Primates of the Edge: An Ethnoprimatological Study of Human and Wildlife Interaction Bordering a Malagasy National Park

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Abstract: The distribution and aspects of the behavior of two lemur species were examined in relation to neighboring human populations in Mt. d'Ambre National Park, Madagascar. Broad surveys and vocalization surveys were conducted in 1989-1991, 2004, and 2009. Contrary to what was expected, lemurs were less common in the forest interior, but both species were found much more often near the forest edge. Lemurs perhaps preferred increased food availability along the forest edge, especially in those areas that gave them access to local crops. Crop-raiding was generally tolerated by local people. In edge areas that did not have local crops, lemurs relied on superabundant edge species. In both of these forest edges, adherence to informal human traditions (*fady*) probably promoted lemur population growth, and lemurs were easily habituated to humans. In the region most subjected to hunting and logging threats, lemurs have become much less common. Overall, humans posed several threats to the park periphery. Important factors that relate to mutually tolerant interactions between humans and wildlife include: resource availability along the forest edge, formal authority, *fady* and other cultural beliefs, road accessibility, and pressures from neighboring regions within Mt. d'Ambre. Further understanding of people's perspectives on the park may prove valuable to the conservation of Mt. d'Ambre.

Keywords: Madagascar, ethnoprimatology, conservation, *Eulemur coronatus*, *Eulemur sanfordi*

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INTRODUCTION

Deforestation in Madagascar, due to logging, mining, and agriculture, has been extensive during the twentieth century through today (Green and Sussman 1990; Jarosz 1996; Klein et al. 2008; Kull 2004; Laing 2012; Morell 1999). National parks and protected forests have been in existence throughout Madagascar's independence, and extend back to the French colonial days (Gezon & Freed 1999). In the conservation community, these locations help preserve Madagascar's unique flora and fauna, and act as deterrents to deforestation. Local people are less likely to use and to exploit resources within these areas.

In 2009 I visited Alaa Joe (AJ), a Malagasy farmer I had last seen twenty years earlier when I observed lemur behavior for my dissertation. He lived on the edge of Mt. d'Ambre National Park in northern Madagascar. Here he had a rice field, raised zebu cattle, and planted fruit and vegetables. Back in 1989 I asked why he let crowned lemurs (*Eulemur coronatus*) and Sanford's lemurs (*E. sanfordi*) come from the neighboring forest and eat fruit from his guava patch. I did not get an answer back then. But in 2009, AJ finally said that the lemurs posed no threat. Although he did not observe local *fady* (taboos) against hunting and eating lemurs, he neither hunted nor trapped them. AJ never gained an *ariary* (money) from ecotourism, a means by which conservation organizations felt would get local people to protect the forest. AJ stated that Mt. d'Ambre forest was the source of his farm's water, and that if the forest went, so would the water, and so would his crops. The forest was his livelihood, it was a route to his relatives, it was his medicine shop, and it was everything he had ever known. To AJ, letting the lemurs eat your fruit was not unlike the custom of providing food for a visitor.

AJ conveyed a sense of knowledge and conservation awareness of the region. AJ was not alone. Many farmers in the region recognized that Mt. d'Ambre was the source of the water that fed their crops. The source of conservation knowledge in this region is not clearly understood, as education, ethnicity, and cultural beliefs vary considerably, especially near Mt. d'Ambre. As Hume (2006, 2012) noted elsewhere in Madagascar, cultural beliefs among farmers in a region can vary considerably, and these beliefs may affect greatly whether conservation programs in a region are successful. Ultimately, what a farmer such as AJ wanted was not a change of livelihood that would restrict access to Mt. d'Ambre's resources. A farmer wanted to continue farming, but without depleting the vital water that came from Mt. d'Ambre.

How do local environmental knowledge and cultural beliefs affect how people interact with wildlife? In sacred areas, people usually protect the local environment, and restrict their own access to its resources (Chandrakanth & Romm 1991; Chandrashekara & Sankar 1998, Decher 1997; Gadgil & Vartak 1976; Horning 2008; Negi 2010). In these regions, people may tolerate the crop damage caused by nonhuman primates, or will still seek more effective, non-invasive means of dealing with crop-raiding (Wiafe & Arku, 2012). Even in nonsacred areas, people local to a region may have extensive knowledge about the environment and wish to protect it (Hardin 2011). Yet elsewhere in the conservation literature, farms that encroach or border protected parks and forests have often put humans and wildlife into conflict. Farming, particularly slash-and-burn or shifting cultivation, poses a significant risk to arboreal species, because it reduces forest cover (Cowlishaw & Dunbar 2000). From a farmer's perspective, wildlife, including

