Bringing Bats off the Brink:
Conservation action for the Critically Endangered Seychelles Sheath-tailed Bat

Nature Seychelles

Seychelles August 2006 – July 2007

BP Follow-up Award Preliminary Report

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1.0 Introduction

This project was funded by a BP Conservation Programme (BPCP) follow-up award, following the previous project 'Bats on the Brink' Conserving the Critically Endangered Seychelles sheath-tailed bat (*Coleura seychellensis*)', better known as the 'Bats on the Brink' project. Detailed background information for these projects is included in the 'Bats on the Brink' project report (Bambini *et al.*, 2005). This current project 'Bringing Bats off the Brink' was driven by Nature Seychelles, a Seychellois nature conservation NGO. The aim was to collect sufficient information to allow positive conservation action to be taken to protect the existing population of Seychelles sheath-tailed bats and to try to increase the number of bats to ensure their future survival.

The Seychelles sheath-tailed bat is the only insectivorous bat known from the granitic Seychelles and prior to the 'Bats on the Brink' project very little data existed on the status and ecology of this species. The Seychelles sheath-tailed bat was historically common throughout the four main granitic islands of Seychelles and was noted as 'very common in the neighbourhood of the town of Port Victoria' by Wright (1868). It has undergone a severe decline since the mid 20th century and is currently listed as Critically Endangered (CR C2a(i,ii)) by the IUCN (2006) and is probably the rarest bat in the world. Efforts to conserve the species were severely restricted by the lack of data and little knowledge about the cause/s of the decline of the species. The aims of the 'Bats on the Brink' project were to establish the population status, distribution and ecology of this Critically Endangered bat, identify possible causes of decline and put forward a species recovery action plan for the Seychelles sheath-tailed bat. Previous to this project bats were known from the four main granitic Seychelles islands, Mahé, Silhouette, Praslin and La Digue (fig. 1.1), however recent surveys had failed to detect bats on the latter two islands since 2001 and 1976 respectively. By the end of the 'Bats on the Brink' project a further two roosts had been found on Mahé (fig. 1.2), however the expedition still failed to discover any bats on either Praslin or La Digue, increasing the likelihood that they may now be extinct on these two islands. As a result of the 'Bats on the Brink' project the total known world population was thought to be in the region of 51 individuals with 32 in a single roost on Silhouette (fig. 1.3) and 19 in three roosts on Mahé (7+ at Cap Ternay, 4+ at Baie Lazare and 8 at Anse Major) (fig. 1.2).

The 'Bats on the Brink' expedition identified the following possible causes of decline for the bat: reduced insect availability as a result of over-use of pesticides and invasion of native forest by exotic vegetation, destruction of roosts as a result of human development and predation by Barn Owls.

The recommendations in the species action plan included:

- Education on the status of the bat and the effects of excessive pesticide use, plus the positive use of native plant species in gardens
- Reserve status given to protect known foraging areas and mature forest
- Legal protection of the bat to allow criminal charges to be brought against anyone killing/disturbing bats
- Full roost protection and non-disclosure of locations
- Legal control of pesticide use and deforestation
- Forest management to increase the presence of mature native species
- Planting of natives in residential areas and removal of cinnamon
- Identification of further roosts and foraging areas
- Further insect abundance research
- Continued roost searches to look at the possibility of seasonal roost use
- Monitoring breeding activity

