Report on a questionnaire survey about bats in the Banks Islands and Sanma province, Vanuatu.
Summary

Twelve species of bats have been recorded in Vanuatu. But other than distribution, comprising a list of islands where these bats have been recorded historically, there is little known about the bats from a scientific perspective. Whilst, little can be found in the scientific literature, considerable knowledge is held by local communities living in or near bat habitat. VESS has designed and conducted a questionnaire to harness the local knowledge to advance our understanding of these animals that have critical roles to play in the ecosystem. The aim of the questionnaire was to:

- Better understand the habitat needs of bats, in particular those threatened with extinction, to inform conservation efforts both at the government level and at the community level.
- Better understand the threats that these bats face so conservation actions can be taken to mitigate or manage these threats
- Understand the perception of bats and their significance to the local communities
- To identify where scientific research will benefit the conservation effort for these bats

The questionnaire has 73 questions and was designed to capture information over several topics:

- Information about the interviewees
- General perspectives on bats
- Information on each species that the interviewee recognised
- Information about threats to bats
- Links to bats and culture
- Tourism involving bats
- Tabu or conservation areas

The target areas for the questionnaire survey were the Banks Islands in Torba province and the province of Sanma. This is because the focus of our projects is to improve the conservation of two threatened species of bat in Vanuatu – the Banks Flying fox (P. fundatus), a fruit bat which is only known from the Banks Islands and the Fiji Mastiff Bat (M. breguelae) an insectivorous bat which has only been recorded from Santo and Malo islands prior to our projects. Both of these bats are listed as endangered under the IUCN Red List of threatened species.

721 responses to the questionnaire were recorded. In the Banks Islands the VESS team interviewed 413 people when visiting 78 locations (villages) on 6 islands. In Sanma province, the interview team visited 75 locations on Santo, Malo and Aore islands and interviewed 308 people.

Significant amount of information was gathered about bats in the Banks Islands and in Sanma Province. Bats are seen commonly. In the Banks the general consensus is that they are not in decline. In Sanma, even though the perception that the number of
flying foxes has decreased, they are still seen very commonly, including the endemic, threatened bats. The decline may be due to the recent cyclone and monitoring in the next few years will identify if the decline has reversed or if it is a trend that needs extra measures to address. The survey has identified behaviours and ecological needs of bats that differ between the species. 142 plants that are used by bats were identified by their language names by communities during the survey. 61 were identified to species or genus level by the VESS team.

The perception of bats differed between survey sites with people in the Banks Islands generally having a positive view of bats whereas in Sanma the most common response was negative. Threats to bats in the survey sites have been assessed. Bats are hunted but it appears that the hunting pressure is not extremely high. Tourism involving bats is relatively common, but it appears to be generally low impact. But this survey has highlighted some concern over practices that may increase health risks and disturbance to bat roosts. Some animal welfare concerns have also been raised by the results of the survey. Points of human and bat interaction have been identified.

The results of this questionnaire have shown that gaps in the knowledge about bats in Vanuatu still exist. We have given recommendations for future research to answer some of the questions that have arisen and to improve the conservation status of threatened species of bats.

The questions we feel that are the most urgent to answer to fill the knowledge gaps are as follows:

- What is the range of the Banks Flying Fox?
- How are the Banks flying fox and the Vanuatu flying fox related?
- How distinct are the subspecies of the Vanuatu Flying Fox?
- Where is the critical habitat of the Fiji Mastiff Bat?
- How big are the populations of all the threatened species of bats in Vanuatu?
- What is the threshold for sustainable take of Pacific Flying Foxes?
- How do cyclones and land clearing affect flying foxes?
- Do human activities in caves affect cave bats?
- What is the relationship between bats and Ni-Vanuatu culture and is it being eroded by development, modernisation and urbanisation?

We believe the following will be needed to answer these questions:

- Scientific studies using mist net surveys to capture endemic fruit bats for metamorphic measurements and sampling for genetic testing
- Observational studies to determine populations size and range for endemic fruit bats
- Observational studies, acoustic monitoring, and capture studies to determine a population size and critical habitat for the Fiji Mastiff Bat. The focus areas for insectivorous bat studies should be widened to include forest sites and not only focused on caves.
• Develop a long-term monitoring plan monitoring to understand the population trend of all threatened bat species. This will act as a baseline to determine effects of climatic events such as cyclones.
• Develop plan to monitor Pacific Flying Fox to understand if the harvest is sustainable.