nonhuman primates, may be viewed as threats to crops, as primates often consume them (e.g., Fitzgibbon et al. 1995; Higham et al. 2009; Hill 2000; Hockings 2011; LaFleur & Gould 2009; Naughton-Treves 1998; Nijman 2004; Riley 2007). Farmers often respond to crop-raiding by hunting, trapping, and scaring away the wildlife; humans will also use fences, rotate crops, guard more vigilantly, and use other techniques (Arlet & Molleman 2010; Chalise 2001; Chhangani & Mohnot 2004; Loudon et al. 2006; Maples et al. 1976; Saj et al. 2001). Conservationists have also used ecotourism, education, and rural development to reduce or halt both logging and the spread of farmland into protected forests. For example, Wright and Andriamihaja (2002) used an integrated conservation and development program to reduce the threat that shifting cultivation posed against Ranomafana National Park in Madagascar. Ecotourism was also promoted as a means of bringing outside money into the local economy (Davenport et al. 2002).

More specifically, under what conditions do people who live beside national parks and forests interact with wildlife in a way that benefits both? In this study, I examine the effects of humans on local lemur populations in and around Mt. d'Ambre National Park in northern Madagascar. I present surveys of two rare and endangered primate species, crowned lemurs (*Eulemur coronatus*) and Sanford's lemurs (*E. sanfordi*). Both lemurs are highly arboreal, frugivorous, and rarely venture far into surrounding savanna, towns, and farmland. The aim of the surveys was to understand these species' habitat selection in relation to forest structure and humans. Did more lemur populations live on the forest edge (near humans), rather than in the interior? When initially located, did lemurs behave alarmed, or were they easily habituated to humans? Did human activity near the lemurs' home ranges pose a threat to the lemurs? Did human traditions promote a mutually beneficial interaction between lemurs and humans?

METHODS

Broad surveys of lemurs were conducted throughout Mt. d'Ambre during the wet season in February through May, 1989 (Freed 1996). In this article, Mt. d'Ambre refers to the approximately 23,000 hectare forest complex that includes the national park, the Foret d'Ambre reserve, and adjoining forest. French colonial administration of Mt. d'Ambre began in the late 1890s, as the French sought greater control of Madagascar's forest resources (Bergeret 1993, Gezon & Freed 1999). Mt. d'Ambre became one of Madagascar's first national parks shortly after Madagascar gained independence in 1960. Beginning in 1989, Mt. d'Ambre was administered by an integrated conservation and development program (ICDP) through the WorldWide Fund for Nature (see Gezon & Freed 1999 for a history). The program devoted time and resources mostly in the Northeast, Rousettes, and East regions of the park.

Formal means of demarcation has existed neither between the two protected zones nor between protected and unprotected areas. Although Mt. d'Ambre is a humid primary forest of volcanic origin, its climate, forest structure, and disturbance varies greatly (Table 1). Seven regions of Mt. d'Ambre were delimited on the basis of geography, forest structure, and disturbance: Northeast, Rousettes village, East, Interior, South, West, and Northwest (Figure 1). Most regions were dominated by continuous forest. Lower elevations (below 600 m) tended to be dry and warm forests; those above 600m tended to be humid and cool.

Table 1. Different forest regions of Mt. d'Ambre.

Region/ Elevation	Forest Description	Number of Survey Sites	Accessibility to Roads	Disturbance
Northeast 200-800m	Both dry and humid continuous	12	**High**: paved road to cities; many paths through forest	Intensive agriculture, horticulture, underplanting, hunting, tourism (2009)
Rousettes 950-1050m	Humid, continuous	8	**High**: Unpaved but maintained road to Northeast; paths throughout forest	Tourism, horticulture, agroforestry (pine, eucalyptus), limited hunting
East 800-1100m	Humid, continuous	14	**High**: Many paths from perimeter to villages; paved road farther away	Agriculture, horticulture
South 500-1200m	Both dry and humid mostly continuous, some patches	7	**Medium**: Many paths between perimeter and villages; farther from large towns	Southern limit felled, farming encroachment (2004, 2010)
Interior 1000-1475m	Humid, continuous	9	**Low**: Few paths	Cattle, tourism (2009)
West 600-1100m	Both dry and humid continuous	12	**Medium**: Footpaths connect forest to towns; major footpath through forest; no paved road nearby	Farming (southwest), logging (southwest 2010)
Northwest 300-700m	Dry and mostly continuous, many patches	7	**Medium**: Many paths to towns and seasonal roads, but far from paved roads	Extensive hunting, extensive logging, agriculture, charcoal