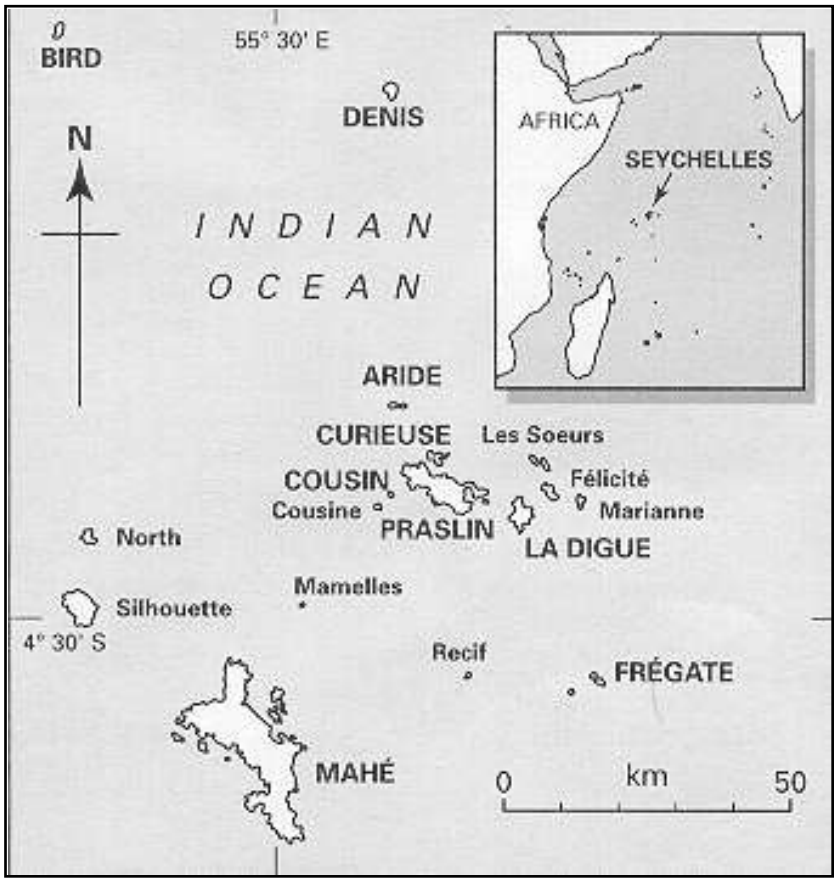

Fig. 1.1 The main Granitic islands of the Seychelles

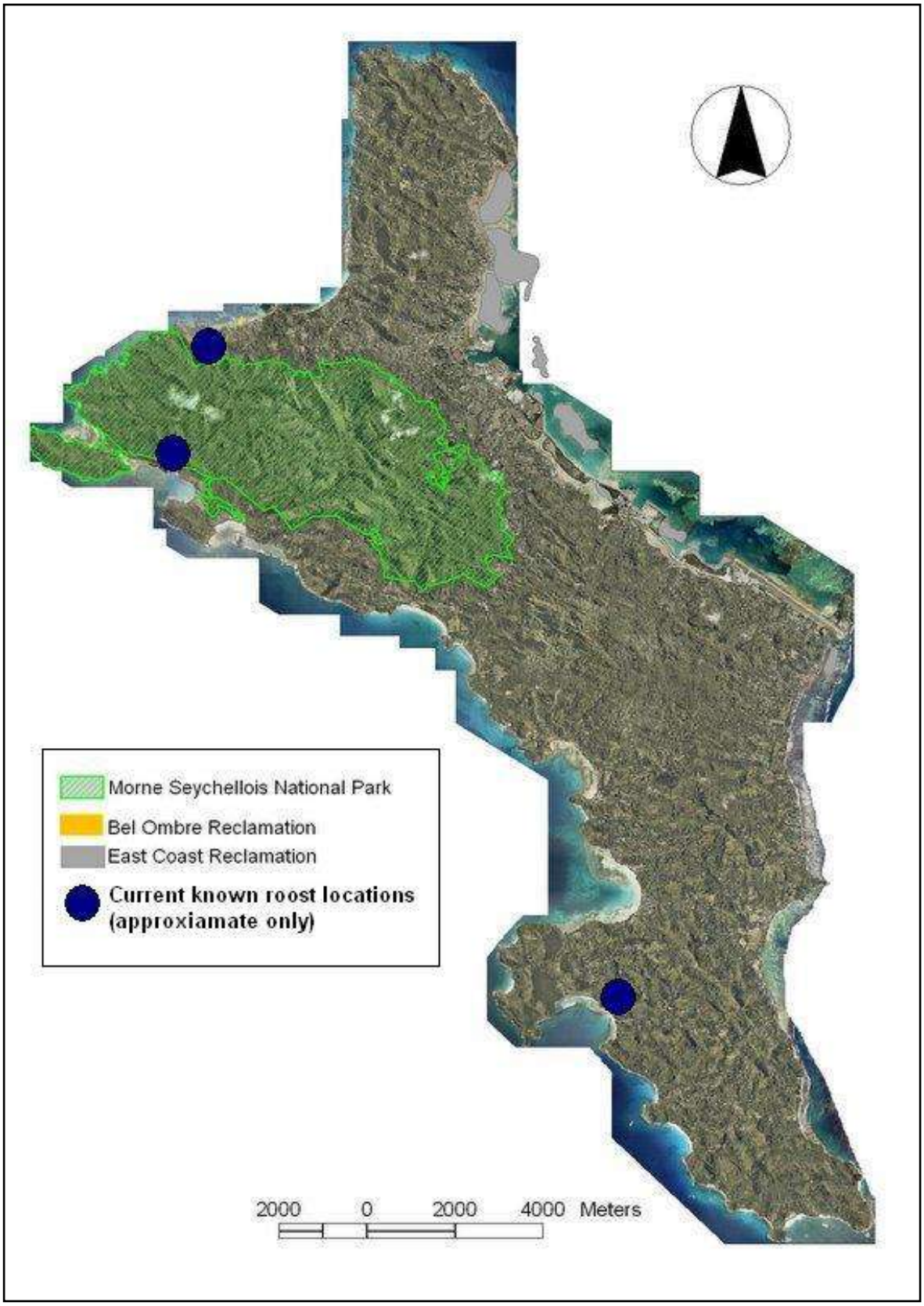

Fig. 1.2 Approximate location of the three known occupied *Coleura* roosts on Mahé

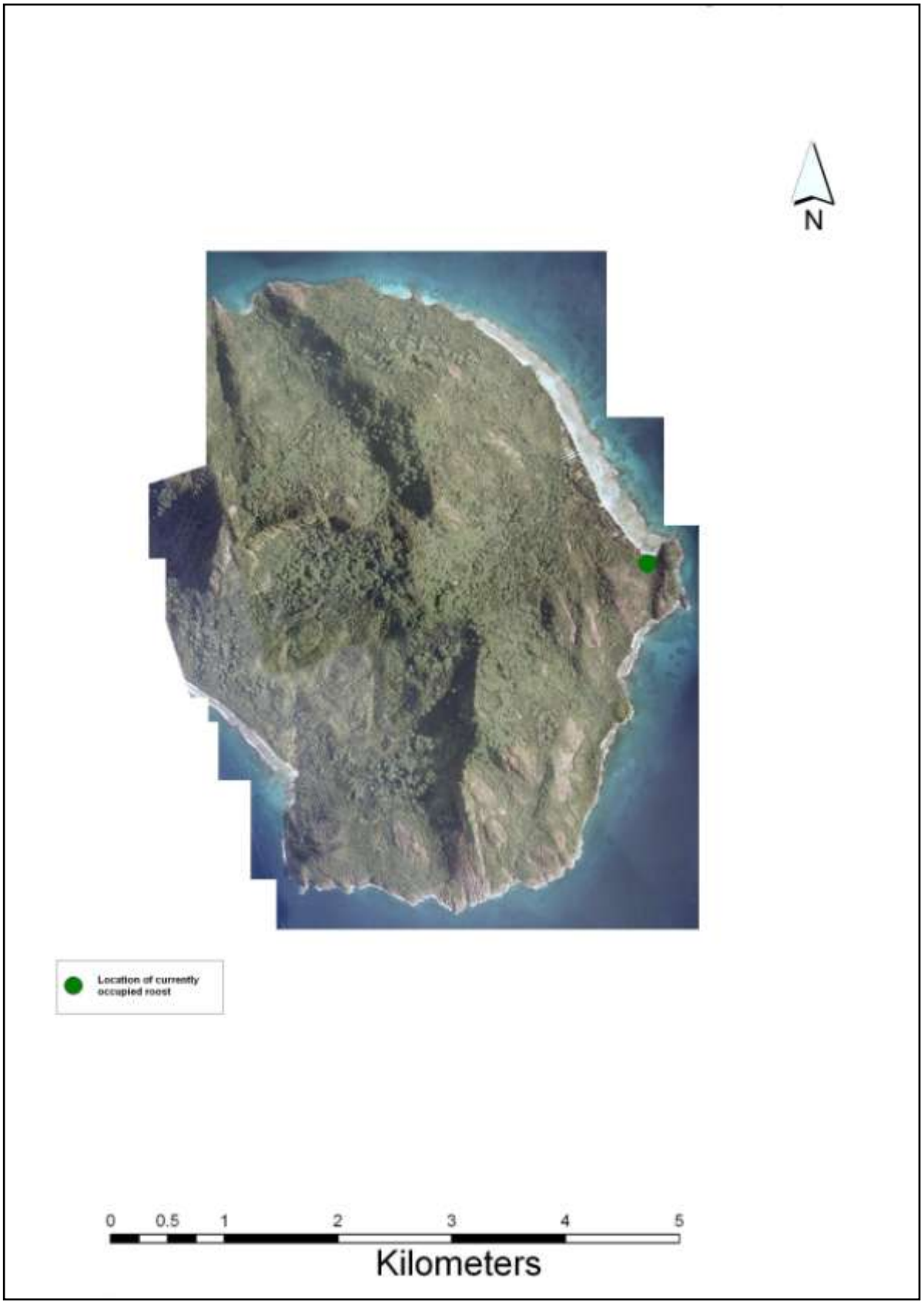

Fig. 1.3 Approximate location of the occupied roost on Silhouette

2.0 ‘Bringing Bats off the Brink’ Fieldwork and Research

This second project was designed to address some of the elements in the species action plan outlined above, although some of the recommendations are more long-term than can be achieved in a year’s project. Logistically it was decided that the project should be concentrated on the four main granitic Seychelles islands, where bats had previously been recorded: Mahé, Silhouette, Praslin and La Digue. Unfortunately it was not possible to visit Silhouette during this or the previous project for political reasons. This is a very important roost; it is a breeding roost and has been more extensively studied than any of the other roosts and would form a valuable comparison to the Mahé roosts, particularly the one at Cap Ternay.

The aim of this project was to halt and reverse the population decline of the Seychelles sheath-tailed bat.

The main objectives were:

- Identify the cause/s of the decline
  - researching the possible threats including habitat destruction, human disturbance and destruction of roosts, pesticide use and predation by barn owls and rank them in terms of their role in the decline of the bat.
- Having identified the main threat/s to the bats, produce recommendations to halt and reverse this population trend
- Clarify the population size of the Seychelles sheath-tailed bat
- Identify patterns of roost use throughout the year using emergence counts to obtain more accurate information on numbers and composition within roosts
- Use remote sampling techniques to try to clarify the population structure within the roost
- Identify further roosts and foraging areas and build on the information on distribution, life history and ecology of the bats
- Lobby for the immediate protection of all known roosts and feeding areas
- Build on the education and awareness work of the previous project and enlist local support and active participation to save the bat
- Update the species action plan

The following are accounts of the work carried out during the project. The main problems encountered were lack of human resources and the inability to find any old abandoned roosts. To achieve all the above objectives we would have needed a dedicated bat team, who could devote all their time to the project, this is something that we must secure during future projects. A number of old roosts are known by people in Seychelles, but to-date it has not been possible to visit these locations with them. Some of the work,

particularly in terms of threat identification required comparisons between old and current roosts. As soon as the old roosts can be located, this work will continue and hopefully give a clearer picture of the past and present ecology of the bats and the reasons why they abandoned the old roosts.