The survey has highlighted some of the threats to bats and the gaps in knowledge that still exist. It showed that there is a lack of understanding of potential health implications for interactions with bats. The following recommendations were given to address these:

Hunting
• Stop the use of indiscriminate methods for hunting such as fishing line and hooks, snares and traps.
• Target only the Pacific Flying Fox (*P. tongonas*) and discourage the hunting of the endemic flying foxes.
• Monitor the numbers of Pacific Flying Foxes to detect a decline and allow for early intervention to reverse any decrease in numbers
• Place a tabu on hunting flying foxes after cyclones when they are at their most vulnerable and the forest would benefit most from their ecosystem services.

Land use
• Create conservation areas which include important habitat for the endemic flying foxes
• Ensure measures to protect both the flying foxes and their habitat are included in the conservation area management plans.
• Limit the amount of land cleared for gardens and agriculture
• Any clearing should follow a land use plan for the area, avoid important bat habitat and reduce the fragmentation of habitat particularly flyways used by bats.
• If land is cleared, the large trees should be left standing, particularly those used by bats such as banyans, melek and breadfruit trees.

Awareness raising and education
• Awareness campaigns to increase general knowledge of bats targeting all members of the community
• Education to support the links of bats to local culture
• Awareness campaigns on hunting methods and monitoring, targeting those that hunt flying foxes
• Awareness raising campaign on health and safety and animal welfare measures, targeting the tourism operators and employees and the Department of Tourism staff.

We also recommended the following actions to address the health and welfare concerns raised.
• Stop the practice of children playing with bats
• Don’t keep bats in captivity
• Develop guidelines for cave visits including for tourism operations
• Stop the use of fishing line and hooks for capturing bats
• Reduce disturbance to bats at roosting sites

FIJI MASTIFF BAT: PHOTO CREDIT DAVE WALDIEN
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Introduction

Twelve species of bats have been recorded in Vanuatu. But other than distribution, comprising a list of islands where these bats have been recorded historically, there is little known about the bats from a scientific perspective. This is particularly so for the endemic bats, and the regionally endemic bats known only from Vanuatu and Fiji. The Vanuatu Environmental Science Society (VESS) has been working to address some of these knowledge gaps under two projects, one focusing on *Pteropus fundatus* (Banks Flying Fox) and *Mops bregullae* (Fiji Mastiff Bat formally named *Chaerephon bregullae*). Whilst, little can be found in the scientific literature, considerable knowledge is held by local communities living in or near bat habitat. Under our two projects, funded by the Critical Ecosystem partnership Fund (CEPF), VESS has designed and conducted a questionnaire to harness the local knowledge to advance our understanding of these animals that have critical roles to play in the ecosystem.

The aim of the questionnaire is to:

- Better understand the habitat needs of bats, in particular those threatened with extinction to inform conservation efforts both at the government level and at the community level.
- Better understand the threats that face these bats so conservation actions can be taken to mitigate or manage these threats.
- Understand the perception of bats and their significance to the local communities.
- To identify where scientific research will benefit the conservation effort for these bats.

Methodology

The questionnaire has 73 questions and was designed to capture information over several topics:

- Information about the interviewees – this is to demonstrate that a wide section of society was interviewed, to ensure that a mix of genders and ages were included, and perspectives were captured from a range of people within the community.
- General perspectives on bats.
- Information on each species that the interviewee recognised, such as behaviour, habitat use and reproductive status.
- Information about threats to bats.
- Links to bats and culture.
- Tourism involving bats.
- Tabu or conservation areas.

Generally, the questions were asked as open questions and the interviewers were instructed to choose the most appropriate category from a number of responses written in the questionnaire. An option of “other” always available if the answer given didn’t not fit in to any of the predetermined answers. Some questions required only
one answer, others the interviewees were given the option of multiple answers. Having predetermined answer options made the questionnaire responses easier to analyse. Some questions were completely open, and the interviewee wrote down what the interviewee said. These were categorised during the analysis.

The target areas for the questionnaire survey were the Banks Islands in Torba province and the province of Sanma, (see figure 1). This is because the focus of our projects is to improve the conservation of two threatened species of bat in Vanuatu – the Banks Flying fox (P. fundatus), a fruit bat which is only known from the Banks Islands and the Fiji Mastiff Bat (M. breguelae) an insectivorous bat which has only been recorded from Santo and Malo islands prior to our projects. Both of these bats are listed as endangered under the IUCN Red List of threatened species. In Sanma the interviews were concentrated, but not exclusively, in the south and the east of the island, as that is where the cast cave system is located, and more insectivorous bat sighting occur. The questionnaires in both areas covered all species of bat, but as the focus was on flying foxes in the Banks and on insectivorous bats in Sanma, the questions were arranged within the survey so that the questions on fruit bats were asked first in the Banks and the questions on insectivorous bats were asked first in Sanma. This was to ensure that the most important information for the target species was collected first so if the interview had to be interrupted or the interviewee became fatigued the important information was not missed. The questionnaires can be found in Appendix A.