Broad surveys were conducted for a minimum of three days per site, using a one kilometer/hour pace (Scott et al. 1976). Observations and counts of all lemurs were made within twenty-five meters of survey paths. To minimize damage to forests, survey paths were constructed following local guidelines, and were never straight transect lines. Locations where lemurs were heard (but not seen) were also recorded, but the exact latitude and longitude of where those vocalizations originated were not identified precisely. Survey site locations were plotted directly onto a map. In each survey site, additional data and observations were recorded on the forest structure, geography, distance to the forest edge, climate, and anthropogenic forest use (e.g., evidence of charcoal, farms, hunting, tourism, and logging). Local students provided translations of local people's perspectives of the forest (e.g., recent forest history, local traditions, and more). From June 1989 through November 1991, eight

more follow-up surveys were conducted while traveling through the West, Interior, East, Rousettes, and Northeast portions of the forest. Lemur density estimates were not calculated for several reasons. First, survey path field of vision varied tremendously. Dense undergrowth, especially along the forest edge prevented adequate and equal fields of vision in different heights off the forest floor. Secondly, steep inclines, undergrowth, and the need to minimize damage to the flora prevented straight-line travel. Finally, crowned lemurs were especially difficult to locate as they were both very cryptic in dense brush, and frequently split into subgroups. In this article, I present summaries of lemur locations, habitat descriptions, and conservation issues faced in each region.

In May through July of 2004 and 2009, follow-up surveys were conducted in each region of the park. These surveys included re-visits to original survey sites in the northeast, Rousettes, interior, south, west, and northwest, as well as additional sites in the northeast, east, and west. Methods were modified to include more precise recording of site locations with more readily available handheld GPS units. Follow-up visits were made to several regions in May-July 2010, but no formal surveys were conducted in this region during this time.

Two significant changes took place in the 2004 field season. First, survey methods were modified to include group locations based on vocalizations. Both lemur species give distinct dusk vocalizations that carry long distances (Freed 1996). In 1991, a crowned lemur vocalization was heard from as far away as four kilometers. In visits to peripheral areas of Mt. d'Ambre, together with field assistants, group locations were triangulated based on these dusk calls. Secondly, the ICDP no longer administered the park; it was replaced by Madagascar's L'Association Nationale pour la Gestion des Aires Protégées (ANGAP), and then later replaced by Madagascar National Parks.

