003	
20			L003	
21	Pilot Walk	L004 Setup		
22	Pilot Walk	L004 Setup		
23	Pilot Setup	L004		
24	Pilot Setup	L004		
25	Pilot	L004	L005 Setup	
26	Pilot	L004	L005 Setup	
27	Pilot	L004	L005	
28	Pilot	L004	L005	
29	Pilot	L004	L005	
30/31	Pilot		L005	

23 WORKS CITED

Adelaar, A., 1995. Asian roots of the Malagasy; A linguistic perspective. *Bijdragen tot de Taal-, Land- en Volkenkunde*, 151(3), pp.325-56.

Andreone, F. et al., 2005. Species Review of Amphibian Extinction Risks in Madagascar: Conclusions from the Global Amphibian Assessment. *Conservation Biology*, 19(6), p.1790–1802.

ANGAP, 2001. *Madagascar Protected Area System Management Plan*. Association Nationale pour la Gestion des Aires protégées.

Ballesteros-Barrera, C., Martínez-Meyer, E. & Gadsden, H., 2007. Effects of Land-Cover Transformation and Climate Change on the Distribution of Two Microendemic Lizards, Genus Uma, of Northern Mexico. *Journal of Herpetology*, 41(4), pp.733-40.

Basso, K., 1984. Stalking with Stories: Names, Places, and Moral Narratives among the Western Apache. In E.M. Bruner, ed. *Text, Play and Story*. Indiana, USA: American Ethnological Society.

Behler, J., 2002. Madagascar tortoise crisis. *Turtle and Tortoise Newsletter*, 5, pp.18-19.

Behler, J.L. & Iaderosa, J., 1991. A Review of the Captive Breeding Program for the Radiated Tortoise at the New York Zoological Society's Wildlife Survival Center. In *Proceedings 1st International Symposium Turtle & Tortoises: Conservation Captive Husbandry*., 1991. California Turtle and Tortoise Club.

Bell, T.P., 2009. A novel technique for monitoring highly cryptic lizard species in forests. *Herpetological Conservation and Biology*, 4(3), pp.415-25.

Bennett, D., 1999. *Expedition Field Techniques Reptiles and Amphibians*. London, UK: Geography Outdoors.

Berger, L. et al., 1998. Chytridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America. *Proceedings of the National Academy of Sciences of the United States of America*, 95(15), pp.9031-36.

Binggeli, P., 2003. Cactaceae, Opuntia spp., Prickly Pear, Raiketa, Rakaita, Raketa. In S.M. Goodman & J.P. Benstead, eds. *The Natural History of Madagascar*. Chicago, Illinois, USA: The University of Chicago Press.

Blench, R., 2006. The Austronesians in Madagascar and on the East African coast: surveying the linguistic evidence for domestic and translocated animals. In *Tenth International Conference on Austronesian Linguistics*. Palawan, Philippines, 2006. Linguistic Society of the Philippines and SIL International.

Blench, R., 2007. New palaeozoogeographical evidence for the settlement of Madagascar. *Azania: Archaeological Research in Africa*, 42, pp.69-82.

Brooks, S., 2005. Images of 'Wild Africa': Nature tourism and the (re)creation of Hluhluwe game reserve, 1930-1945. *Journal of Historical Geography*, 31, pp.220-40.

Bull, J.J., 1980. Sex Determination in Reptiles. *The Quarterly Review of Biology*, 55(1), pp.3-21.

Butler, R., 2009. *Threats to Madagascar's biodiversity and ecosystems*. [Online] Available at: http://www.wildmadagascar.org/conservation/threats.html [Accessed 17 May 2012].

Cagle, F.R., 1939. A System of Marking Turtles for Future Identification. *Copeia*, 1939(3), pp.170-73.

Cain, R. et al., 2003. *Project Tany Tsilo*. Expedition Report. Durham: University of Durham.

Carignan, V. & Villard, M.-A., 2002. Selecting Indicator Species to Monitor Ecological Integrity: A Review. *Environmental Monitoring and Assessment*, 78, pp.45-61.