Some discussion points are included in the results section at this stage, full discussion sections and conclusions will be included in the final report after all the data has been collated and analysed.

2.1 Threat Investigation

A number of possible reasons for the decline of the Seychelles sheath-tailed bat have been suggested including habitat destruction, human disturbance, introduced Barn Owls, reduction of insect availability as a result of over-use of pesticides and exotic vegetation in roost/foraging areas (Joubert 1996, Gerlach 1997, Bambini *et al.,* 2005). One of the main objectives of this project was to try to identify and prioritise the key threat/s to the bats to allow effective conservation measures to be put in place.

Most/all of the methods outlined below required the comparison of threat levels near old abandoned roosts versus currently used roosts. All roosts investigated were cave roosts. To date it has not been possible to identify/locate any of the old abandoned roosts, but enquiries are continuing.

The following methods are the protocols that the team will follow as soon as old abandoned roosts can be located, and the alternative actions taken during the period of this project in the absence of old roosts. The results section details the information that has been collected during the period of this project.

2.1.1 Habitat destruction

2.1.1.1 Methods

A comparison of the habitat around old and current roosts will be conducted to see if loss of habitat both in terms of roosting and foraging will account for the loss of bats from old roosting areas. The following questions will be addressed: do the old roosts still exist or have they been destroyed during development projects; if the old roosts still exist are they more closely affected by housing/other buildings etc; are the old roosts no longer accessible as a result of encroachment of exotic vegetation; is the area surrounding the roosts suitable for bats to spread out for foraging, whilst still affording them some protection from potential predators?

Land ownership was established for each of the known roosts on Mahé and any proposed development projects in the area were identified and their possible effect on the roosts evaluated.

2.1.1.2 Results

All currently occupied sheath-tailed bat roosts are located in boulder caves near the coast (less than 100 m altitude). All the granitic Seychelles islands are mountainous and the majority of the development is in the coastal region. Prior to construction the boulder fields are blasted and removed to clear sufficient ground and marshy areas are drained. It seems highly likely that a number of old bat roosts will have been lost during this type of development in the past 40+ years. Development has been most intensive on Mahé and affects nearly all the coastal region. In contrast the location of two of the previously known roosts on Praslin and La Digue are in areas with little or no development either now or historically, suggesting that there must be other factors affecting the status of the bats in these locations. Two further possible locations of bat roosts on Praslin are now quarries and any bat roost will either have been destroyed or subject to so many disturbances with blasting that the bats would be likely to abandon them. It was reported that the effects of blasting on the south coast of Praslin can be felt on Cousin (D. Toews, pers comm.).

Exotic vegetation could be a major factor in the decline of the bat on Seychelles. Areas of exotic forest are very dense in comparison with native/endemic forest areas where the canopy is more open. The Seychelles sheath-tailed bat has long narrow wings, suggesting that it is adapted to flying in the open air and capable of covering large distances as opposed to being able to manoeuvre in a cluttered environment. As the bats emerge from their roosts they all follow the same route to exit the roost area and this route follows the line with the least vegetation cover (Senior, pers. obs.). Echolocation call frequency has been shown to be linked to wing-beat frequency and the bats echolocation frequency is very rapid as they exit the roost entrances, particularly at Baie Lazare where the exit route is very narrow (Senior, pers. obs.), suggesting that they are restricted in their movements as they negotiate their way out of the roost. At this roost the bats changed their exit route when a palm tree blocked their previous route, forcing them to use a different route (Doak, pers. obs.). The bats at this particular roost were subject to attack by a Barn Owl over a 2-3 week period (this is discussed in the Barn Owl section below in more detail) and the predictable emergence behaviour of these bats makes them very vulnerable to such a predator. Any encroachment of vegetation will make entry and exit to the roosts harder for these bats and could be a likely reason for roost abandonment in many areas as all the islands are subject to high levels of exotic vegetation cover. During the course of this project the vegetation levels around the Cap Ternay roost increased dramatically (Senior, pers. obs.) and may need to be managed to ensure that this roost remains accessible to the bats in future. A similar pattern of encroachment has been seen at Baie Lazare, but is not as intense as there is a greater concentration of native vegetation in this area.

Part of this project involved finding out who owns the land where each of the currently known Mahé roosts is located and establishing any development projects that may threaten the roosts.

The roost at Cap Ternay is situated off the road between two peninsulas; Port Launay and Cap Ternay (fig. 1.3), on land owned by the Government of

Seychelles. Plans have been approved for the development of hotel complexes on both these peninsulas; the former is not likely to have a major effect on the bat roost except in terms of increased human presence and a possible increase in the numbers of cats and rats in the area. The proposed hotel at Cap Ternay, to be built by Emirates Hotels and Resorts, however, could have a major effect on the bat roost – it will be 400+ rooms and is projected to cost $253 million. Access to the hotel complex would be via the road running past the bat roost; this road is currently single track and it is hard to believe that the plans do not include improvement and widening of this road, both in terms of construction traffic and transporting guests to and from the hotel in the longer term. The land on the opposite side of the road to the roost is narrow and part of the adjacent marine national park. Its status as part of the marine protected area and the fact that the road runs alongside the beach with the high water mark often reaching the road means widening the road in that direction would not be possible. Any widening of the road on the roost side would bring the road within 50 m of the roost and would probably involve the removal of a large number of trees that surround a clearing that the bats use for foraging immediately after emergence from the roost. As part of the announcement about the hotel development, Emirates outlined their plans to establish a conservation trust '*aimed at identifying threatened species, and establishing a long-term strategy for the management of ecosystems and the surrounding marine environment*', they also propose to establish a feral free wildlife reserve. In view of the close proximity of the development to the Seychelles sheath-tailed bat roost a member of the Nature Seychelles board is in discussion with Emirates to try to encourage them to make the bat the flagship species for their conservation efforts. This would hopefully ensure protection of the roost at Cap Ternay, which is probably one of only two remaining breeding roosts for the bat and possibly the largest roost in the world for this species.

The roost at Baie Lazare is situated on privately owned land. Recent development work has moved increasingly towards the area of the roost. Having discussed the bat roost with the land owner, the bat team has been assured that there is no more development work planned nearer to the roost, which should prevent disturbance and the land owner was interested in the presence of the bats and appeared to be keen that they remain there.

The roost at Anse Major is on privately owned land. However the situation of the roost makes it unlikely to be subject to disturbance from development work and there do not appear to be any plans for development in that area.

2.1.2 Human Disturbance

If the roosts are not subject to direct destruction of habitat, are the levels of human disturbance likely to have affected the bats' use of these areas? Is there evidence of human activity in old and not current roost caves; is human traffic heavier near/around old versus current caves; if caves aren't directly affected by humans are the old roosts in areas of greater human occupancy

leading to an increase in cats, rats and as a consequence of an increase in rats possibly more Barn Owls in the area?

2.1.2.1 Methods
The methods require a comparison between currently occupied roosts and old abandoned roosts and as already outlined the search for all of the old abandoned roosts is ongoing.