RESULTS

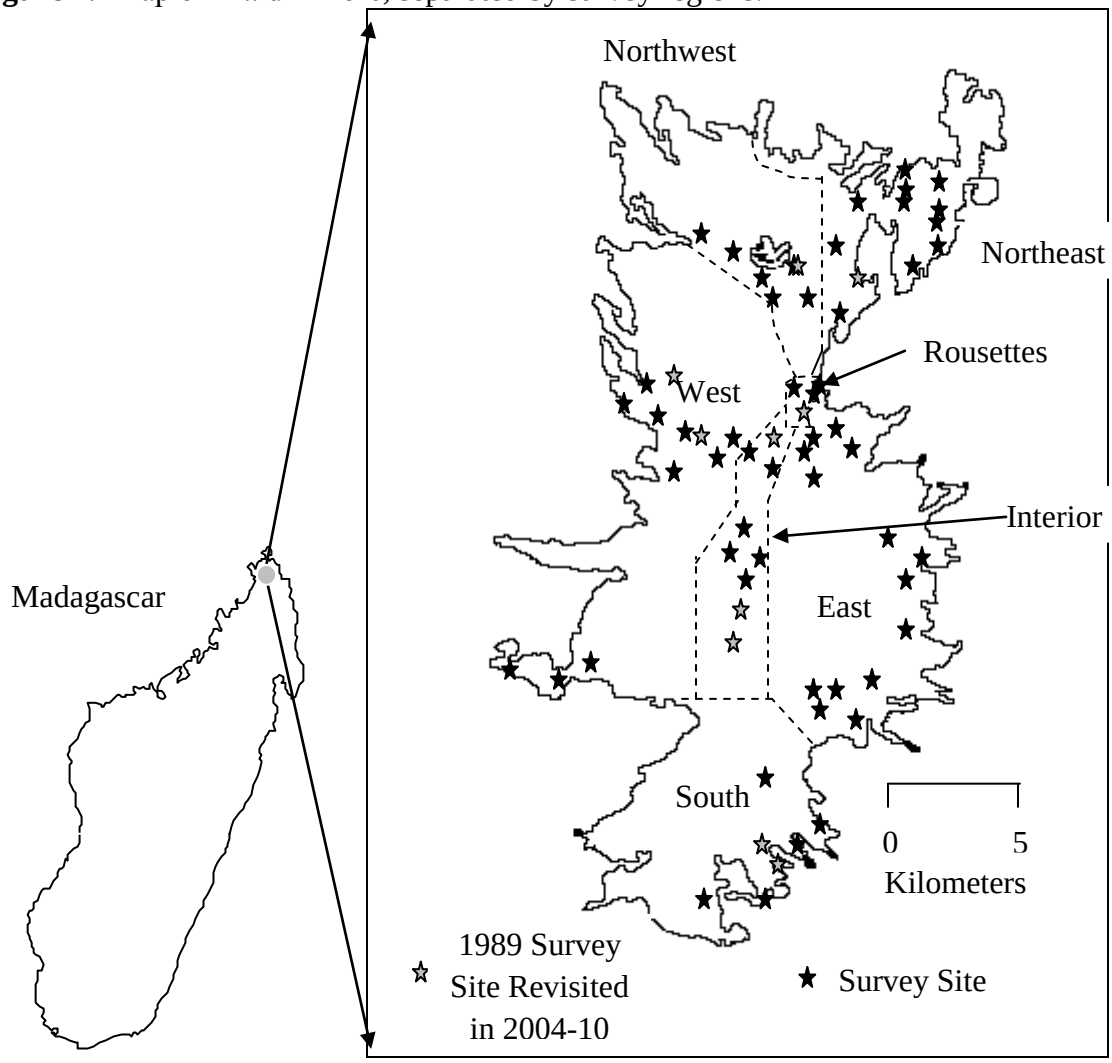
NORTHEAST

The Northeast forest is best described as one big forest edge. More than two-thirds of the forest is within two kilometers of the forest edge. Lower elevation forests are drier, and contain many of the dry forest species found in the forests west and north of Mt. d'Ambre; higher elevation forests resemble the forest near Rousettes. Forests along the eastern edge contain banana, papaya, and other cultivated fruit. The former two species are underplanted (i.e., planted under the cover of the forest). Although deforestation has increased in the region due to intensive agriculture (mangoes, rice, pineapples). Large tracts of land in this region's southeastern and northern edge contain mangoes that are transported and sold in Antsiranana.

Both lemur species were observed in the Northeast, although crowned lemur groups were found in more than twice the survey sites (see Figure 1 for lemur distribution in each section). The only field site devoid of lemurs was along the western edge that was closest to extensive soil erosion. throughout the region lemurs were used to the presence of humans. Lemurs were habituated within minutes to the presence of observers, and most lemur home ranges were within one kilometer of humans. Lemurs were readily observed eating all cultivated fruits.

Small-scale hunting has occurred in some small areas within this region, but for the most part, the lemurs appeared unthreatened by local humans. Local *fady* against the killing and eating of lemurs does occur within the region, but the adherence to these *fady* varies considerably, as many people in the region have emigrated from elsewhere in Madagascar.

Figure 1. Map of Mt. d'Ambre, separated by survey regions.



Many people from nearby Antsiranana do not follow these *fady*, and have settled into the region's largest town, Joffre-Ville. Local people may use guns, dogs, and slingshots to scare away lemurs from crops, but people in and around Joffre-Ville have mostly refrained from the hunting of lemurs. Nowhere in this region were lemur traps ever found. Local enforcement and vigilance against hunting increased during 1989-2001, when a conservation and development program worked in the region, and has continued through 2010 under the authority of Madagascar National Parks. In 2009, an ecotourist lodge was established near Joffre-Ville, but its effects on lemur populations were not observed in this study. In contrastto Joffre-Ville, hunting has most likely occurred near the northeastern edge of the forest near the town of Sakaramy, but these reports could not be substantiated thoroughly. Lemur populations local to this town and observed in Arbelot-Tracqui (1983) were not found in 1989-2009.

ROUSETTES

Rousettes is a heavily touristed village and campground within the national park. This humid forest has a continuous canopy, and is interspersed with edge forest areas

near where local people live and cultivate, and where tourists camp. Park workers have lived in this village since colonial days, and have raised produce irrigated by local streams. No more than ten families have ever lived in Rousettes at any one time. Park visitors use extensive trails to visit most of this region's landmarks. Tourism in Mt. d'Ambre is largely limited to this region. Most visitors come from Antsiranana for one or two days.

Lemurs are habituated within several minutes to humans, and have been the subjects of an initial behavioral study (Arbelot-Tracqui 1983). More than twelve groups each of both species were identified in 1989-1991 within this region (note that due to the small size of this region, each survey site could not be identified on the maps in Figures 1 and 2), and similar numbers were observed in 2004. Lemurs consume many of the same food species observed elsewhere in Mt. d'Ambre (e.g., *Ficus, Harungana, Canarium, Celtis, Diospyros*), but they generally rely on many of the plants near humans (bananas, *Lantana* bushes, and provisioned fruit). Although tour guides have been told not to provision the lemurs, when I began this study most tour guides reported to me that they did provision the lemurs with bananas. Some lemurs may still be provisioned.