CEPF Madagascar, 2007. *Ampihany Map*. [Online] Available at: http://www.vegmad.org/downloads/pdfs/ftm/10_Amoanihy.pdf [Accessed 25 May 2012].

CIA, 2012. *Madagascar*. [Online] Available at: https://www.cia.gov/library/publications/the-world-factbook/geos/ma.html [Accessed 28 January 2012].

CITES, 2011. *Appendices I, II, and III*. [Online] Available at: http://www.cites.org/eng/app/appendices.php [Accessed 16 January 2012].

Clayton, A., 2011. A Review of Policies to Combat Deforestation in Madagascar. *Backgrounder*, 12, pp.1-8.

Corlett, R.T., In Press. Climate change in the tropics: The end of the world as we know it? *Biological Conservation*.

Cornet, A., 1972. Carte Bioclimatique de Madagascar.

Cox, M.P. et al., 2012. A small cohort of Island Southeast Asian women founded Madagascar. *Proceedings of the Royal Society: B*.

Crosswhite, D.L., Fox, S.F. & Thill, R.E., 1999. Comparison of Methods for Monitoring Reptiles and Amphibians in Upland Forests of the Ouachita Mountains. *Proceedings of the Oklahoma Academy of Science*, 79, pp.45-50.

Crowley, B.E., 2010. A refined chronology of prehistoric Madagascar and the demise of the megafauna. *Quaternary Science Reviews*, 29, pp.2591-603.

D'Cruze, N., Green, K.E., Robinson, J.E. & Gardner, C.J., 2006. A rapid assessment of the amphibians and reptiles of an uprotected area of dry deciduous forest in north Madagascar. *Herpetological Bulletin*, 96, pp.17-25.

D'Cruze, N. & Kumar, S., 2011. Effects of anthropogenic activities on lizard communities in northern Madagascar. *Animal Conservation*, 14, pp.542-52.

D'Cruze, N., Olsonn, A., Henson, D. & Sunil Kumar, D.E., 2009. The Amphibians and Reptiles of the Lower Onilahy River Valley, A Temporary Protected Area in Southwest Madagascar. *Herpetological Conservation and Biology*, 4(1), pp.92-79.

de Wit, M.J., 2003. MADAGASCAR: Heads It's a Continent, Tails It's an Island. *Annual Review of Earth and Planetary Science*, 21, pp.213-48.

Denton, B., 2003. *Bevia Expedition 2003*. Expedition Report. The University of East Anglia.

Devaux, B., 2010. Astrochelys radiata a very threatened "star". *Chelonii*, 8.

Du Puy, D. & Moat, J., 1996. A Refined Classification of the Primary Vegetation of Madagascar Based on the Underlying Geology Using GIS to Map its Distribution and to Assess its Conservation Status. *Biogeographic de Madagascar*, pp.205-18.

Du Puy, D.J. & Moat, J.F., 1998. Vegetation Mapping and Classification in Madagascar (using GIS): Implications and Recommendations for the Conservation of Biodiversity. In C.R. Huxley, J.M. Lock & D.F. Cutler, eds. *Chorology, taxonomy and Ecology of the African and Madagascan floras.*. Kew: Royal Botanic Gardens. pp.97-117.

Du Puy, D.J. & Moat, J., 2003. Using Geological Substrate to Identify and Map Primary Vegetation Types in Madagascar and the Implications for Planning Biodiversity Conservation. In S.M. Goodamn & J.P. Benstead, eds. *The Natural History of Madagascar*. Chicago, Illinois, USA: The University of Chicago Press. pp.51-67.

Dufils, J.M., 2003. Remaining forest cover. In S.M. Benstead & J.P. Benstead, eds. *The Natural History of Madagascar*. Chicago, Illinois, USA: University of Chicago Press. pp.88-96.

Durbin, J., 2007. *British and Irish Association of Zoos and Aquariums*. [Online] Available at: www.biaza.org.uk/resources/library/images/01DurbanVision.pdf [Accessed 12 January 2012].