An interview team was put together consisting of VESS staff and recent science graduates. Ten recent graduates attended 4 days of training where they were taught about bats of Vanuatu and how to conduct the questionnaire. The team travelled to north Efate to conduct a practice survey for two days. The final day of the training the team uploaded the data into electronic form. This gave the recent graduates practical experience and allowed us to test the questionnaire in a real setting before traveling to the outer islands. Unfortunately, due to funding restrictions and logistics, we could not take all 10 recent graduates into the field to conduct the survey. The field expedition team consisted of 3 VESS staff and two of the graduates who best performed during the training.

The questionnaire was conducted using pen and paper. As some of the areas were remote without electricity, we considered in safer than relying on electronic means of recording the information, such as tablets. This did mean that the questionnaire needed to be transcribed into an excel for analysis. The questionnaire was printed in sections, the main questionnaire, species information sheets and conservation area information sheets. All the special data was written on to printed paper maps of the areas and this information was plotted in Google Earth™ once the team had returned to the VESS office.
FIGURE 1: MAP OF VANUATU SHOWING LOCATION OF THE BANKS ISLANDS SURVEY (GREEN ICONS) AND THE SANMA PROVINCE SURVEY (BLUE ICONS)
Results
In the Banks Islands the interview team visited 78 locations (villages) on 6 islands (see figure 2). 413 people were interviewed between 14\textsuperscript{th} November 2019 and 24\textsuperscript{th} February 2020. In Sanma province, the interview team visited 75 locations (villages and urban areas) on three islands; Santo, Malo and Aore (see figure 3). 308 people were interviewed between the 8\textsuperscript{th} and 29\textsuperscript{th} April 2021.

Figure 2: Locations of interviews in the Banks Islands survey
Figure 3: Locations of interviews in the Sanma province survey
Details of interviewees
Banks Islands
The interview team were asked to ensure that there was a good mix of people being interviewed. Whilst the target interviewee is someone who visits the forest or bush regularly and is therefore most likely to encounter bats, we also wanted to capture information from a wide selection of the community. Two thirds (66.7%) of the interviewees were male and one third (33.3%) were female. This exceeded our target of at least 25% females. The ages of the respondents are depicted in figure 4.

FIGURE 4: DISTRIBUTION OF AGES AMONGST INTERVIEWEES IN THE BANKS ISLANDS

Samna Province
Again, the interview team were asked to ensure that there was a good mix of people being interviewed. 151 (49%) were male and 154 (50%) were female. Again, this exceeded our 25% female target. The ages of the respondents are depicted in figure 5.

FIGURE 5: DISTRIBUTION OF AGES AMONGST INTERVIEWEES IN SANMA
**General questions about bats**

The questions in this section of the questionnaire refer to all species of bat; fruit bats, blossom bats and insectivorous bats. How often bats are seen is depicted in figure 6. It shows that bats are seen often in both locations by the majority of people interviewed. However, in the Banks Islands more people report see bats more frequently.

![How often bats are seen](image)

**FIGURE 6: HOW OFTEN BATS ARE SEEN BY THE INTERVIEWEES**

The interviewees were asked how many different kinds of bats they see and to describe them. After they had said how many kinds of bat they see and had described them, they were shown photographs of the bats to identify which species they were referring to. This was to prevent bias being introduced into the survey from showing the photographs first.

**Fruit bats**

The results are given in figure 7 for both the Banks Islands and Sanma province. In both areas the most commonly seen bat is the Pacific flying fox (*Pteropus tongonas*). The endemic flying foxes (*Pteropus anetianus* and *Pteropus fundatus*) look very similar and are hard to tell apart. They are small flying foxes. *P. fundatus* has a grey head with a red-brown body. There are a number of sub-species of *P. anetianus*, some have white bodies and others have red-brown bodies very similar to the Banks Flying Fox. The two species can be differentiated by their tibia length and the size of their teeth, both of which are smaller in the Banks Flying Fox. These two species are quite distinct in appearance from the Pacific Flying Fox and the Fiji Blossom Bat. *P. fundatus* is only known from the Banks Islands. *P. anetianus* is known from the whole of the Vanuatu archipelago. Most of the interviewees only identified seeing one kind of small
red or white flying fox. In the Banks Islands where both species have been described only 23 people (5.6%) described two different kinds of small flying fox (see figure 8).