Although *fady* may exist in Rousettes, most park personnel living in Rousettes recognize that their jobs depend on maintaining the resources of the park, including the lemurs. Nearly all local tour guides also recognize that their livelihoods depend on having visitors see the lemurs. In 1989, I had been told of hunting that occurred in this region, yet there is less evidence of hunting here than elsewhere. I found no ammunition, guns, nor traps.

EAST

About half of the eastern region is higher elevation, more humid continuous forest not unlike the interior; the remaining half is a blend of humid continuous forest mixed with species that are typically found along the forest edge (e.g., *Harungana*) or near humans. Rice and produce are grown along most of the eastern forest edge, particularly near the large farming towns of Ambahivabe and Antsalaka.

In 2004, I heard vocalizations of both lemurs along the eastern forest edge from the north all the way south to the eventual survey site at the Saharenana River. Although Sanford's lemurs were more readily observed in the northern section of the East, I found nearly equal numbers of both species' groups in survey sites at both the Saharenana River and farther south at the Lac Texier region. At both of these survey sites, no more than two lemur groups were surveyed 1-2 km from the forest edge. Two interior lemur groups may live in the East region (see Interior). In contrast, three or more lemur groups were observed at each eastern edge survey site. Nearly all observed lemur groups were habituated within minutes.

No tourism occurs in the East, and very little evidence exists of any hunting in the region. No traps were observed. Much as in the Northeast, traditional *fadys* against the killing of lemurs occur in the region, but increased immigration has probably decreased the numbers of people who adhere to these *fady*.

SOUTH

About half of the southern region is higher elevation, humid continuous forest not unlike the interior, but the remainder is a drier, lower elevation edge forest all within two kilometers of local people. These edge forests are not unlike the southeastern forests near Lac Texier (East); the southern edge forests are perhaps a little shorter.

Rice and several crops are grown in small farms along most of the southern edge. The southern forest edge was hit severely by cyclone damage in 1984, and several isolated forest patches within four kilometers of the southern edge may have, at one time, been connected to Mt. d'Ambre. These isolated forests were logged extensively in the 1980s, and are facing more encroachment by surrounding farms. No tourism occurs in this region.

Although I only surveyed one southern site that was not an edge forest, I heard very few dusk vocalizations coming from the interior. All but one edge survey site in the South contained three or more groups of crowned lemurs. One or two Sanford's lemur groups were observed in all but one of the same sites that had crowned lemurs. Although most crowned lemur groups contained multiple males and females as they are typically found elsewhere, five uni-adult groups were observed in 1989, but none were observed in 2004. Freed (1996) observed that crowned lemurs frequently subdivide and rejoin during the day, particularly during the season when the lemurs were surveyed in the South. Both lemur species were readily approachable without any fear of the observers. Habituation occurred within several minutes. A footpath that crosses the South of Mt. d'Ambre has received extensive use by local people, not unlike what was observed in the West (Freed 1996). Very little evidence exists of any hunting or trapping of lemurs in the South. As very few people live in this region, little information was obtained about the presence of *fady*. However, in forest patches further south of Mt. d'Ambre, most local people maintained *fady* or had traditional beliefs about the lemurs that restricted the hunting of the lemurs. One lemur trap was found; otherwise, most farmers let nearby lemurs consume cultivated papaya, jackfruit, and bananas. Despite this, hunters were found in this region, and even a pet Sanford's lemur was observed. Yet even to the hunters, people were not supposed to hunt in Mt. d'Ambre, as it was viewed as both sacred, and as being protected by local authorities.

INTERIOR

The interior itself was remarkably devoid of many of the fruiting species that formed more than 75% of the lemurs' diet reported in Freed (1996). Food species observed in Arbelot-Tracqui (1983) were also rarely observed. The interior forest is at the park's highest altitude, and tends to include shorter trees and more ferns. The climate is much cooler and more humid than in any other region. Very little evidence exists of the conservation threats found elsewhere in the park. No underplanting or any other cultivation occurred in the interior, but many cattle were observed grazing throughout the lake region. Tourism in the interior was essentially absent beginning in 1984, when a cyclone blocked the main footpath. This footpath was re-opened shortly before the 2004 field season, but tourists generally still avoid the interior.
Neither lemur species was ever actually seen in the interior of the park. In 1989, surveys took place along a seven kilometer path connecting Rousettes with two interior lakes. In 2004, surveys were repeated in at least three locations along this path. In 1989, distant Sanford's lemur vocalizations were heard twice and distant crowned lemur vocalizations were heard, but the precise locations of these groups may have been as far away as two kilometers east or west of the survey path. These three groups were most likely found away from the edge of the forest.