Durrell, L., Goombridge, B., Tonge, S. & Bloxam, Q., 1989. Geochelone radiata, Radiated Tortoise. In I.R. Swingland & M.W. Klemens, eds. *The Conservation Biology of Tortoises*. Gland, Switzerland: IUCN. pp.96-98.

Durso, A.M., Willson, J.D. & Winne, C.T., 2011. Needles in haystacks: Estimating detection probability and occupancy of rare and cryptic snakes. *Biological Conservation* , 144, p.1508–1515.

Ellison, A.M. & Farnsworth, E.J., 1996. Anthropogenic Disturbance of Caribbean Mangrove Ecosystems: Past Impacts, Present Trends, and Future Predictions. *Biotropica*, 28(4), pp.549-565.

Enge, K.M., 2001. The Pitfalls of Pitfall Traps. *Journal of Herpetology*, 35(3), pp.467-78.

Erdmann, T.K., 2003. Selected Forest Management Initiatives and Issues with an Emphasis on the Cadre d'Appui Forestier Project. In S.M. Goodman & J.P. Benstead, eds. *The Natural History of Madagascar*. Chicago, Illinois, USA: University of Chicago Press.

Fenn, M.D., 2003. The Spiny Forest Ecoregion. In S.M. Goodman & J.P. Benstead, eds. *The Natural History of Madagascar*. Chicago, Illinois, USA: The University of Chicago Press. pp.1525-30.

Ferguson, B., 2011a. *Ifotaka North Protected Area—Participatory Environmental Monitoring Plan 3rd Draft*. Centre Ecologique de Libanona.

Ferguson, B., 2011b. *Photo Guide to the Plants of the Mandrare Valley, Madagascar*. 3rd ed.

Ferguson, B. et al., 1999. *Project Ifotaka 1999 Final Report*. Expedition Report. Durham: University of Durham.

Fowler, J., Cohen, L. & Jarvis, P., 1998. *Practical Statistics for Field Biology*. 2nd ed. Chichester, West Sussex, UK: John Wiley & Sons Ltd.

Gardner, T.A., Barlow, J. & Peres, C.A., 2007. Paradox, presumption and pitfalls in conservation biology: The importance of habitat change for amphibians and reptiles. *Biological Conservation*, 138, pp.166-79.

Gautier, L. & Goodman, S.M., 2003. Introduction to the Flora of Madagascar. In S.M. Goodman & J.P. Benstead, eds. *The Natural History of Madagascar*. Chicago, Illinois, USA: The University of Chicago Press. pp.229-50.

Glaw, F. & Vences, M., 2003. Amphibians. In S.M. Goodman & J.P. Benstead, eds. *The Natural History of Madagascar*. Chicago, Illinois, USA: The University of Chicago Press. pp.883-933.

Glaw, F. & Vences, M., 2007. *A Field Guide to the Reptiles and Amphibians of Madagascar*. 3rd ed. Cologne, Germany: Vences & Glaw Verlags GbR.

Golden, C.D. et al., 2011. Benefits of wildlife consumption to child nutrition in a biodiversity hotspot. *Proceedings of the National Academy of Sciences of the United States of America*, 108(49), pp.19653-56.

Goodman, S.M. & Benstead, J.P., eds., 2003. *The Natural History of Madagascar*. Chicago, Illinois, United States of America: The University of Chicago Press.

Greenberg, C.H., Neary, D.G. & Harris, L.D., 1994. A Comparison of Herpetofaunal Sampling Effectiveness of Pitfall, Single-ended, and Double-ended Funnel Traps Used with Drift Fences. *Journal of Herpetology*, 28(3), pp.319-24.

Guah, R., 1997. The authoritarianism of the biologist and the arrogance of anti-humanism. *The Ecologist*, 27(1), pp.14-20.

Hardin, G., 2001. The Tragedy of the Commons. *The Social Contract*, Fall. pp.26-35.