**Figure 7: Which bats are seen in the two survey sites by species**

**Figure 8: Different endemic flying fox species reported as seen in the Banks Islands**

As the species are hard to tell apart it is difficult to know which of the two endemic species the interviewee was referring to. Therefore, the figures for the two endemic species have been amalgamated with the final number being the number of respondents that see one, or other or both of these species (to avoid duplication). We have done this for all the questions and throughout the report we have use the term
endemic flying foxes to refer to either or both of these species. People in Sanma identified seeing P. fundatus (the Banks Flying Fox) from the photos we showed them of the different flying foxes. As the Banks flying fox’s range as described in the literature is restricted to the Banks Islands, we assume that all the sighting and information reported to us as P. fundatus in Sanma were in fact P. anetianus.

**Insectivorous bats**

In the Banks Islands one only interviewee identified more than one type of insectivorous bat. In Sanma the interviewees identified up to 4 different species of insectivorous bat, but the majority did not differentiate between species and only recognised one kind. 92% of the interviewees only recognised one to two different kinds of insectivorous bat (see figure 9). Six species of insectivorous bats have been reported in the scientific literature in Sanma.

![Figure 9: Number of insectivorous bat types seen in Sanma](image)

**Habitat use**

Bats are seen using a variety of habitat, as seen in figure 10. The bush refers to the forest. The forest can be virgin forest, but much of it is secondary regrown replacing previous plantations or shifting subsistence agriculture. Gardens refer to small areas where the local population grow subsistence or cash crops. Gardens are often distant from people’s houses and can be cleared areas in the forest.
Importance of Bats

The interviewees were asked if they thought bats are important. The majority said yes although there was a slight variation between the two sites with slightly more people in the Banks saying yes than in Sanma and more people in Sanma saying they did not know if bats are important. See figure 11.

Interviewees were then asked why they thought bats are, or are not, important. This was asked as an open question with the interviewers writing down their responses. During the analysis, the responses were grouped into similar reasons and these are depicted in figures 12 and 13.
**Figure 12:** Reasons given by interviewees in the Banks Islands as to why they think bats are important.

**Figure 13:** Reasons given by interviewees in the Sanma as to why they think bats are important.
Figure 14: Responses to the question "Are bats important to your culture?"

Figure 14 shows the responses to the question “are bats important to your culture”. 65% said “yes” in the Banks, but in Sanma 51% say “no”. Only 16 people (5.2% of respondents) knew of custom stories or art associated with bats in Sanma province. In the Banks 82 people (19.9% of respondents) said they know of stories, songs, beliefs, myths, sand drawings or other arts associated with bats.

Bat behaviour and ecology

Fruit bats
Of those that participated in the questionnaire survey, 410 people report seeing *P. tongonas* in the Banks and 273 in Sanma. 332 and 269 people report seeing the endemic flying foxes in the Banks and Sanma respectively. 101 people report seeing *N. macdolaldi* in the Banks Islands and 33 people in Sanma.
Figure 15 depicts the differences in how often people see the different kinds of fruit and blossom bats in both survey sites. The majority of people in both the Banks Islands and in Sanma report seeing the Pacific Flying Fox (*P. tongonas*) very commonly. In contrast most people do not see the Fiji Blossom bat (*N. macdonaldi*) frequently. The results for the endemic fruit bats vary by site, in that in Sanma most people report seeing them commonly but in the Banks the majority of people report seeing them a few times a month or less.

Figures 16 and 17 show the responses given when people were asked where they see the different kinds of bat. People could give multiple answers to this question. So as comparisons can be made between species, the results are depicted as the percentage of the people who report seeing that bat type, rather than the proportion of all interviews. For example, 304 people say they see *P. tongonas* in the bush in the Banks and 190 people say they see the endemic bat species, this calculates to be 74.1% of people who say they see *P. tongonas* (410) and 57.2% of people who say they see the endemic bats (332).

