

# Three flying fox (*Pteropodidae: Pteropus rufus*) roosts, three conservation challenges in south-eastern Madagascar

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## ABSTRACT

We visited three roosts of the Madagascar flying fox *Pteropus rufus* in December 2005 in the Anosy Region. Colony size was 900 at Berenty Private Reserve, 412 at Amborabao and 54 at Sainte Luce, based on single counts at each site. Hunting at the roost is prohibited at Berenty but *P. rufus* is trapped at night in the area surrounding the reserve, where it feeds on sisal. At Amborabao, the bats roost in a sacred forest and hunting is forbidden. At Sainte Luce, the forest is highly degraded and the bats are hunted frequently, despite efforts to engage the local community in forest conservation. Questionnaires with people living near the roosts revealed the flying foxes were regarded as pests of litchis in Amborabao and Sainte Luce. Berenty is the only site where tourists are able to observe roosting *P. rufus*. The role of sacred forests and local taboos (*fady*) is very relevant for *P. rufus* conservation and might be the only practical mechanism in sites where legislation on hunting and land use is not being enforced.

## RÉSUMÉ

Trois gîtes de *Pteropus rufus* ont été visités dans la région Anosy en décembre 2005. La population était composée de 900 individus à Berenty, 412 à Amborabao et 54 à Sainte Luce, le comptage ayant été fait une seule fois dans chaque gîte. La chasse au dortoir est interdite à Berenty mais *P. rufus* est capturé la nuit, lorsque les individus se nourrissent dans les plantations de sisal environnantes. A Amborabao, le dortoir se trouve dans une forêt sacrée où la chasse est interdite. A Sainte Luce, la forêt est extrêmement dégradée et les chauves-souris sont chassées fréquemment malgré les efforts pour impliquer la communauté locale dans la conservation de la forêt. Les interviews avec les gens vivant près des dortoirs ont montré que les *P. rufus* sont considérés comme nuisibles car consommateurs de fruits de litchis à Amborabao et Sainte Luce. Berenty est le seul site où les touristes peuvent observer *P. rufus* au dortoir. Les forêts sacrées, les croyances locales et les tabous (*fady*) sont importants pour la conservation de *P. rufus* et pourraient être les seuls facteurs pour expliquer le respect des régulations cynégétiques et foncières.

KEYWORDS: Madagascar, *Pteropus rufus*, roost, Tolagnaro

## INTRODUCTION

The conservation of the Madagascar flying fox *Pteropus rufus* poses a major challenge because even though it is a threatened species (IUCN 2007) it is not fully protected by Malagasy law and can be legally hunted by people for food between May and September (Durbin 2007, MacKinnon et al. 2003, Racey et al. in press). In practice however, people either deliberately ignore or are unaware of the hunting season and *P. rufus* is widely exploited throughout the year and this is believed to be causing some colonies to abandon traditional roosts (MacKinnon et al. 2003, Racey et al. in press). Roosting and foraging sites are also threatened by the degradation of native forests, a situation exacerbated by the tendency for *P. rufus* to use small forest patches outside of protected areas (Jenkins et al. 2007ab, Racey et al. in press).

Colonies of up to 5,000 *P. rufus* have been recorded in Madagascar (MacKinnon et al. 2003) and roosts are attractive to hunters because of the concentration of bats. However, roosts should also be important conservation sites for bats in Madagascar because they present a viable focus for monitoring and protection (Goodman et al. 2005).

Previous studies on the ecology of *P. rufus* in the Anosy Region have demonstrated that it has a varied diet that includes exotic plants and that it plays an important role in seed dispersal (Bollen and van Elsacker 2002, Raheriarisena 2005, Long and Racey 2007). As part of a regional programme to assess the status of flying fox colonies (Jenkins et al. 2007b) and to determine the local anthropogenic factors that influence the conservation of roosts we made a rapid survey of three sites.