WEST

Much more time was spent in this region, as it contains the field site of the

1989-1991 behavioral field study of both lemurs (Freed 1996). The West contains continuous humid forest, but, compared with the East, is drier, due to a rain shadow effect. Peripheral areas, especially those in the southwest near the agricultural town of Bobakilandy, are much drier than even the South of Mt. d'Ambre. Roughly 33-40% of this region is within two kilometers of the forest edge; thus many of the species found in Freed (1996) were observed throughout this region. Throughout the western forest edge, lemurs find a greater abundance of food species (e.g., *Leea spinea*, *Lantana*, and *Ficus*) than has been observed elsewhere in Mt. d'Ambre. Local people have taken paths through this region nearly every day for the last century, as this serves as the most economical way to transport rice from west of Mt. d'Ambre to the East, where it eventually gets distributed to Antsiranana. Perhaps the greatest threats to this region are in the southwest, where more intensive agriculture occurs, and where logging has increased since 2009. Some agriculture has begun alongside the northern portion of the West. In the rest of the region, very little evidence exists of logging, underplanting, or any agricultural encroachment into the forest. Irrigation canals have been constructed before and throughout the years of this study.

Large numbers of both lemur species were found in this region, especially along the western edge. For example, Freed (1996) observed more than thirteen groups each of both species in an edge habitat of eighty-three hectares. Both crowned lemurs and Sanford's lemurs were observed at each survey site, and dusk vocalizations occurred throughout the entire forest edge. In almost all cases, lemurs could be habituated within minutes.

Most people who live beside this region are ethnic Sakalava and Antankarana farmers who generally adhere to *fady* against the harming of lemurs. Farmers in at least three towns west of this region reported that the lemurs and the forest condition directly related to the amount of water they would receive on their farms. Several elderly people west of Mt. d'Ambre reported that the source of their beliefs might have stemmed from the colonial period. During this time, French military who came over Mt. d'Ambre to collect taxes from local people were spotted by lemurs, who gave their loud alarm calls that echoed down the valley to the villages. Many people also recognize the value of the forest as it relates to the success of their farms (see Gezon & Freed 1999). Local cattle range through the West, especially during the dry season (May – November).

NORTHWEST

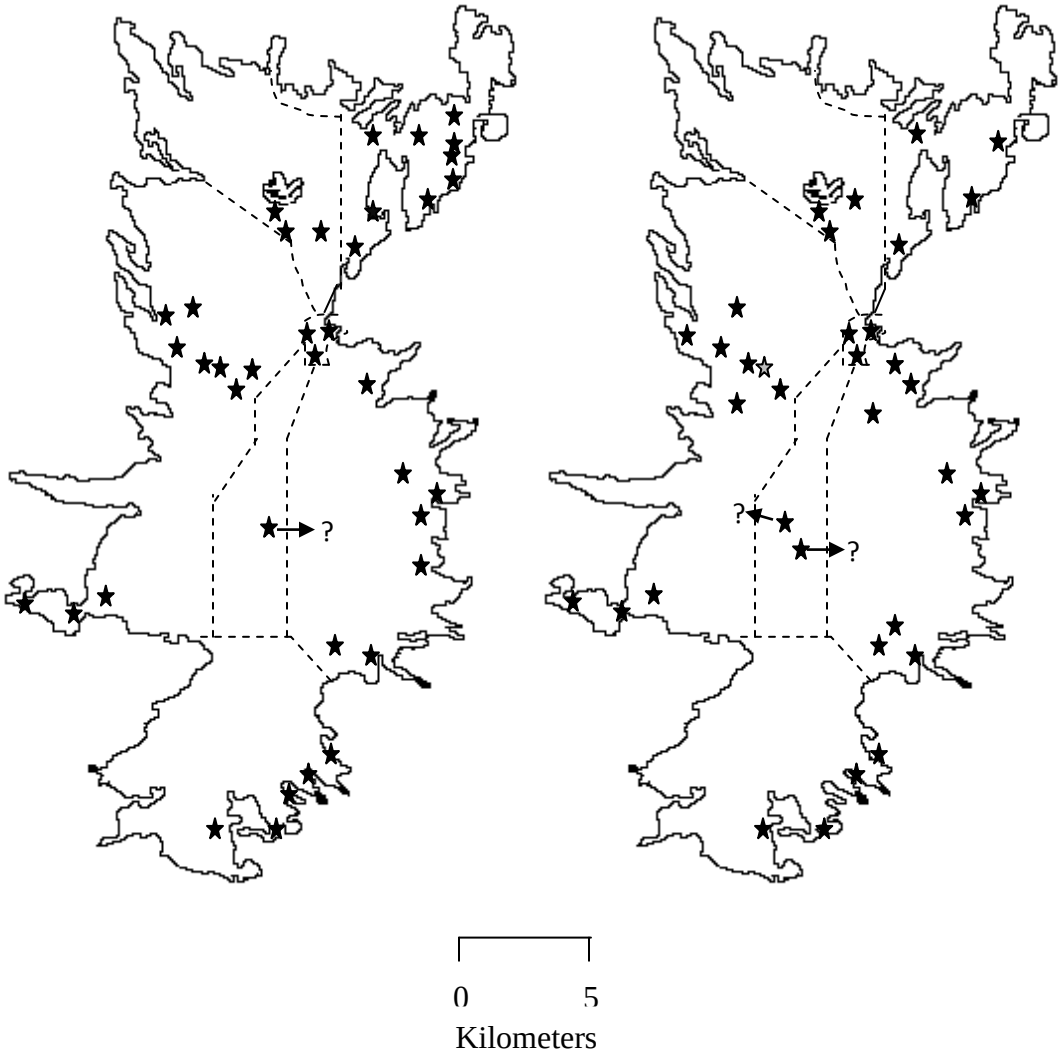
The Northwest is largely unprotected, with much deforestation. Most of it does not fall within the national park's boundaries. The town of Ankorefo near the northwest forest edge contains many people brought to the region to help log forests west of Mt. d'Ambre in the 1980s. Much logging continues through today. Although the rate of deforestation since 2004 is undetermined, wood from this region is routinely confiscated, but undoubtedly much wood makes it to market. In 2009, several families from Ankorefo pushed further south, and have begun to farm just north of the West. Farmers have also increased activities along the northern edge of the Northwest. As in the West, the forests in the Northwest are much drier than what one finds in the East. The Northwest had continuous forest, but the amount of disturbance in the region is extensive. The path that connects Ankorefo to Rousettes has become more open, with less continuous canopy.