**Figure 16: Habitat where people interviewed in the Banks Islands say they see fruit and blossom bats**
The interviewees were asked what the bats were doing when they were seen. People could give multiple responses to this question. Figure 18 depicts the responses. People see all species of fruit and blossom bats performing resting and foraging behaviours. However, the Fiji Blossom bat (*N. macdonaldi*) is only rarely seen resting, either in caves or trees.
The interviewees were asked what size groups the different kinds of bat roost in. There is a distinct difference between species with *P. tongonas* seen more commonly in large groups and the endemic flying foxes more often seen alone. There is also a difference between the two sites for the *N. macdonaldi*. In Sanma more people report seeing *N. macdonaldi* roosting alone whereas in the Banks more people see them roosting in groups. (see figure 19). When asked the estimated number of bats in any one group the most common answer for *P. tongonas* was between 101 and 1000, for the endemic flying foxes it was less than 10 and for *N. macdonaldi* it was 21 to 50. This was the same for both survey sites.

![Roosting group size](image)

**Figure 19: The group size of roosting bats by bat type and survey site**

Most people (more than 80%) have seen all types of fruit and blossom bats foraging in Sanma. In the Banks this is true of *P. tongonas* but less (73.7% of people) see the endemic bats foraging and only 50.5% see *N. macdonaldi* foraging. Figures 20 to 22 show the habitat where *P. tongonas*, the endemic flying foxes and *N. macdonaldi* are seen to forage.
**Figure 20: Habitats where P. tongonas are seen foraging**

**Figure 21: Habitats where the endemic bats are seen foraging**

**Figure 22: Habitats where N. macdonaldi are seen foraging**
In the Sanma survey the participants were asked what time of day they see the fruit and blossom bats foraging. They could give multiple answers. There was a difference between the species (see figure 23). The Pacific flying fox (*P. tongonas*) was most often seen foraging in the evening and at night. The endemic fruit bat (presumed to be *P. anetianus*) was seen more commonly during the day and *N. macdonaldi* was rarely seen during sunlight hours with most people reporting only seeing them at night. This question was not asked in the Banks Islands survey.

**FIGURE 23: TIME OF DAY THAT FRUIT AND BLOSSOM BATS ARE SEEN FORAGING**

The survey participants were asked which plants the bats were seen either roosting on or foraging in. A list of these plants can be found in Appendix B. The local or language name were given by the interviewee during the survey. The plants were identified by scientific name when the VESS team returned from the fieldtrip. 61 species of plant used by bats were identified to species of genus level. However, some local names were unknown to the VESS staff and were not in our reference text so not all the plants have been identified to scientific name. 81 of the common and language names have not been identified by scientific name. Some of these names could be synonyms for the same plant.

The survey participants were asked if they saw female bats with pups and if they could recall what time of year this was. Most people said they do see *P. tongonas* pups (77.8% in the Banks and 63.9% in Sanma). In the Banks only a few people report seeing the endemic flying fox pups (11%) but in Sanma the proportion of people who see the endemic pups is higher (47.2%). Few people report seeing *N. macdonaldi* pups (16.7% in the Banks and 3.2% in Sanma). A lot of people could not remember what time of year they see pups. Of those that do recall, the months cited vary across the year with a peak in March and April in Sanma and higher numbers in October and November in the Banks (see figure 24).
The interviewees were asked if they have seen bats breeding. The majority of people said no. In The Banks 41 people (10%) of people said they had seen *P. tongonas* breeding and only 7 people (2.2%) said they had seen the endemic flying foxes breeding. In Sanma 23 people (8.8%) said they had seen *P. tongonas* breeding and 17 people (6.8%) said they had seen the endemic flying foxes breeding. No one in either site said they has seen *N. macdonaldi* breeding. Close to half of those that did witness breeding could not recall what time of the year it occurred. Those that do recall the breeding months cited months throughout the year with a peak in June and July in Sanma and in October in the Banks. See figure 25.

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**Figure 24:** The months of the year when pups are seen with female bats. (Results are shown only for *P. tongonas* and the endemic flying foxes as the number of people who report seeing *N. macdonaldi* pups and remembered in which month, was too low.)

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**Figure 25:** Time of year fruit bats seen breeding. No result was plotted for the endemic flying foxes in the Banks as the number of people who witness breeding and could recall the months was too low (n=6). No one reported witnessing *N. macdonaldi* breeding.
Insectivorous bats

134 people in the Banks Islands (32.4% of the respondents) report seeing insectivorous bats. In Sanma this number is 267 (87.0% of the respondents).

In the Banks Island 91.8% of people who see insectivorous bats report seeing them roosting and 19.4% report seeing them foraging. In Sanma 91.8% of people that see insectivorous bats say they see them foraging, 61.4% see them roosting in caves and 9.3% say they see them roosting in tree hollows. Most people generally see groups of insectivorous bats in both survey sites, rather than single animals. But about half the respondents in the Banks say they see insectivorous bats foraging alone and half in small groups. Whereas in Sanma close to 60% say they see insectivorous bats foraging alone. In Sanma slightly more people report seeing larger numbers of bats than in the Banks but in both locations the majority of people say they see groups of 100 to 1000 individuals (see figure 26).