**STUDY SITE** Roosts were surveyed at Berenty Private Reserve (referred to as Berenty hereafter), Amborabao and Sainte Luce over a three-week period during December 2005 (Figure 1). Berenty (Malaza forest S25°00', E46°18'), 85 km west of Tolagnaro, is a ca. 200 ha fragment of gallery forest on the Mandrare River and is a major tourist attraction because of its tame lemurs. The roost at Amborabao (Mahanoro Forest S24°49', E47°02'), 27 km northeast of Tolagnaro, is in a small

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VOLUME 3

ISSUE 1

DECEMBER 2008

# MADAGASCAR CONSERVATION & DEVELOPMENT



INVESTING FOR A SUSTAINABLE NATURAL ENVIRONMENT FOR FUTURE  
GENERATIONS OF HUMANS, ANIMALS AND PLANTS OF MADAGASCAR

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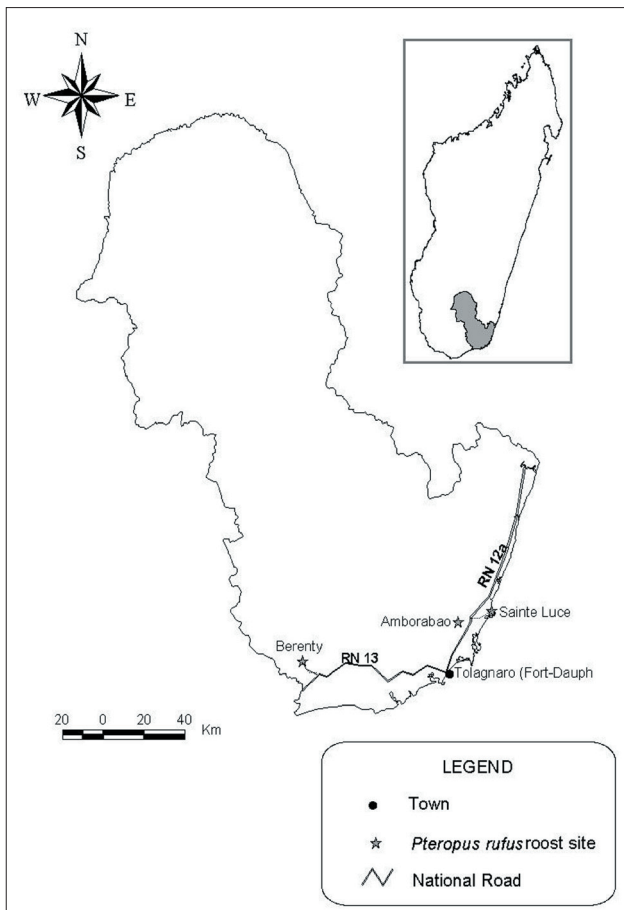


FIGURE 1. Map showing the three forests with roosting colonies of the Madagascar flying fox *Pteropus rufus* in the Anosy Region (shaded) of southeastern Madagascar.

forest considered sacred by local inhabitants. Sainte Luce (Etazo forest S24°48', E46°18') forest, 50 km northeast of Tolagnaro, is highly fragmented and the *P. rufus* colony is currently found in a small fragment identified as S7 and the nearby S6 fragment is no longer used by the bats.

## METHODS

We estimated the size of the *P. rufus* populations by counting the bats as they dispersed from each roost on a single evening (1830 - 2000 h) and also by counting flying and roosting bats the following morning (0800 - 1000h). During the evening counts, two observers (VNR and DA) were stationed at separate vantage points that facilitated good views of dispersing bats and number of bats leaving the roost was counted until a 30 minute period elapsed with no bats flying from the direction of the roost. The morning survey was undertaken by the same observers who scanned each roost tree and counted all visible bats with the aid of binoculars.

The inhabitants of villages surrounding the roosts were interviewed by one of us (VNR) to record local perceptions of fruit bats. All interviewees were questioned individually but no specific method was adopted for the selection of interviewees but every effort was made to sample a range of households within the study villages.

## RESULTS

The largest colony, with over 900 bats at the time of our visit, was at Berenty and the smallest, with only 54 bats, was at Sainte Luce (Table 1). There was a notable difference between the proportion of the colony that was observed during the dispersal and roosting counts, with 87% of bats at Sainte Luce leaving the colony during our nocturnal observation period but only 11% and 20% at the other two sites (Table 1).