2.1.2.2 Results
Without a direct comparison between old and current roosts it is difficult to draw conclusions about the effect of human disturbance on the Seychelles sheath-tailed bat. All current roosts on Mahé are in areas of forest and with the exception of Baie Lazare, where recent development work has resulted in houses within the vicinity of the roost, they are some distance from human habitation. Continued monitoring of the Baie Lazare roost will show whether the recent development work has any negative effects on the bat roost. A hotel has recently been built on Silhouette in the area of the current bat roost, although not immediately adjacent to the roost. Although the building work has probably not had a general disturbance effect it has resulted in an increase of human beings in the area and an increase in cats and rats. A small decrease in the number of the bats in the roost has been noted (J. Gerlach, pers. comm.), which may be temporary or permanent. This roost is closely monitored and the long-term effects of this hotel will be recorded. The results of both these development projects have important implications for the effect of development on the Cap Ternay roost.

In terms of human presence in and around the roosts there is sign of occasional human presence at the Cap Ternay roost, with some rubbish and discarded snail shells. The signs are sufficiently far away from the roost area and entrance/exit, that unless these disturbances became a regular occurrence they are unlikely to affect the bats.

2.1.3 Predation by Barn Owls

Barn Owls were first introduced to the Seychelles in 1949 and a total of 40 birds were introduced onto Ile Platte and Mahé as detailed below (Department of Agriculture, 1952):

27/4/49 – 3 birds onto Ile Platte
31/12/51 – 15 birds onto Mahé, Union Vale
29/7/52 – 6 birds onto Mahé, Niol
9/8/52 – 6 birds onto Mahé, Niol

Barn Owls were introduced in an attempt to control rats on the islands, but they started to spread and prey on other things such as seabirds; by 1969 a bounty was being offered for all Barn Owls handed into the Government (Lionnet, 1971). Bats may also have become a prey item by this time.

2.1.3.1 Methods

A comparison of accessibility of old versus current roosts to Barn Owls and evidence/reports of the level of Barn Owl activity/roosts will be conducted around old versus current roosts. Previous work on the Seychelles has involved extensive searches for Barn Owl roosts; these will be followed up to allow the collection of owl pellets to check for the presence of bat remains in the pellets.

2.1.3.2 Results

Barn Owls are not regularly reported on Mahé, so do not appear to be present in high densities. The Baie Lazare roost was visited by the bat team twice during the period 18th January 2007 to 25th January 2007 and on both these occasions a Barn Owl was seen in the area of the roost targeting the bats leaving the roost (Doak and Valmont, pers. comm.). This period coincided with a slight decrease in the number of bats leaving the roost. The Barn Owl was not seen after this time and it may have moved elsewhere as the effort per successful bat capture was too great. Close observation for Barn Owls will continue in the area of all three Mahé roosts and if a bird is detected immediate action will be taken to catch and/or destroy it. A Barn Owl targeting the Cap Ternay roost could be very damaging to the population. Clearly Barn Owls are a threat to the Seychelles sheath-tailed bat, but may not be present in sufficient numbers to be the only cause for the decline in the numbers of the bats.

There are two people who have found Barn Owl roosts in the past on Mahé, one is currently not in the Seychelles and the other is prepared to take the team to known roosts to collect owl pellets, but has not been available to date. This is a project that will be pursued.

2.1.4 Pesticides

Reduced insect abundance and diversity, as a result of over-use of pesticides and increased exotic vegetation, is proposed as a possible cause of the decline of the bat. Searches of the archived data during the original 'Bats on the Brink' project identified a number of potentially damaging chemicals used on the Seychelles, however records are sparse and there was little indication of extensive pesticide use across the islands over prolonged time periods. Spraying pyrethrum in coastal zones, near tourist areas, to control sandflies was recommended in the 1970's, which may have had an effect on the bats as they are believed to be coastal foragers, however pyrethrum is believed to have low mammalian toxicity (Morse and McNamara, 2004 cited in Bambini *et al*., 2005), however cumulative doses over a long period should be considered. Diet analysis has shown that the Seychelles sheath-tailed bat is probably an opportunistic feeder, rather than a specialist, with the main prey being coleoptera, diptera and lepidoptera (Joubert, 1996; Bambini *et al*., 2005). The 'Bats on the Brink' team showed that in general insect abundance was low, but the bats targeted areas with higher than average insect abundance for foraging. They suggested that pesticide use, resulting in low insect abundance may be a major factor in the decline of the bat.

2.1.4.1 Methods
Further searches were conducted of the archived information on the use of pesticides on Seychelles since 1947; however reports from the Department of Agriculture between 1971 and 1994 were lost during a departmental move.

It was decided that records of pesticide use were unlikely to give sufficient information about the bats' exposure to pesticides and that a more direct testing method was required. A laboratory in the UK is able to analyse faecal samples for the levels of pesticides and it was proposed that samples be taken at increasing depths, representing greater time periods, into guano piles from roosts to look at the levels of pesticides consumed by the bats over time, in both old and current roosts.

2.1.4.2 Results
No further records of widespread pesticide use were found during archived information searches in the national library. The annual reports of the Department of Agriculture were searched for the period 1947-1971 and 1994-1999 and the annual reports for the Medical and Health Department 1949-69, 1978 and 1999. The Department of Environmental Health has more recent records of pesticide use, but was not prepared to release the information. There have been reports of widespread pesticide use in 2006 as a result of the outbreak of the mosquito borne virus chikungunya, once again details of the chemicals used or the distribution of the spraying were not available.

None of the current roosts contain large piles of bat guano in the areas where the team has entered the roost, however, the actual roosting areas have not been entered to avoid disturbing the bats. Samples could be collected for pesticide analysis from the current population of bats using the same protocol used to collect material for genetic analysis (see section 2.2.2.1 below). Reports of the old roosts suggest that they do contain substantial guano piles and as soon as any of these roosts are located samples will be taken for analysis.

2.2 Roost Surveys

Identifying as many roosts as possible is vital to protecting this species. All roosts must be protected and monitored to ensure that they remain suitable for occupancy by the bats. Unfortunately none of the roosts fall within the Morne Seychellois National Park, which would ensure full habitat protection, although two of the roosts are just outside the Park and the bats may well use the National Park for foraging. The 'Bats on the Brink' project showed that the roosts were important locations for social and foraging activity (Bambini *et al*., 2005). Only general area locations for each of the roosts will be given due to their sensitive nature and to prevent any unnecessary disturbance.

2.2.1 Roost use and movements

2.2.1.1 Methods

Originally the proposal was to do monthly emergence counts at each of the three roosts identified on Mahé during the last BP funded project and at any further roosts identified during this project. The data from these counts would be used to look at patterns of roost use and possibly infer movements between roosts. The roosts were visited on a monthly basis from August 2006 until November 2006. At this time a better counting position was found at the Cap Ternay roost and weekly roost counts were started at all three roosts coinciding with the suspected breeding period for this bat. A visual inspection of the Anse Major roost suggested that it was inappropriate for a breeding colony and repeated counts only showed that two bats were using the roost, so the count was reduced to monthly at this roost from December onwards; weekly roost counts were continued, when possible, at the other two roosts. (Roost counting will continue beyond the end of the project on a regular basis).