![Number of insectivorous bats seen](image)

**Figure 26: The estimated number of bats seen in groups by survey site**

Figure 27 shows the habitat where the interviewees generally see insectivorous bats in both survey sites. Figure 28 shows where people report seeing insectivorous bats foraging. Most people see these bats roosting in caves or cracks in the rocks. But thirty-one people in Saman reported seeing b insectivorous bats roosting in tree hollows. The “melek” or milk tree (*Antiaris toxicaria*) and the “nabanga” or banyan tree (*Ficus glandifera*) were the most commonly reported roosting trees. In the Banks just one person reported seeing insectivorous bats using hollows in a nabanga tree. A list of all trees that were reported to be used by bats can be found in appendix B.
In the Banks Islands 29.6% of people who report seeing insectivorous bats (40 people) said they see mother bats with pups. 16 could identify which month. The months reported ranged throughout the year. 32.1% of the people who report seeing insectivorous bats (85 people) in Sanma say they have seen mothers with pups. 44 could identify the month. The months mentioned ranged throughout the year with a peak in April (see figure 29). Only 19 interviewees in Sanma said they had witnessed insectivorous bats breeding. Only nine could remember which months of the year this was, and the month noted ranged from January through to August. In the Banks only one two people said they witnessed insectivorous bats breeding and only one could identify which month (September).
**Distribution**

The interviewees were asked to draw on a paper map of the areas where they see the different bats species including important roosts (caves or camps). Whilst this does not replace scientific studies to identify the range and distribution of the bats, it gives an indication of where they have been sighted. It can also indicate where to conduct the studies to define their range more definitely. The information from the paper maps was transferred to Google Earth once the survey team had returned from the field. The information from the Banks was mapped on our behalf by Alison Derry, who was assisting us as a remote Australian volunteer for 3 months during the pandemic in 2020 and 2021. Figure 30 shows and example of a map depicting the areas where community members say they see the two species of endemic flying foxes in the Banks Islands. The other maps of sightings of the other bat species or types can be found in Appendix C. The data from the Sanma survey is yet to be mapped.
**Figure 30:** Map of where community members say they see the two endemic flying fox species in the Banks Islands
Threats to bats

Perception of population trend
Interviewees were asked if they thought the number of bats was increasing, decreasing, or staying the same. In the Banks questionnaire they were asked to comment on all the bat species in within one question in the section on hunting. Only those that reported hunting that species of bat were asked this question on population trend. In Sanma this question was asked of all interviewees that reported seeing insectivorous bats and the individual flying fox species, not just those who reported hunting them. The question was asked in the section for information about each species seen. The responses are shown in figure 31.

![Change in bat numbers over time](image)

**Figure 31: Interviewees perception of whether the number of bats has changed over time**

In the Banks *P. tongonas* is perceived to be increasing. Similar numbers of people think the endemic fruit bats are increasing and decreasing with 20% thinking they have
stayed the same. In Sanma insectivorous bats are perceived to be increasing, but the fruit bats are perceived to be decreasing although more people were unsure of the trend for the Fiji Blossom bat. In the Banks questionnaire only 3 people each answered the question for *N. macdonaldi* and insectivorous bats, so they have not included in the analysis, although all the responses indicated that these bats were increasing.

Reasons in the Banks Island survey cited for the increase in bats were:

- Less hunting pressure and reasons for this were given as
  - People are less inclined to hunt.
  - People get most of their food from marine resources rather than from the forest
  - No guns to hunt with
  - No recent cyclones
- Bats are perceived to rapidly reproduce
- Hunting restricted in Tabu areas

Reasons cited for a decrease in bats were:

- More hunting pressure due to:
  - Human population increase
  - After cyclones they are easier to hunt
  - Seen as a pest that eats fruits in the gardens.

In Sanma province many people observed the number of fruit bats decrease after the Tropical Cyclone Harold which impacted the area in April 2020. They believe it was due to loss of roosting habitat, loss of food and increase in hunting. But they report increasing number as the trees have resumed fruiting. Interviewees in both survey sites also gave a reason for the endemic bats increasing as people don’t like hunting these bats as they taste or smell unpleasant, and they prefer to hunt *P. tongonas*.