The owner of Berenty had prohibited tree cutting and animal hunting within the reserve and access by local people is restricted (Table 1). Some tourist groups are shown the *P. rufus* roost from a vantage point approximately 100 m from the roost during guided tours of the forest reserve. There is also an interpretation board with some information about *P. rufus* on the trail that passes close to the roost. The roost is therefore well protected from both hunting and other types of disturbance.

The fragment at Sainte Luce is frequently accessed by villagers who traditionally visit the forest to hunt animals, extract wood and search for non-timber products. With support from conservation partners and a mining company, the local community around Sainte Luce has created a social contract (*dina* in Malagasy) to manage the forest but this does not yet appear to have conferred significant benefits to the *P. rufus* colony, which was still small on a visit in May 2008 (D. Andriafidison pers. obs).

The presence of a cemetery in the Amborabao forest fragment protects the *P. rufus* because cultural sensitivities prohibit the hunting of bats at the site. The collection of dead wood in the forest though, is tolerated by the local community association communauté locale de base (COBA) that manages the forest (Table 1). Thus although the bats are not hunted the colony is frequently disturbed. This colony is located less than one kilometer from the Tsiotongambarika forest and members of the COBA reportedly ensure that the traditional rules governing access to and use of non-timber resources are upheld.

A total of 205 people participated in the questionnaires and discussions and sample size varied between sites because of logistical reasons (Table 2). Respondents near Berenty were a mix of Antanosy and Antandroy people but the other two sites consisted entirely of the former ethnic group. The percentage of people who admitted to hunting *P. rufus* was notably higher in Amborabao and Sainte Luce than near Berenty. However there was less difference in the percentage of people who had eaten fruit bats at each site, varying between 40% and 50%.

TABLE 1. Three *Pteropus rufus* roosts in the Anosy Region, Madagascar, assessed during December 2005

	Fragment size (ha)	Dispersal counts	Roosting counts	Distance to village (km)	Hunting permitted in roost	Evidence of hunting found in roost	Hunting reported from roost	Village access to the forest
Berenty	200	184	903	2.2	No	No	Yes	No
Sainte Luce	225	47	54	4.5	No	No	Yes	Yes
Amborabao	180	46	412	0.6	No	No	No	Yes

TABLE 2. Summary of a questionnaire about *Pteropus rufus* from three villages located near roosts (N = number of respondents). Question 4 only concerns those people who answered 'yes' in question 3. Question 5 only concerns those people who answered 'no' in question 3

		Berenty		Sainte Luce		Amborabao	
		N	%	N	%	N	%
1. Ethnic group	Antanosy	18	40	80	100	80	100
	Antandroy	27	60	0	0	0	0
2. Do you hunt <i>P. rufus</i> ?	No	42	93	55	69	40	50
	Yes	3	7	25	31	40	50
3. Have you eaten <i>P. rufus</i> ?	No	27	60	42	53	40	50
	Yes	18	40	38	47	40	50
4. Frequency:	All year	4	29	21	55	32	80
	Sometimes	14	71	17	45	8	20
5. Reasons for not eating	Taboo ( <i>fady</i> )	24	89	0	0	40	100
	Religion	3	11	0	0	0	0
	Never trapped	0	0	40	95	0	0
	Frightening	0	0	2	5	0	0
6. Heard about bat conservation?	No	0	0	80	100	80	100
	Yes	45	100	0	0	0	0

From the sample of people who consumed *P. rufus* those at Berenty appeared to only do so occasionally whilst consumption occurred more regularly at the other sites. At all sites people preferred to eat *P. rufus* when the bats were fat and when other sources of protein were scarce. Taboos were mentioned near Berenty and Amborabao as the primary reason for not eating *P. rufus*, the former associated with ethnicity and the latter with a burial site. At Sainte Luce it appeared that those who had not eaten bats had never trapped them or otherwise had the opportunity to obtain them. We were unable to obtain detailed information on previous environmental education efforts but we were aware of an attempt near Berenty and Sainte Luce to inform people about conservation. In the survey, only the people near Berenty had been exposed to the notion of bat conservation.