Lemur populations have declined during this study. In 1989-1991, seven or more

groups of each species were observed near the southeastern portion of the region. These groups were habituated within minutes. In 2004, at least four groups of Sanford's lemurs were observed (possibly two more groups were heard), but crowned lemurs were neither heard nor observed. Sanford's lemur groups were not habituated, and fleed from the observer. In 2009, reports from field assistants in the region confirm these observations.

No *fady* exist against hunting the lemurs. As the safety of identified lemur groups could not be assured, lemur surveys were not conducted in the northern section of the Northwest.

Figure 2. Mt. d'Ambre survey sites in which crowned lemurs (left) and Sanford's lemurs (right) were observed.



DISCUSSION

In Mt. d'Ambre crowned lemurs and Sanford's lemurs were found most often near human populations (e.g., Rousettes) or within two kilometers of the forest edge. Both lemur species inhabited interior regions of the park, but they were much less readily heard and seen than they were along the forest edge. One possible explanation is

that the lemurs benefit from an edge effect, or a change in biological or physical conditions at an ecosystem's boundary (Harper et al. 2005; Lindenmayer & Fischer 2006). Although primatologists have focused on edge effects on forest fragments, Irwin (2008) examined edge effects among both continuous forest primates as well as those that lived in fragments. Continuous forest groups of diademed sifakas (*Propithecus diadema*) in Tsinjoarivo, Madagascar fed and foraged more along forest edges than was expected. Irwin concluded that these sifakas were energy-maximizers, maintaining larger home ranges and more time foraging for rare fruiting trees than did sifaka groups that lived in fragments. The groups that lived in fragments instead spent less time on the edge, relying more on fallback food species in the interior.

Both crowned lemurs and Sanford's lemurs in Mt. d'Ambre may take advantage of higher food species diversity or abundance along the forest edge near humans. Although plant species diversity and abundance were not assessed quantitatively in this study, human populations near the Northeast, East, Rousettes, and South forest edges cultivated additional food resources (e.g., bananas, papayas, guava, and mangoes) and brought in other food species that lemurs consume (e.g., *Lantana camara*). Lemurs were most often observed foraging for cultivated fruit in northeastern Mt. d'Ambre, and were seen infrequently foraging on these in other forest edges. Unlike what Irwin reported for sifakas, large fruiting trees (especially *Ficus*, *Diospyros*, and *Canarium*) were found in both the interior and along the edge of all of these regions in Mt. d'Ambre. The lemurs did not appear to maintain large home or day ranges just to get to these sorts of food resources.

Lemurs in western Mt. d'Ambre, relied not on fruit cultivated by local humans, but on an overabundance of fruiting edge species (*Leea spinea* and *Harungana madagascariensis*) and an introduced bush (*Lantana camara*) (Freed 1996). Cultivated plants were not nearly as common in the West as they were elsewhere in Mt. d'Ambre. In the West lemurs maintained very small, highly overlapping home ranges throughout the year, but foraged over more time and distance during the wet season, when *Leea spinea* fruit was not available.