Harper, G.J. et al., 2007. Fifty years of deforestation and forest fragmentation in Madagascar. *Environmental Conservation*, 34(4), pp.1-9.

Hecnar, S.J. & M'Closkey, R.T., 1998. Effects of human disturbance on five-lined skink, Eumecesfasciatus, abundance and distribution. *Biological Conservation*, 85, pp.213-22.

Holloway, L., 2003. Ecosystem Restoration and Rehabilitation in Madagascar. In S.M. Goodman & J.P. Benstead, eds. *The Natural History of Madagascar*. Chicago, Illinois, USA: The University of Chicago Press.

Innes, J.L., 2010. Madagascar rosewood, illegal logging and the tropical timber trade. *Madagascar Conservation and Development*, 5(1), pp.6-10.

IRIN, 2006. *Madagascar establishes new park system to protect lemurs, benefit people*. [Online] Available at: http://news.mongabay.com/2006/0117-madagascar.html [Accessed 12 January 2012].

Irwin, M.T. et al., 2010. Patterns of species change in anthropogenically disturbed forests of Madagascar. *Biological Conservation*, 143, p.2351–2362.

IUCN, 2001. *2001 Categories & Criteria*. [Online] (3.1) Available at: http://www.iucnredlist.org/apps/redlist/static/categories_criteria_3_1 [Accessed 29 January 2012].

IUCN, 2011a. *Another leap towards the Barometer of Life*. [Online] Available at: http://iucn.org/about/work/programmes/species/?8548/Another-leap-towards-the-Barometer-of-Life [Accessed 10 January 2012].

IUCN, 2011b. *The IUCN Red List of Threatened Species*. [Online] Available at: http://www.iucnredlist.org/ [Accessed 16 January 2012].

Janzen, F.J. & Paukstis, G.L., 1991. Environmental Sex Determination in Reptiles: Ecology, Evolution, and Experimental Design. *The Quarterly Review of Biology*, 66(2), pp.149-79.

Jarosz, L., 1993. Defining and Explaining Tropical Deforestation: Shifting Cultivation and Population Growth in Colonial Madagascar (1896-1940). *Economic Geography*, 69(4), pp.366-79.

Jenkins, R.K.B. et al., 2003. Forest disturbance and river proximity influence chameleon abundance in Madagascar. *Biological Conservation*, 109, pp.407-15.

Kaufmann, J.C., 2004. Prickly Pear Cactus and Pastoralism in Southwest Madagascar. *Ethnology*, 43(4), pp.345-61.

Kaufmann, J.C., 2008. The non-modern constitution of famines in Madagascar's spiny forests: "water-food" plants, cattle and Mahafale landscape praxis. *Environmental Sciences*, 5(2), pp.73-89.

Kew Gardens, 2012a. *GIS and Conservation for Madagascar - Vegetation mapping*. [Online] Available at: http://www.kew.org/gis/projects/madagascar/primary_veg.html [Accessed 24 May 2012].

Kew Gardens, 2012b. *GIS and Conservation for Madagascar - Vegetation mapping*. [Online] Available at: http://www.kew.org/gis/projects/madagascar/fr_southern.html [Accessed 24 May 2012].

Kiss, A., 2004. Is community-based ecotousim a good use of biodiversity conservation funds? *Trends in Ecology and Evolution*, 19(5), pp.232-37.

Krause, D.W., 2010. Washed up in Madagascar. *Nature*, 463, pp.613-14.

Kuhnz, L.A., Burton, R.K., Slattery, P.N. & Oakden, J.M., 2005. Microhabitats and Population Densities of California Legless Lizards, with Comments on Effectiveness of Various Techniques for Estimating Numbers of Fossorial Reptiles. *Journal of Herpetology*, 39(3), pp.395-402.

Labat, J.-N. & Moat, J., 2003. Leguminosae (Fabaceae). In S.M. Goodman & J.P. Benstead, eds. *The Natural History of Madagascar*. Chicago, Illinois, United States of America: University of Chicago Press. pp.346-73.