Hunters at Berenty reported using nets at nocturnal feeding sites situated outside the reserve to trap *P. rufus* feeding on sisal. A hunter can expect to catch 8 to 12 bats per week between September and May and 25 to 30 between June and August. Live bats are sold discretely in villages around the reserve for between 1,400 MGA and 2,000 MGA each (\$0.9-1.3 US). At Sainte Luce and Amborabao, fruit bats are hunted at night by local people between December and February when the bats feed on cultivated fruits (e.g. *Litchi chinensis* Sapindaceae) and other plants (e.g. *Typhonodorum lindleyanum* Araceae) or during June and July when Kapok trees (*Ceiba pentandra* Malvaceae) are in flower. Questionnaires revealed that Sainte Luce was the only roost directly targeted by hunters during day. Firearms are used by hunters who make day trips from Tolagnaro.

## DISCUSSION

This short study draws attention to the challenges associated with conserving the Madagascar flying fox *P. rufus* and uses examples from three different roosts to present some of the most common threats to the species in south-eastern Madagascar. All three roosts receive different forms of protection, ranging

from owner-imposed regulations on private land, to ancestral traditions and locally generated rules designed to encourage sustainable forest management. Whilst it is not unusual for *Pteropus rufus* roosts to be associated with forests of cultural importance and a few other colonies have *dinas* (Jenkins et al. 2007a), the majority of sites in Madagascar are without any protection (MacKinnon et al. 2003).

*Pteropus* bats are a traditional source of meat for people throughout most of their range (Mickleburgh et al. 1992). In many island states there is demand for flying fox meat and the off take is considered to be threatening the survival of a range of species (Brooke and Tschapka 2002, Struebig et al. 2007). In Madagascar, hunting is one of the main threats to *P. rufus* and occurs in many parts of the island where these bats can be observed for sale in markets or served in restaurants (Jenkins and Racey this volume). Although hunting only occurred at one of the roosts in our study site, the bats were trapped in the vicinity of all three roosts. Trapping appeared to coincide with periods when the bats fed on plants near villages and were thus relatively easy to catch; there was no evidence therefore that people respected the legal hunting season per se. Bats were hunted both for subsistence and commercial purposes although there are insufficient data to assess the sustainability of the harvest or the socioeconomic importance of the meat. Locally managed harvests of foraging bats may be a viable option in some parts of Madagascar (Jenkins and Racey this volume), but hunting at roosts sites causes severe disturbance and should be prohibited (Racey et al. in press). Considerable further study is needed on *P. rufus* roosting dynamics, harvest patterns and local resource governance options before regulated harvests can be promoted.

The loss and degradation of native forest habitats is a major threat to *P. rufus* roosts (MacKinnon et al. 2003, Jenkins et al. 2007a). Roost occupancy by *P. rufus* varies temporally in areas of high disturbance (Jenkins et al. 2007a) and both the

Sainte Luce and Amborabao forest fragments have only been occupied in recent years following disturbance and degradation at nearby traditional roosts. This indicates a certain resilience to roost perturbation as long as alternative sites are available in the vicinity, although there may be other impacts on the bats, such as to social organization or behaviour that are not immediately discernable following roost switching. The Sainte Luce fragment will be cleared for forest in the next 40 years by a mining company and it might be instructive to follow the impact of this disturbance on the colony by marking and radio tagging the bats.

Because *P. rufus* roosts in small fragments or gallery forests that are usually without protected area status their persistence at any given site is often precarious. Gallery forest is an important habitat in other countries (e.g. Ukizintambara et al. 2007) and should be included in conservation plans in Madagascar. Sacred forests, which are usually small and isolated, also provide important roosting habitats for *P. rufus*. Significantly, whilst small sacred or gallery forests might be relatively poor in overall biodiversity terms compared to intact forest, they provide an important refuge for species which are not found in large forest blocks and that play key ecological roles in the ecosystem. In other parts of the tropics, sacred forests have an established importance in biodiversity planning across fragmented landscapes (e.g. Decher and Bahian 1999, Wadley and Colfer 2004) and in Madagascar where most existing protected areas are large (ANGAP 2003) local taboos protect resources in small forest patches that would otherwise be openly exploited (Tenbö et al. 2007).