All people involved in the counting were trained to ensure consistency between recorders. Recorders were positioned outside the cave entrance where they could see the bats leaving the roost, but in a position where they would not disturb the bats. Bat detectors (Batbox III and a Batbox Duet (Batbox Ltd, Steyning, UK)) set at 37 kHz were used to indicate when a bat was approaching an observer. The count was based on visual counts of the number of bats leaving the roost, minus those returning to the roost, rather than bat passes on the detectors as the bats often light sample in the roost entrances, coming out of the roost and then going back in again until the light levels have dropped sufficiently for them to leave. There was a risk of overestimating the bat population using bat passes and the bats always left the roost before it got too dark to be able to see them emerging. Recorders noted the time of first and last emergence of a bat, the numbers of bats leaving the roost, the numbers of bats returning to the roost and the weather conditions at the start of the count and any major changes during the counting period, any bats foraging in the area were also recorded. By subtracting the number of bats returning to the roost from the number leaving the roost, there was a risk of underestimating the population by subtracting an individual that had entered the roost from elsewhere, but it was felt that an accurate minimum population estimate was the best option.

2.2.1.2 Results

The number of bats emerging from each roost is shown in fig. 2.1 and the average number of bats in each roost are shown in table 2.1 along with the figures from the ‘Bats on the Brink’ project. Initial results suggest that these roosts have a very stable year-round population. Having found the new counting location at Cap Ternay the number of bats at the roost has risen from 7+ after the ‘Bats on the Brink’ project to an average of 27 ± 5 during this project. This may indicate a population increase, however it is more likely that we have just found the true location that the bats emerge, as counts during this project previous to finding this location were in the region of 8-10 bats in the roost. Initial figures suggest that there may have been breeding at the Cap Ternay roost, but this will require further analysis to confirm this, however the figures also suggest that shortly after the increase in numbers, they dropped back to their former level (fig 2.1). A change in behaviour was also

observed around the suspected breeding time; prior to this time bats would emerge from the roost and leave the area for foraging, in early December the bats started emerging from the roost as usual but then some re-entered the roost and this behaviour continued throughout the evening and bats were noted feeding in the region of the roost during this time, by mid-January the bats had reverted to exiting the roost and leaving the area. The return to previous numbers suggests that either the juveniles disperse rapidly after fledging or there is nearly 100% juvenile mortality. It seems unlikely that juveniles disperse this quickly as in general juvenile bats do not wean before fledging and are still dependent on their mothers for food for approximately 4-8 weeks (Racey, 1982) post-fledging. Inbreeding depression may result in high juvenile mortality and data on inbreeding from DNA analysis will give a better picture of this. The stability of the numbers at each roost suggests that each roost may be a closed population, which would dramatically increase the risk of inbreeding. There was no indication of breeding at the other two roosts during the November/December proposed breeding period, leaving just two breeding roosts; one at Cap Ternay on Mahé and one on Silhouette, with no indication at the current time that there is any exchange of animals between the two roosts, although wing morphology would suggest that this is not entirely impossible. If the genetic analysis is successful we should aim to include faecal samples from the roost on Silhouette as well. Figure 2.1 shows an increase in the average number of bats emerging at both the Cap Ternay and Baie Lazare roosts from April onwards. Nicoll and Suttie (1982) noted juveniles in a roost on Praslin in April and suggested that this was a second breeding period. Figure 2.1 shows an apparent increase in the average number of bats leaving the Cap Ternay and Baie Lazare roosts from April/May onwards, with no observed change in behaviour (Doak, pers. obs.). If breeding has not occurred at this time the other possible cause of the increase in numbers would be male bats that have been roosting elsewhere moving into the roosts for possible breeding opportunities. If the DNA analysis shows a skew in the male/female ratio, this may be a possibility and would indicate that there are more bats on Mahé than the current counts indicate. A third possibility would be bats from other unknown roosts moving to these roosts for mating purposes to increase genetic mixing. Numbers of emerging bats will be monitored on a continuing basis to see if these increases are permanent or just seasonal.

	2004	**2006-2007**		
	No. bats	**Mean no. bats (S.D.)**	**Range**	**No. visits**
Anse Major	8	2 (± 0.29)	1-2	12
Baie Lazare	4 +	7 (± 2.14)	3-12	28
Cap Ternay	7 +	27 (± 5.03)	18-40	38
TOTAL	**19 +**	**36**		

Table 2.1 The minimum number of bats counted during the 'Bats on the Brink' 2004 expedition and the mean number of bats counted during the current 'Bringing bats off the brink' project.

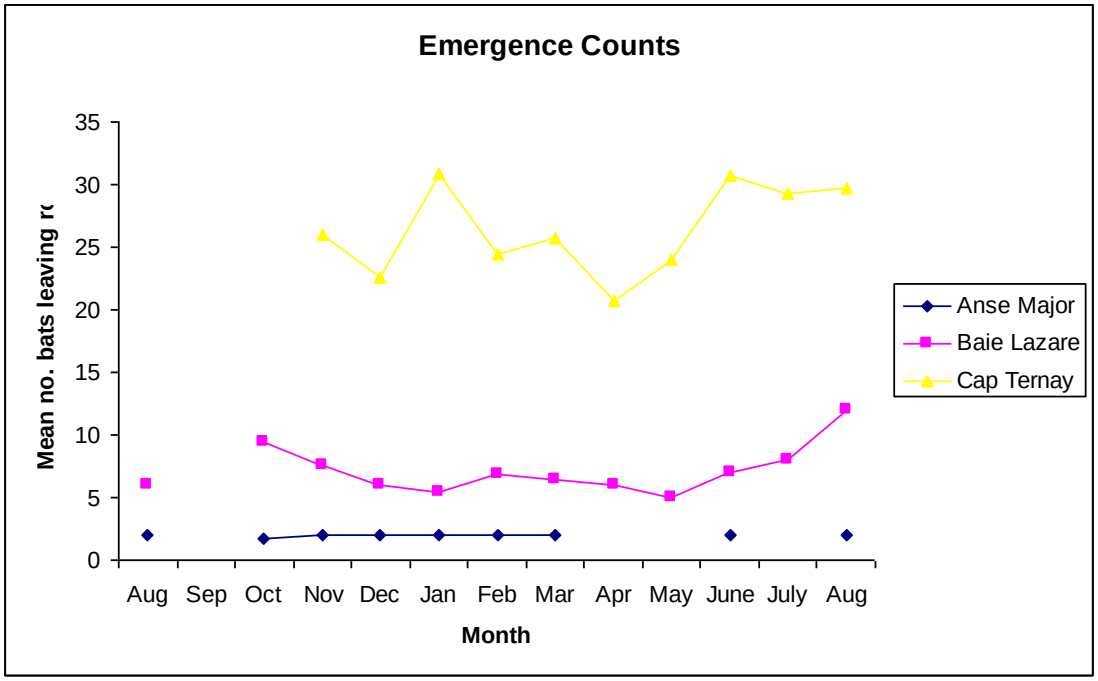

Fig. 2.1 Mean monthly counts of emerging bats from the three known roosts on Mahé

Data will be analysed to look at variation in numbers of bats emerging from each roost to see if there are any patterns or whether the roosts show stability throughout the year. Emergence data will also be analysed to see if the bats adapt their emergence time to coincide with a change in the time of sunset.

2.2.2 Sex Ratio in Roosts and Population Structure

Nicoll and Suttie (1982) showed that colonies of *C. seychellensis* were divided into harem groups, like those of *Coleura afra* its sister species found on mainland Africa (McWilliam, 1987) with a few males securing the majority of the mating opportunities with the females in a roost. This type of mating system has several implications for the Seychelles sheath-tailed bat, firstly the total bat population may be larger if non-harem males do not roost with the mating groups; secondly, negatively and more importantly a harem mating system would lead to greater levels of inbreeding in an already very small bat population, with only a few males contributing genetic material to the next generation. This would be compounded if the bats are not moving between roosts and swapping genetic material within the whole population.