Lehtinen, R.M., Ramanamanjato, J.-B. & Raveloarison, J.G., 2003. Edge effects and extinction proneness in a herpetofauna from Madagascar. *Biodiversity and Conservation* , 12, p.1357–1370.

Leuteritz, T.E.J., Lamb, T. & Limberaza, J.C., 2005. Distribution, status, and conservation of radiated tortoises (Geochelone radiata) in Madagascar. *Biological Conservation*, 124, p.451–461.

Leuteritz, T.E.J. & Ravolanaivo, R., 2005. Reproductive ecology and egg production of the radiated tortoise (Geochelone radiata) in southern Madagascar. *African Zoology*, 40(2), pp.233-42.

Leuteritz, T. & Rioux Paquette, S., 2008. *Astrochelys radiata*. [Online] (2011.2) Available at: www.iucnredlist.org [Accessed 29 January 2012].

Lewis, R., 1995. *Status of the Radiated Tortoise (Geochelone radiata)*. Unpublished. Madagascar: WWF.

Martin, T. et al., 2001. *Project Ifotaka 2001*. Expedition Report. Durham: University of Durham.

Miller, L., 2008. *Walking Amongst the Sacred Spines*. Fort Dauphin: School of International Training, CEL.

Missouri Botanical Garden, 2012. *Catalogue of the Vascular Plants of Madagascar*. [Online] Available at: http://www.tropicos.org/Project/MADA [Accessed 27 January 2012].

Morton, O., Conoboy, N., Baker, R. & King, P., 2010. *Spiny Forest Expedition*. Expedition Report. Brighton: University of Brighton.

Nagy, Z.T., Glaw, F. & Vences, M., 2010. Systematics of the snake genera Stenophis and Lycodryas from Madagascar and the Comoros. *Zoological Scripta*, 39(5), pp.426-35.

Noonan, B.P. & Chippindale, P.T., 2006a. Dispersal and vicariance: The complex evolutionary history of boid snakes. *Molecular Phylogenetics and Evolution*, 40, pp.347-58.

Noonan, B.P. & Chippindale, P.T., 2006b. Vicariant Origin of Malagasy Reptiles Supports Late Cretaceous Antarctic Land Bridge. *The American Naturalist*, 168(6), pp.730-41.

O'Brien, S.E.E.R. et al., 2003. Decline of the Madagascar radiated tortoise (Geochelone radiata) due to overexploitation. *Oryx*, 37, pp.338-43.

O'Brien, S.H., 2002. *Population dynamics and exploitation of the radiated tortoise Geochelone radiata in Madagascar*. PhD Thesis. Cambridge: University of Cambridge and the Zoological Society of London.

Olsen, N., Bishop, J. & Anstee, S., 2011. ISBN: 978-2-8317-1379-3 *Exploring ecosystem valuation to move towards net positive impact on biodiversity in the mining sector*. Technical Series No. 1. Gland, Switzerland: IUCN IUCN and Rio Tinto.

Palsson, G., 1996. Human-environmental relations: orientalism, paternalism and communalism. In P. Descola & G. Palsson, eds. *Nature and Society: Anthropological Perspectives*. London, United Kingdom: Routledge. pp.63-81.

Pedrono, M. & Smith, L.L., 2003. Testudinae, Land Tortoises. In S.M. Goodman & J.P. Benstead, eds. *The Natural History of Madagascar*. Chicago, Illinois, USA: The University of Chicago Press. pp.951-56.

Rakotondravony, H.A. & Goodman, S.M., 2011. Rapid Herpetofaunal Surveys within Five Isolated Forests on Sedimentary Rock in Western Madagascar. *Herpetological Conservation and Biology*, 6(2), pp.297-311.

Randriamahazo, H., Traylor-Holzer, K., Leus, K. & Byers, H.O., 2007. *Population and Habitat Viability Assessment Workshop for Endemic Tortoise Species in Madagascar Geochelone radiata (Madagascar radiated tortoise) Pyxis arachnoides (spider tortoise)*. IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, MN.