Berenty is a major tourist attraction and in 2005 received approximately 600 visitors per month between August and September (Rahaingodrahety 2007). This reserve is famous for its lemurs but it is not clear what percentages of the tourists also visit the *P. rufus* roost. Ecotourism might provide the right economic incentives at other locations and thus benefit local people as well as the bat roosts. The Amborabao roost has some ecotourism potential because the hillock adjacent to the forest provides a suitable vantage point from where the bats can be viewed with a telescope or binoculars. However, the lack of alternative attractions in the area is likely to prohibit this site from being developed for tourists and Sainte Luce is too remote for ecotourism purposes and the colony is not large or stable enough.

In both Amborabao and Sainte Luce fruit bats are considered as pests of litchis and some of the hunting could be attributed to pest control measures. At Amborabao we encountered some resentment to the traditional protection afforded to the fruit bats from the sacred forests as it was perceived to be sustaining high depredation rates on local litchi crops.

Culture and taboo can impact two aspects of flying fox conservation. Firstly, forests that are considered sacred for mystical or burial reasons are often protected by local people and this is particularly true for southern Madagascar (Tenbö et al. 2007). Although the actual rules that govern the type of protection vary on a site by site basis, flying fox hunting is usually prohibited at these sites. This was the case for Amborabao where limited access by local people is permitted but flying fox hunting is strongly discouraged. As the flying foxes only arrived at this site recently it is important to recognize the value of working with village groups because in many cases traditional beliefs

are open to new interpretation or dilution through demographic mixing (Banks et al. 2007). The value of conveying the ecological importance and conservation status of threatened flying foxes to local communities and the general public is well established in the western Indian Ocean (Trehwella et al. 2005). In the Anosy Region, additional support to community groups in the form of awareness raising will benefit *P. rufus* conservation and assist the preservation of traditional taboos and beliefs.

The other impact of culture and taboo is on hunting and consumption of *Pteropus* bats. In many parts of Madagascar local taboo (or *fady*) governs resource use and can benefit species conservation because certain taxa are forbidden to be hunted or consumed (e.g. Jones et al. 2006). In our study there was some evidence for this because the Antandroy people rarely ate *P. rufus* because it was taboo. In other circumstances, taboo might not determine which species are eaten but it may impact the way in which the animal is exploited (e.g. Jones et al. 2006). However, in many areas *fady* is being eroded and as this occurs the animals that were once traditionally protected are exploited (e.g. Mutschler et al. 2001).

#### RECOMMENDATIONS

1. Conduct conservation relevant research on *P. rufus* that will lead to policy recommendations to ensure protection of the species and with the ecosystem services it provides.
2. Detailed study of the hunting and consumption of flying foxes by people to determine the importance of bat meat in cultural and socioeconomic contexts, as well as the ratio hunting for subsistence and commercial purposes.
3. Assess whether roosts are large enough to sustain managed harvests of bats trapped whilst foraging at night and whether such initiatives would benefit conservation.
4. Improve the viewing experience at Berenty by creating a new poster that would provide greater information to the guides and encourage more tourists to request a visit to the roosts and also consider a remote video camera that would allow researchers and tourists alike to view bat behavior on screens in the reserve buildings.
5. Investigate the actual economic losses to growers of litchis and other commercial crops that are directly attributable to *P. rufus* in order to assess whether the species should be treated as a pest.
6. Achieve enhanced community engagement in fruit bat conservation through a monitoring project conducted by local people and supervised by conservation technicians with the possibility of some tangible reward available for the village if the roost is conserved.
7. Awareness raising and environmental education on *P. rufus* in villages/schools on the ecosystem services the species provides.

#### ACKNOWLEDGEMENTS

This study was funded by the Rio Tinto Fauna and Flora International Biodiversity Partnership, the Darwin Initiative and the BP Conservation (Leadership) Programme. We are very grateful to QMM for assisting us with the project and are indebted to the people who voluntarily contributed information. Emma Long

and an anonymous referee helped to improve an earlier version of the manuscript. Hanta Julie Razafimanahaka translated the abstract into French.

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