2.2.2.1 Methods

It is important to try and establish the sex distribution and population structure of this bat in each of the roosts and it was decided, in conjunction with the project advisors, that catching these bats was not an option. Genetic material had to be collect remotely, without disturbing the bats to look at the sex ratio within each roost. Techniques have been developed to extract DNA from bat

faecal samples (Puechmaille *et al*., 2007) and it seemed possible that samples could be collected without having to go into the actual roosting area. Observing the bats leaving the roosts showed that they follow a very similar emergence routine every night. At Cap Ternay the bats move towards the entrance of the cave towards nightfall and they tend to hang in a location just inside the entrance whilst they take it in turns to light sample just at the entrance before emergence. By placing plastic sheeting just inside the entrances to each of the three caves faecal samples could be collected during the day when the bats were roosting further back in the caves. Faecal samples were collected from all three roosts on Mahé and samples were collected on several consecutive nights at Cap Ternay to give duplicate samples for trial extractions and testing and to maximise the chance of sampling all the individuals from the roost. Having placed plastic sheeting underneath the place where the bats hang prior to emergence we managed to collect greater numbers of faecal samples than the number of bats emerging from the roost, suggesting that they possibly hang in the same place as they re-enter the roost at dawn, which may have a social function. The majority of the faecal samples were stored on ethanol, however, a trial sample were stored on silica gel to allow a comparison of the levels of DNA that could be extracted after the two different storage methods.

In discussion with a Population Geneticist at Sheffield University, UK, he has agreed that post-graduate students on his team will undertake the sexing and also try to run some microsatellite analysis if DNA can successfully be extracted from the samples. Sexing will be used to look at whether the roosts contain a 50:50 sex ratio or whether the suspected harem mating system means that there is a female bias within the roosts, assuming that male and female bats defecate at approximately similar rates and in the same position as they leave the roost. The microsatellite data will be analysed to look at population structure across the roosts on Mahé, but also at the individual roost level. Paternity analysis will also be possible, which may indicate the mating system and importantly the level of inbreeding can be analysed.

2.3 New roosts

All the current roosts and the majority of old roosts for the Seychelles sheath-tailed bat are in boulder caves. If boulder caves are the preferred roosting location, initial inspection suggests that roosts should not be limiting, however much of the rock on Seychelles consists of large granite slabs and most of the boulder caves are restricted to the lower coastal plateau areas where lumps have fallen off the slabs and rolled down and come to rest amongst other boulders.

2.3.1 Methods

Searches for new roosts were carried out both opportunistically and based on information both from the previous ‘Bats on the Brink’ expedition and from local people. Opportunistic searches involved travelling at less than 30 km/hr in the car along both coastal and upland roads with a bat detector, tuned to 37 kHz, held out of the window to pick up any bat activity in the area. Several of

the coastal and upland trails were also walked at dusk with a bat detector to see if any bat activity could be picked up close to emergence time (around 1830). The 'Bats on the Brink' team had suggested a further two possible roost locations during their expedition, but had not had the time to follow these up. These locations were checked with bat detectors at dusk for any activity. Additionally several Seychellois reported that they saw 'bats' shortly before dark flying in groups in several different locations on the west coast of Mahé including:

- Beoliere (several reports of slightly different locations), both coastal and a report of a cave further inland
- Following the detection of a foraging bat on the Sans Soucis road a nearby house-owner said they regularly saw bats in that area around 6pm, particularly on rainy nights

All locations were checked with bat detectors and the people were asked to give detailed accounts of what they saw in terms of numbers, behaviour, did they see them every night or only occasionally, were the sightings historical or recent etc. In those locations where activity was picked up early in the evening a team of people were spread around the area before emergence time to see if any evidence of emergence could be detected. A possible roost would be identified by localising the search effort around the area where the first signal was detected on a previous night.

2.3.2 Results

It appears that many of the reports we received from local people may be of cave swiftlets (*Collocalia francica elaphra*), these are often seen flying in groups about an hour before sunset and could easily be mistaken for bats. No bats were detected on any of the occasions that we went to do emergence surveys, but these areas will continue to be monitored in future in case there are roosts that are used seasonally.

2.4 Foraging area surveys

The 'Bats on the Brink' project team identified seven foraging areas on Mahé, none on Praslin and La Digue and they were not able to visit Silhouette (fig. 2.2). The bats on Mahé showed a preference for foraging in relatively open areas within mature forest with an apparent avoidance of non-native vegetation. Habitat sampling revealed no apparent lack of such habitat on Praslin and La Digue suggesting that foraging habitat loss could not account for the apparent lack of bats on either island. The wing morphology of the Seychelles sheath-tailed bat (pers. obs.) and the echolocation call structure analysed during the 'Bats on the Brink' project (Bambini *et al*., 2005), suggest that this bat is a fast-flying, aerial hawking species, better adapted to open areas than cluttered foraging environments, and this was supported by observations of foraging bats, although there was some evidence of bats foraging in cluttered environments during Joubert's (1996) study on Silhouette. Bats were also seen foraging in pairs during the 'Bats on the Brink' project (Bambini *et al*., 2005). It must be noted that as the bats are

down to such low numbers on both Mahé and Silhouette any observed behaviour may not be optimal, but just a behaviour that they are forced to show as a result of the severe pressure they are facing.

2.4.1 Methods

Rather than repeating the targeted transect protocol devised in the 'Bats on the Brink' expedition it was decided to do opportunistic bat detector surveying for foraging bats, both from a slow moving vehicle (less than 30 km/hr) and on foot on targeted trails. All the major roads on the island were surveyed at least once, many of them several times and trails were targeted in coastal areas, those that were in the region of known roosts and trails that passed through current or historical marshy areas as the bats on Silhouette are known to preferentially forage in the marshy plateau area, where insect diversity is high (Joubert, 1996). The areas where the 'Bats on the Brink' team had foraging bats were also targeted to see if the bats repeatedly use the same foraging areas. It was hoped that regular surveying would reveal patterns of seasonal foraging area use.

2.4.2 Results

Five to six more foraging areas were found during this project (see points 1-6 on fig. 2.2), however neither these or previous foraging areas seemed to be used on a nightly or even regular basis. Bats were recorded more than once in several of the foraging locations, but not often enough to say that they were key foraging areas or to pick up any pattern of seasonal use. As a consequence it would be difficult to identify areas that should be protected as important foraging areas and it would appear that these bats do not hold foraging territories that they visit every night. All foraging bats encountered were solitary, except for a single occasion when 2-3 bats were encountered near houses where burning was being carried out, resulting in large numbers of flying insects.

All foraging areas identified during this project seemed to be clearings in forest areas or to mimic such habitat, where the bats could fly freely. Data from previous projects suggest that these bats are not specialist feeders (Bambini *et al*., (2005), (2006); Joubert (1996)). Although a lot of the Seychelles forest has been invaded by exotic vegetation it would seems likely that limited roosting sites may be the greater factor in the decline of the bats.