Randrianandianina, B.N., Andriamahaly, L.R., Harisoa, F.M. & Nicoll, M.E., 2003. The Role of the Protected Areas in the Management of the Island's Biodiversy. In S.M. Goodman & J.P. Benstead, eds. *The Natural History of Madagascar*. Chicago, Illinois, USA: The University of Chicago Press. pp.1423-32.

Raselimanana, A.P., 2003. Trade in Reptiles and Amphibians. In S.M. Goodman & J.P. Benstead, eds. *The Natural History of Madagascar*. Chicago, Illinois, USA: The University of Chicago Press.

Raxworthy, C.J., 2003. Introduction to the Reptiles. In S.M. Goodman & J.P. Benstead, eds. *The Natural History of Madagascar*. Chicago, Illinois, United States of America: The University of Chicago Press. pp.934-49.

Raxworthy, C.J., Forstner, M.R.J. & Nussbaum, R.A., 2002. Chameleon radiation by oceanic dispersal. *Nature*, 415, pp.784-87.

Raxworthy, C.J. & Nussbaum, R.A., 1994. A Rainforest Survey of Amphibians, Reptiles and Small Mammals at Montagne D'Ambre, Madagascar. *Biological Conservation*, 69, pp.65-73.

Rioux Paquette, S., Ferguson, B.H., Lapointe, F.-J. & Louis Jr, E.E., 2009. Conservation Genetics of the Radiated Tortoise (Astrochelys radiata) Population from Andohahela National Park, Southeast Madagascar, with a Discussion on the Conservation of This Declining Species. *Chelonian Conservation and Biology*, 8(1), pp.84-93.

Rioux Paquette, S. & Lapointe, F.J., 2007. The use of shell morphometrics for the management of the endangered malagasy radiated tortoise (Geochelone radiata). *Biological Conservation*, 134, pp.31-39.

Rioux Paquette, S., Louis Jr, E.E. & Lapointe, F.-J., 2010. Microsatellite Analyses Provide Evidence of Male-Biased Dispersal in the Radiated Tortoise Astrochelys radiata (Chelonia: Testudinidae). *Journal of Heredity*, 101(4), pp.403-12.

Rowland, N. et al., 2010. *Project Angavo, Madagascar 2010*. Expedition Report. Edinburgh: University of Edinburgh. Draft.

Ryan, T.J. et al., 2002. Monitoring herpetofauna in a managed forest landscape: effects of habitat types and census techniques. *Forest Ecology and Management*, 167, pp.83-90.

Sahlins, M., 1968. Notes on the Original Affluent Societies. In R. Lee & I. DeVore, eds. *Man the Hunter*. Chicago, Illinois, United States of America: Aldine. pp.85-89.

Said, E.W., 1995. *Orientalism: Western Conceptions of the Orient*. New Edition ed. London, United Kingdom: Penguin Books.

Samonds, K.E. et al., 2012. Spatial and temporal arrival patterns of Madagascar's vertebrate fauna explained by distance, ocean currents, and ancestor type. *PNAS*.

Schatz, G.E., 2001. *Generic Tree Flora of Madagascar*. Kew, UK: Royal Botanic Gardens.

Scherberger, A., 2008. *Ecotourism: the reality of its impacts and challenges, a case study of community based ecotousim in Ifotaka*.

Schnabel, Z., 1938. The estimation of total fish populations of a lake. *Am. Math. Monthly*, 45, pp.348-52.

Scott, D.M. et al., 2006. The impacts of forest clearance on lizard, small mammal and bird communities in the arid spiny forest, southern Madagascar. *Biological Conservation*, 127(1), pp.72-87.

Serva, M., 2012. The Settlement of Madagascar: What Dialects and Languages Can Tell Us. *PLoS One*, 7(1), p.e30666.

Slim, H. & Thompson, P.R., 1993. *Listening for a Change: Oral Testimony and Community Development*. London, UK: Panos Publications.