In addition to the reason listed about interviewees in Sanma give the following reasons for perceived decreases in insectivorous bats:

- Killed by people because of superstition- people believe bats are associated with the devil
- Habitat round roosting sites in modified by people cutting down bushes near caves
- Smoke from fires in caves or gardens
- Disturbance by people in roosting sites
- Killed by children with stick in the village

Additional reasons cited for increases in insectivorous bats in Sanma included:

- People do not hunt insectivorous bats.
- People do not go into the caves or cannot access the forest because the bush is very thick.
Hunting
In the Banks islands 68% of interviewees said they hunt bats. In the Sanma province survey the question was framed slightly differently as the interviewees were asked if they hunt flying foxes separately to being asked if they hunt insectivorous bats. 61% of respondents said they hunted flying foxes and 42 people (16.9 % of those that responded to the question) said they hunted insectivorous bats.

Figure 32 show the proportions of the different species of bat hunted in the Banks. The people that said that they hunt bats were asked which bats they hunt. Again, due to the difficulty in differentiating the two species the figures for *P. fundatus* and *P. anetianus* were amalgamated and one figure is shown for people who reported hunting either or both species. Everyone who hunts, reported hunting *P. tongonas* but only 13.9% of hunters (39 people) hunt the endemic flying foxes. Only a few people in the Banks Islands report hunting *N. macdonaldi* (3 people) or insectivorous bats (2 people).

Figure 33 shows the proportion of species hunted in Sanma. In the Sanma questionnaire survey the question was framed differently to the Banks survey. People who reported seeing each species of bat were asked if they hunt it. Again, everyone who reported hunting bats said they hunt *P. tongonas*. Less people (106 or 39.4% of the people that see them) report hunting the endemic flying foxes. Only 3 people said they hunted *N. macdonaldi* but as mentioned above 16.9 % said that they hunt insectivorous bats.

![Figure 32: The proportion of people who say they hunt bats in the Banks](image-url)
Over half the people who report hunting the endemic fruit bats in Sanma (51.0%) say they caught less than 20 in the preceding year (see figure 34). The number of bats caught in the proceeding 12 months was not asked in the Banks Islands survey. Most people that reported hunting bats say they hunt less than every week with the majority reporting they hunt several times a month. The question was asked in the Banks survey referring to all bat species. In the Sanma survey it was asked of each species that the interviewee reported hunting. The hunting frequency in Sanma is similar to the Banks (see figures 35 & 36).
The vast majority of the hunting in both survey sites is done by a projectile, with the slingshot most common method. Throwing a piece of wood or stone at the bats is also common. Bows and arrows or guns are used by a few hunters (See figures 37 and 38). Some people use the fishing line and hook method where fishing hooks on fishing line are placed in the trees, sometimes using bamboo poles to place the lines and the bats fly into the lines and their wings get caught on the hooks. A small number of people use traps and nets. When people say they use bush knives it is usually to cut down a banana or pawpaw tree that a bat is feeding on to access the bat.
The interviewees were asked where they preferred to hunt bats, having the option to give multiple answers. Whilst the majority of hunters say they prefer to hunt in the bush, significant numbers prefer modified habitat occupied by human activity (gardens, villages and plantations). See Figure 39.
The majority of hunters report that they hunt the bats when they are feeding (87.5% in the Banks Islands and 59.7 – 69.2% in Sanma depending on species). 33.6% of hunters in the Banks Islands report hunting bats when they are roosting. In Sanma this figure is between 20.7% and 25.9% depending on species.

In the Banks islands about half the hunters said that there is a preferred time of year for hunting. However, the preferred months they stated ranged throughout the year, with a small increase towards the end of the year. In Sanma only a third of the hunters stated that there is a preferred time of the year. Again, the preferred months ranged throughout the year, but more people said they preferred to hunt in the months that fall in the middle and at the end of the year.

In the Banks, 99.3% of the people interviewed said that they hunted the bats for food. 6.1% collect the teeth and 9.6% hunt to sell bats they catch. In Sanma 85.4% of the respondents say that the bats caught are eaten, none are hunted for their teeth and 12.0% pf respondents say that they sell bats they have caught. The majority of the bats are eaten within the household and family of the hunter in both survey sites. Apart from the meat, some other parts of bats are used. 77.1% of respondents in the Banks say they collect the teeth. The main uses are necklaces and home decorations. Only one person in Sanma reported collecting the teeth. 13.5% of respondents in the Banks (and none in Sanma) use the wing, wingtip or claw for wristbands and hooks. 11.5% or respondents in the Banks and 2.5% in Sanma, say they use the muzzle or jaw as decoration or trophies. The bones are used by 5.2% of the respondents in the Banks and three people in Sanma for making tools and arrows, tattooing or home decorations.
In the Banks 24.7% of interviewees say they sell bats. Most sell them local in the village or surrounds, but 2 said they take them to the market in the provincial capital and one said they sell them to a restaurant in Port Vila. The lowest price that was reported was Vt20 (Approx. USD$0.18) and the highest Vt1000 (Approx. USD$8.75). The most common price was Vt200 (Approx. USD$1.75).