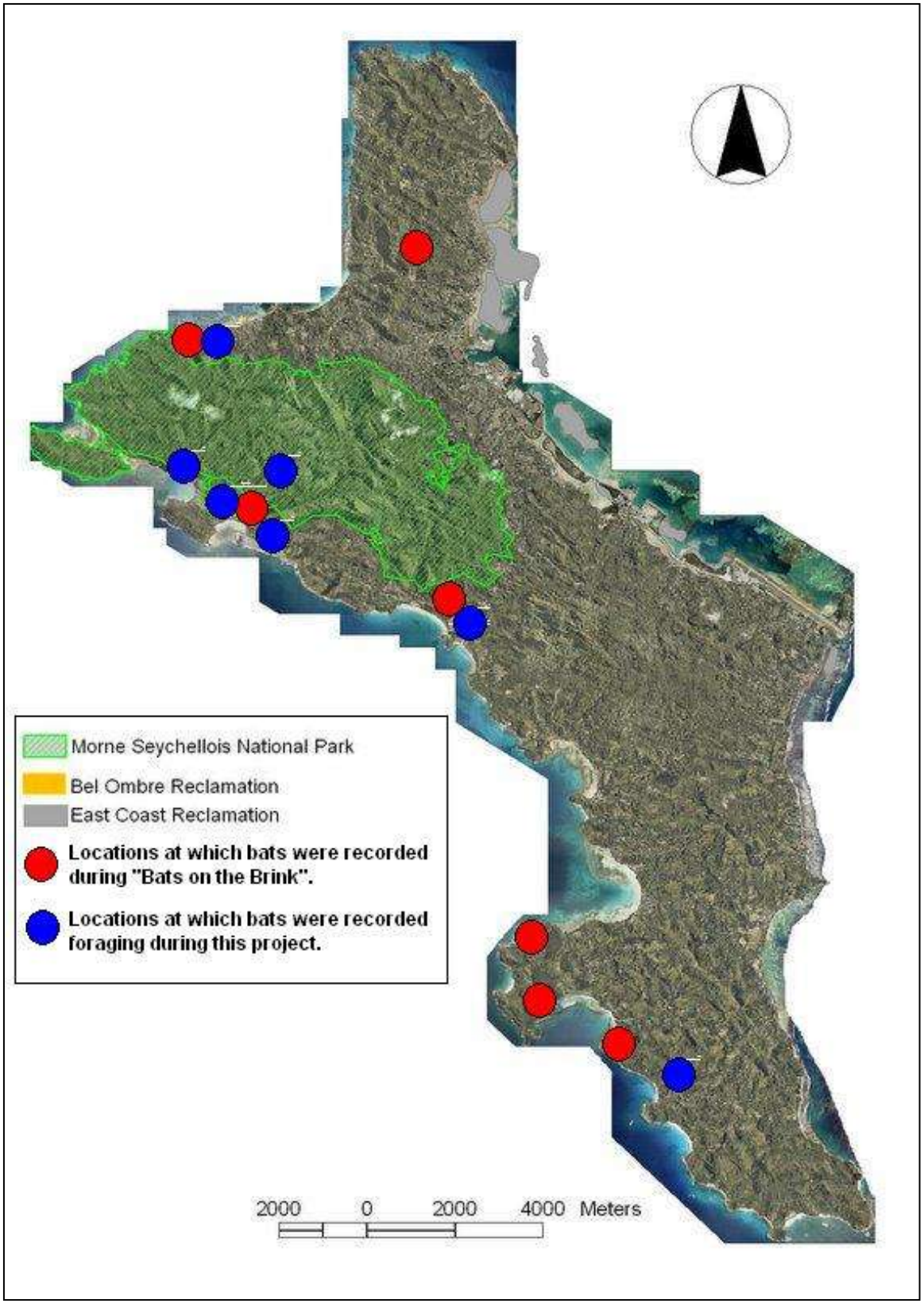

Fig. 2.2 Foraging locations recorded from the BOTB expedition (red dots) and those recorded during the current project (blue dots)

2.5 Presence/Absence on Praslin and La Digue

2.5.1 Methods

Numerous bat detector surveys on Praslin and La Digue have failed to pick up any indication that bats are present on these islands since 2001 and 1976 respectively. An Autobat, which is an acoustic lure, was bought to test for the presence or absence of Coleura on both Praslin and La Digue in conjunction with bat detector surveys. The Autobat reproduces the social calls of bats, these calls are used for communication between bats and the device has proven very effective in the UK at attracting multiple species of bats and aided their capture in mist nets (Hill and Greenaway, 2005). The device comes with eight pre-recorded sound sequences based on the social calls of European bats, but has proved effective with bats in many parts of the world (Hill, pers. comm.). To test for the presence or absence of bats in an area the autobat was used for 1.5 hours, changing the call used after a period of 10 minutes. The Autobat operator stayed in a fixed location with a bat detector to pick up any bat activity around the lure and other team members spread out in the immediate area with bat detectors to see if bats could be detected in the broadcast area of the device and just beyond it. These trials were combined with bat detector surveys along the islands' roads, by car on Praslin and by bicycle on La Digue and on foot on trails in both locations following the protocol described in section 2.4.1. Locations were also surveyed where there were reports of previous bat activity.

2.5.2 Results

No bats have been detected during any of the surveys on either Praslin or La Digue, suggesting that bats may now be extinct on both these islands as proposed in the 'Bats on the Brink' project. The Autobat has not attracted bats on either of these two islands, however the Seychelles sheath-tailed bat may not respond to the pre-programmed calls on the Autobat. For this reason the Autobat is being tested with the bats emerging from the Cap Ternay roost. The Autobat operator positioned the equipment at a substantial distance from the roost to prevent potential disturbance at the roost, but at a point where commuting bats pass. One call was trialed per session around roost emergence time and team members used bat detectors and visual surveying to see if the bats show any alteration in behaviour in response to the simulated calls. These trials are ongoing as time is left between each trial to minimise any potential disturbance. To date the Cap Ternay bats have shown no discernable response to the calls trailed. If this is the case for all the calls it will be necessary to train the equipment to the social call of the Seychelles sheath-tailed bat itself and only when a notable response is detected from the Cap Ternay bats will the equipment be used on Praslin and La Digue again. Social calling in bats is highly complex and not fully understood and it is vital that the equipment elicits a positive measurable response from the bats to test for presence or absence as a call that repels bats may lead to false negative results.

2.6 Protection of roosts

The ‘Bats on the Brink’ project found three roosts on Mahé, these roost areas have subsequently been granted Environmentally Sensitive Area (ESA) status. On the basis that the Emirates hotel complex has been given approval, it seems that the bat roost may still be vulnerable to disturbance despite its environmentally sensitive area status as a full environmental impact assessment must already have been completed. To the best of our knowledge to date, no particular provision has been made to ensure full protection of the bat roost and its surrounding environment during the hotel development project . Direct approaches to Emirates will hopefully result in a firmer commitment to protect the roost and ensure that the Seychelles sheath-tailed bat is adopted as the flagship species for their Conservation Trust programme. Any disturbance to this roost may result in the bats abandoning the site and if roost sites are limited they may not have anywhere else to go. This would result in the loss of apparently the only breeding roost on Mahé, which presumably will lead to extinction of this species on Mahé, leaving only a single known roost on Silhouette with a maximum of 32 individuals, which is unlikely to be a viable population. Complete and legal protection of all known roosts is probably the most important aspect of this project and without this all other actions may be pointless.

An alternative method for protecting the roosts may be to try to raise the money to buy the land surrounding at least the Cap Ternay and Baie Lazare roosts. The land owners may not be willing to selling the land, particularly the Government owned land and it may not be possible to raise sufficient funds, but it should be explored.

There is currently no protection for foraging sites and it would be difficult at this stage to identify any site that is used sufficiently regularly to warrant protection.

2.7 Education and communications

Sheath-tailed bats are a lowland coastal species. The coastal zone is the zone of highest human population and development pressure in Seychelles. It is vital therefore that any meaningful effort to conserve the sheath-tailed bat must involve local communities to raise awareness and engender their support. Cryptic species such as the sheath-tailed bat are easily overlooked, making public education even more necessary.