Spotila, J.R. et al., 1994. Effects of Incubation Conditions on Sex Determination, Hatching Success, and Growth of Hatchling Desert Tortoises, Gopherus agassizii. *Herpetological Monographs*, 8, pp.103-16.

Sprugel, D.G., 1991. Disturbance, Equilibrium, and Environmental Variability: What is 'Natural' Vegetation in a Changing Environment?. *Biological Conservation*, 58, pp.1-18.

Tofanelli, S. et al., 2009. On the Origins and Admixture of Malagasy: New Evidence from High-Resolution Analyses of Paternal and Maternal Lineages. *Molecular Biology and Evolution*, 26(9), p.2109–2124.

Tollenaere, C. et al., 2010. Phylogeography of the introduced species Rattus rattus in the western Indian Ocean, with special emphasis on the colonization history of Madagascar. *Journal of Biogeography*, 37, pp.398-410.

Vačkář, D. et al., 2012. Review of multispecies indices for monitoring human impacts on biodiversity. *Ecological Indicators*, 17, pp.58-67.

Valenzuela, N. & Janzen, F.J., 2001. Nest-site philopatry and the evolution of temperature-dependent sex determination. *Evolutionary Ecology Research*, 3, pp.779-94.

Vallan, D., 2003. Consequences of rain forest fragmentation for herpetofauna: a case study from Ambohitantley. In S.M. Goodman & J.P. Benstead, eds. *The Natural History of Madagascar*. Chicago, Illinois, USA: The University of Chicago Press. pp.899-907.

van Vliet, N. et al., 2012. Trends, drivers and impacts of changes in swidden cultivation in tropical forest-agriculture frontiers: A global assessment. *Global Environmental Change*.

Vieites, D.R. et al., 2009. Vast underestimation of Madagascar's biodiversity evidenced by an integrative amphibian inventory. *PNAS*, 106(20), pp.8267-72.

Viljanen, H., Escobar, F. & Hansk, I., 2010. Low local but high beta diversity of tropical forest dung beetles in Madagascargeb_552 886.894. *Global Ecology and Biogeography*, 19, pp.886-94.

Vincelette, M. et al., 2003. Mining and Environmental Conservation: The Case of QIT Madagascar Minerals in the Southeast. In S.M. Goodman & J.P. Benstead, eds. *The Natural History of Madagascar*. Chicago, Illinois, United States of America: University of Chicago Press. pp.1535-37.

Vogler, A.J. et al., 2011. Phylogeography and Molecular Epidemiology of Yersinia pestis in Madagascar. *PLoS Neglected Tropical Diseases*, 5(9), p.e1319.

Wallach, V., 1993. The Supralabial Imbrication Pattern of the Typhlopoidea (Reptilia: Serpentes). *Journal of Herpetology*, 27(2), pp.214-18.

Wallach, V. & Glaw, F., 2009. A new mid-altitude rainforest species of Typhlops (Serpentes: Typhlopidae) from Madagascar with notes on the taxonomic status of T. boettgeri Boulenger, T. microcephalus Werner, and T. capensis Rendahl. *Zootaxa*, 2294, pp.23-38.

Warrington, S., 2006. Listening to individual voices. *LEISA Magazine*, March. pp.37-39.

Weldon, C. et al., 2004. Origin of the Amphibian Chytrid Fungus. *Emerging Infectious Diseases*, 10(12), pp.2100-05.

Wells, N.A., 2003. Some Hypotheses on the Mesozoic and Cenozoic Paleoenvironmental History of Madagascar. In S.M. Goodman & J.P. Benstead, eds. *The Natural History of Madagascar*. Chicago, Illinois, USA: The University of Chicago Press. pp.16-34.

West, P. & Carrier, J., 2004. Ecotourism and Authenticity, Getting away from it all? *Current Anthropology*, 45(4), pp.483-98.