Overall, the lemurs' responded to humans by tolerating them. Throughout most of Mt. d'Ambre lemurs were easily habituated to humans. In the Northwest lemurs were also easily habituated, but as hunting pressure increased before 2004, the lemurs became much more cryptic, and now typically flee when identified. When lemurs are subjected to hunting, they assume more alarm behaviors in the presence of humans, and do not become habituated.

In several ways, humans seem to tolerate the lemurs. First, humans largely have non-invasive responses to the lemurs, even to those lemurs that consume crops. Except in the Northeast and East, where several farmers took to more active methods of deterring the crop raiding (trapping, gunfire, and slingshots), farmers generally simply tolerated lemurs that consumed fruit they had planted.

Secondly, at least for now, humans near Mt. d'Ambre have posed less of a threat from hunting and bushmeat consumption than has been observed elsewhere in Madagascar (see Jenkins et al. 2011). Subsistence hunting is not currently a common issue, as people have access to cattle, poultry, and fish. People also recognize the power or authority of their own forestry agents who live among them. Lemurs perhaps receive the most protection

in portions of the West. Local people have received adequate protection and visits from forestry agents, and have less accessibility to roads, thus restricting who can actually interact with wildlife. In contrast, the greatest direct threat to lemurs came from hunting pressure in areas that were either highly accessible from paved roads or were in areas that received little formal protection (i.e., the Northwest).

Finally, people also tolerate, and even protect, local lemurs because of informal traditions or *fady*. People in nearly every village that I visited along the forest edge could report at least some *fady*, belief, or explanation as to why most did not hunt or trap lemurs. People in the West were mostly ethnic Sakalava and Antankarana (who generally adhered to *fady* that protect the forest). Farmers and elderly people provided cultural reasons and beliefs that ultimately reduced any threat of hunting. As Freed (1996) reported, people in the West routinely passed through the home ranges of study subjects nearly every day during his study. In the Northwest, however, informal traditions and *fady* were less common, as many more people were from other ethnic groups and were known to more traditions associated with logging. They simply do not adhere to any *fady* observed elsewhere in Mt. d'Ambre. As has been described elsewhere in Madagascar (see e.g., Banks et al. 2007), in these areas, immigration may have led to a greater percentage of people who did not adhere to local traditions about the consumption of forest resources. Conservation efforts should be more directed to this region so that its threats do not spread elsewhere in Mt. d'Ambre.

The mere presence of *fady*, taboos, or other informal local traditions about the environment does not guarantee the safety of wildlife in any one region of Mt. d'Ambre. Walsh (2002: 465) observed among Antankarana, that taboos "cannot actually prevent people from doing things." What these traditions seem to do is set a target of ideal behavior that many people go along with. Jones et al. (2008) reported that *fady* or traditions have proven vital to the survival of local fauna in Eastern Madagascar, but when non-local conservation rules were imposed on local people, their informal traditions and *fady* became less effective. Likewise, Jenkins et al. (2011) found that local *fady* preventing the hunting of lemurs have largely broken down as the region has experienced rapid social change. Yet *fady* and other cultural beliefs, much as in traditional sacred groves described from elsewhere, seem to be at least one set of factors associated with the promotion of mutually tolerant interactions between humans and wildlife in Mt. d'Ambre.

Understanding people's perspectives from around Mt. d'Ambre National Park might prove valuable to promoting the conservation of the region. By using ethnographic and interviewing techniques, Ormsby (2008) identified concrete steps that conservation staff and officials in Masoala National Park could act upon to involve local people in the conservation of their park. From the surveys done in Mt. d'Ambre, a similar approach to that of Ormsby may prove the most effective way of promoting the long-term future of Mt. d'Ambre National Park, its people, and its wildlife.

CONCLUSION

Crowned lemurs and Sanford's lemurs thrive along most of Mt. d'Ambre's forest edge, often in close proximity to people. Resources are readily abundant in these regions, perhaps due to an edge effect that may be enhanced by the actions of local people. The lemurs tolerate the presence of humans, and could be easily habituated to humans throughout most of Mt. d'Ambre,

despite abundant evidence of human disturbance. For their part, humans generally tolerate the presence of these lemurs, even when the lemurs eat cultivated fruit. Formal authority, together with cultural beliefs, may play an important role in promoting mutually tolerant interactions between humans and wildlife in Mt. d'Ambre. In areas where formal authority and beneficial local traditions are absent, lemurs are most endangered. One of the emerging themes from this research is that the effects of local human attitudes towards wildlife and forests are complex and varied, whether it be in Mt. d'Ambre or elsewhere. Further study of local people's perspectives towards the park and its wildlife may prove valuable for the conservation of this site, especially in areas where human disturbance is greatest.

NOTES

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