2.7.1 Methods and Results

During this project and a further project funded by the Chicago Board of Trade (CBOT) a body of material has been produced to present to local communities to help raise their awareness of the species and its status and to gain their support and active participation in conservation activities. It is hoped that encouraging local community efforts to reduce unnecessary pesticide use and to garden wisely, using native species as much as possible and maintaining

mature trees as part of the garden setting will greatly protect foraging habitat. An information leaflet (in both Creole and English) and a travelling exhibition will be used as back-up material during a series of public meetings planned for late 2007. Initially meetings will be held in the vicinity of the two major roosts on Mahé, but these can be taken to other areas if there is sufficient interest and man-power.

An activity pack aimed at children was produced and was presented as part of a training workshop for the leaders of the Wildlife Clubs of Seychelles (WCS) on 9th May 2007. The Wildlife Clubs of Seychelles is a non-profit environmental organisation run by volunteers, which educates and inspires the youth of the Seychelles to protect their environment and wildlife for future generations. The organisation has around 100 leaders and over 800 student members in 33 schools on Mahé, Silhouette, Praslin and La Digue (the four key islands for the bats). The activity pack was tailored to two different age-groups (primary and secondary) and included information sheets, a quiz, a crossword, a bat mask to make, a 'build a bat' template and some activities to teach children about echolocation in bats. These activity packs will be circulated to all the WCS leaders for use with each of their groups. It is hoped that the youngsters will then act as ambassadors for the protection and hopeful recovery of the sheath-tailed bat and that they will communicate messages about the threats and ways to help this species to the wider community in which they live.

A number of media opportunities have been created to promote the plight of the sheath-tailed bat and to promote the work of the BP and CBOT project team.

- Zwazo - articles on the bat and the project work have been published in this the biannual magazine produced by Nature Seychelles, which is circulated to people and companies nationally and internationally that are interested in the conservation work of this NGO.
- Going, Going, Gone (Tait, 2006) – the sheath-tailed bat is included in a newly published book that features plants and animals on the brink of extinction
- Seychelles Broadcasting Corporation (SBC) – a radio interview and background information was supplied to SBC to raise the profile of the sheath-tailed bat across the Seychelles
- Seychelles Nation – the sheath-tailed bat is mentioned as part of the work of Nature Seychelles in an article in this the premiere daily newspaper for Seychelles
- Nature Seychelles website
- Nature Seychelles e-newsletter – this is circulated to more than 150 national and international recipients
- WIOMSA (Western Indian Ocean Marine Science Association) Conference – the work from the BP and CBOT projects will be presented at the above conference (October 2007) highlighting the sheath-tailed bat as an indicator species for the health of the Seychelles' coastal environment

- Public meetings – advertisements and features promoting the series of public meetings on the bat (mentioned in the conservation achievements section) will be run on Seychelles national TV, radio and in the press as well as through Community Centres and the Wildlife Clubs of Seychelles

Through these and continuing PR opportunities we aim to achieve the following:

- Increased community awareness and empathy for the bat
- Communities acting as watchdogs and actively contributing to bat conservation through enlightened use of pesticides and gardening practices
- Solid base of community support for continued bat conservation initiatives

2.8 Capacity Building

In terms of capacity building a Seychellois member of Nature Seychelles staff (Ian Valmont) was extensively trained in bat survey techniques and was heavily involved in the monitoring programme. Other Seychellois members of staff were trained in roost emergence counting techniques. These members of staff are good ambassadors for the plight of the bat and can communicate the key messages to the predominantly Creole-speaking community very effectively. The Seychellois staff also provide a long-term and stable group of people aware of the threats and issues facing the Seychelles sheath-tailed bat and have a determination to ensure that the bat still exists for future generations to see.

3.0 Preliminary Conclusions

From initial results, the most important conclusion from this project is that all the existing roosts must be given maximum protection to ensure that there is NO disturbance to the few remaining individuals of this species. With around 70 individuals possibly in four closed populations, some indication of decline at some of the roosts and no indication of increase in the population at any roost over the period of the monitoring programmes to date, this species cannot afford any further pressures on the existing population. Without complete protection of the current population any other efforts to improve roosting or foraging habitat is likely to be pointless and further monitoring may well just document the extinction of this species over the next few years.

It appears that there may not be a single factor that has contributed to the decline of the bat. Clearly Barn Owls will prey on the Seychelles sheath-tailed bat and may have had a dramatic effect in previous times. There are so few bats now that the Barn Owl is probably not having a major effect on the population currently, but if the population starts to recover Barn Owls could start to have an impact again. A Barn Owl at the Cap Ternay or Silhouette roosts could have devastating effects and must be destroyed immediately.

4.0 Future Work

The recommendations that follow are preliminary and will be refined in the final report.

4.1 A Permanent Bat Team to search for roosts and foraging sites

The 'Bats on the Brink' project benefited from a large team of researchers, which enabled them to conduct a large amount of fieldwork in a relatively short time, however they could not make this team available for the duration of the project, so seasonal differences in behaviour and roost occupancy etc were not noted. In the 'Bringing the bat off the Brink' project the small team and the fact that they had other work to do meant that some of the work proposed was not possible in the time allowed for the project. In future a compromise would be to have a team of at least two people dedicated to working on the bat project full-time.

This team would:

- Continue monitoring current roosts and use emergence counts to look at roost numbers, seasonal stability and possible breeding and/or movement of individuals into and out of known roosts

- Carry out thorough searches of the forest looking for boulder caves

Having found a cave they would:

- Check for bat activity with evening emergence surveys. If there is no activity they should check for piles of guano
- Note all characteristics – GPS ref, aspect, altitude, approximate depth of cave, vegetation cover at entrance

- Carry out night-time foraging activity surveys using bat detectors at a variety of altitudes in the areas that they are searching during the day

4.2 Barn Owl Monitoring and Capture

In view of the observation of a Barn Owl trying to capture bats at Baie Lazare these birds must be regarded as a serious threat to the bats. Is the Cap Ternay roost the main roost because it is not subject to Barn Owl activity?

- Resurrect the bounty on dead Barn Owls handed in.
- Dawn surveys at bat roosts to see if there is any/more Barn Owl activity at this time.

The following is a more work intensive proposal

- Trapping barn owls at each roost site (or at least the main two).

- A team to try to eradicate the Barn Owl. This will be a big job, but it would appear that once an Owl has found a bat roost it will just hang around each night slowly picking off individuals as they emerge. Some trial control work of Barn Owls and recommendations for future control work has been done on Aride (Nicoll, 1996).

4.3 Roost Creation

If roost sites are limiting, why are the bats not using similar caves to Cap Ternay?

- Find another boulder cave near Cap Ternay
- Check for bat activity
- Check for guano if no activity
- If choked by vegetation – clear the entrance
- If not choked by vegetation compare the characteristics with Cap Ternay to see why they may be using one and not the other and make alterations if possible
- Monitor regularly to see if the bats use it following alteration

This is a slightly wilder suggestion and could be both costly and impractical

- Build a variety of boulder caves, particularly in Cap Ternay area
- Monitor for activity

4.4 Surveys of Outer islands

Initial bat detector surveys to see if the bats have been reduced in numbers or pushed onto less disturbed islands.

4.5 Comparative study of **Coleura afra**

Comparative studies of the more numerous sister species (*C. afra*) found on mainland Africa, which may give some information about the population structure and behaviour of *C. seychellensis*.

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