Yoder, A.D. & Nowak, M.D., 2006. Has Vicariance or Dispersal Been the Predominant Biogeographic Force in Madagascar? Only Time Will Tell. *The Annual Review of Ecology, Evolution, and Systematics*, 37, pp.405-31.

APPENDIX I: RESEARCH PERMITS

REPOBLIKAN'I MADAGASIKARA
Fitiavana-Tanindrazana-Fandrosoana

MINISTERE DE L'ENVIRONNEMENT ET DES FORETS
B.P: 3948, Antsahavola – ANTANANARIVO – 101-
Tel: (261 20) 22 411 55 – Fax: (261 20) 22 419 19

AUTORISATION DE :

x - RECHERCHE
- ETUDE

N° 167/11/MEF/SG/DGF/DCB.SAP/ SCBSE

NOM BARDSLEY
PRENOMS Elise
ADRESSE B.P 175 Antananarivo
FONCTION Etudiante

ACCOMPAGNE DE : Rakotomalaza Miadanarivo, Hermann Tsiafa Anicet, Tapiet Morulla Danvi, Natalie Smith, Justine Taylor, Mark Scherz, Matthew May, un représentant du CAFF/CORE.

ORGANISME TUTELLE : ESSA/ Département des Eaux et Forêts.

EST AUTORISE(E) A FAIRE DES RECHERCHES / ETUDES DANS :
La N.A.P Nord Ifotaka – Amboasary Sud.
« L'accès dans les forêts transférées à un comité de gestion fera l'objet de négociation avec ce dernier »

MENTION SPECIALE EVENTUELLE:
Expédition de recherche multidisciplinaire dans la communauté de Kobokara
Etude et collecte de données sur :
Herpetofaune, tortue radié, betail, plantes
Aucune collecte ni prélèvement biologique.

DUREE : Deux (02) 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.
Le bénéficiaire de la présente autorisation doit :
- faire viser la présente par la Direction Régionale de l'Environnement et des Forêts Anosy et/ou CEF Amboasary 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
- DCAI
- DREF Anosy
- CEF Amboasary
- Communes concernées
  « Pour contrôle et suivi »

- ESSA/Département des Eaux et Forêts
  « Pour le rapport

Antananarivo, le 15 JUIL 2011

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

RASOAVAHINY Laurette Fi. mino
Ingénieur des Eaux et Forêts

Vu au passage à la DREF Anosy.
le 18 JUL 2011
LE DIRECTEUR

RATSALAHAMANANA
Drouot Thomassien

APPENDIX II: TORTOISE MEASUREMENTS

(1) Plastron Total Length

(2) Bridge Length

(3) Gular Scute Median Length

(4) Humeral Scute Median Length

(5) Pectoral Scute Median Length

(6) Abdominal Scute Median Length

(7) Femoral Scute Median Length

(8) Anal Scute Median Length

(9) Left Gu- Lar Scute Width

(10) Left Gular Scute External Length

(11) Left Humeral Scute Width

(12) Left Pectoral Scute Width

(13) Left Abdominal Scute Width

(14) Left Femoral Scute Width

(15) Left Anal Scute Width

(16) Anal Fork Length

(17) Anal Fork Width

(18) Linear Carapace Length

(19) Carapace Width

(20) Nuchal Scute Width

(21) Nuchal Scute Length

(22) First Central Scute Median Length

(23) Second Central Scute Median Length

(24) Third Central Scute Median Length

(25) Fourth Central Scute Median Length

(26) Fifth Central Scute Median Length

(27) Supracaudal Scute Median Length

(28) First Central Scute Width

(29) Second Central Scute Width

(30) Third Central Scute Width

(31) Fourth Central Scute Width

(32) Fifth Central Scute Width

(33) Supracaudal Scute Width

(34) First Right Cos- Tal Scute Length

(35) Second Right Costal Scute Length

(36) Third Right Costal Scute Length

(37) Fourth Right Costal Scute Length

(38) Carapace Height

(39) Curvilinear Carapace Length.

From Rioux Paquette and Lapointe (2007).