In Sanma only 29 people (14.8% of respondents) said they sell *P. tongonas* and only 9 people sell the endemic fruit bats. The price ranges from Vt100 to Vt1,000 for *P. tongonas*, with most people reporting the price as Vt500. The reported price for the endemic fruit bats ranged from Vt100 to Vt500 with the most common price Vt200. Close to two thirds (64.7%) of the respondents who sell bats, sell them in the market.

Generally, *P. tongonas* was said to be the easiest bat to catch and was the preferred bat to eat.

**Hunting of insectivorous bats in Sanma**

In Sanma 42 people said that they hunted insectivorous bats (16.9% of respondents). Most (63.9%) said that they caught less than 100 bats in the preceding 12 months with only 1 person saying they caught over 1000 bats (see Figure 40).

![Figure 40: Number of insectivorous bats caught in Sanma in the previous 12 months](image)

A variety of tools are used to catch insectivorous bats, (see figure 41), with the majority of people saying the use pieces of wood or branches. The vast majority of insectivorous bat hunting is reported in caves (92.9%) with a few people reporting the hunt close to tree hollows or cracks in rocks or in flyways in the bush. Most people (88.1%) report that the bats are roosting when they are hunted. Only 10 people said there was a preferred time of year to hunt and 3 of them could not name the months. The preferred month of the other seven responses were spread throughout the year. All the bats are hunted for the meat, and it is eaten within the village. One person said they use the skin to make purse but otherwise no other parts of the bats are used. No one reported selling insectivorous bats. As a separate question to hunting interviewees were asked if children kill the bats for fun. 49.2% of the respondents said yes they do. They catch them by hand in caves or swipe them with branches or used slingshots.
when they fly into the village. Some are deliberately killed, and some died when the children are playing with them.

![Tools used to hunt insectivorous bats in Sanma](image)

**Figure 41: Tools used by bat hunters in Sanma to catch insectivorous bats**

**Land-use**

In the Banks, most people (98.3%) said that land is cleared for subsistence gardens. 56% of them think that it affects the bats and 42% think it has no effect. 64.5% of interviewees responded that land had been cleared for agriculture and of those 65.7% believe it affects the bats.

In Sanma 96.1% of interviewees said that land had been cleared for subsistence gardening. 45.1% believed it had an effect on *P. tongonas*, 39.1% think it had an effect on the endemic fruit bats. 73% of people said that land had been cleared for agriculture and just under half thought it had had an effect on the bats. The interviewees were asked which crops or livestock was being grown on the plantations or farms. The vast majority reported coconuts and cattle. Below is a list of all the crops and livestock mentioned.

<table>
<thead>
<tr>
<th>Banana</th>
<th>Cocoa</th>
<th>Kumala</th>
<th>Peanuts</th>
<th>Sandalwood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beans</td>
<td>Coconut</td>
<td>Manioc</td>
<td>Pepper</td>
<td>Taro</td>
</tr>
<tr>
<td>Cabbage</td>
<td>Corn</td>
<td>Natangura</td>
<td>Piggery</td>
<td>White wood</td>
</tr>
<tr>
<td>Cattle</td>
<td>Kava</td>
<td>Nonie</td>
<td>Poultry</td>
<td>Yam</td>
</tr>
</tbody>
</table>

**Bats kept in captivity.**

In Sanma 58 people reported keeping or knowing of people keeping flying foxes in captivity (55 *P. tongonas*, and 15 for the endemic flying foxes). This mostly involved keeping them in cages made of chicken wire. Some were kept as pets, and some kept
to eat, or sell, at a later date. Often, they were pups or juvenile bats. Some reported that the bats died in captivity. The question was not asked in the Banks survey.

Adverse weather events
Tropical Cyclone Harold, a category 5 cyclone passed over the southern part of Santo and Aore and Malo islands, leaving significant destruction in its wake. The interviewees in Sanma were asked if they thought the cyclone had any effect on the bats.

Effect on fruit bats
73.0% of respondents believed that TC. Harold had an effect on P. tongonas, with similar figures for the endemic fruit bats. Most people suggested the reasons for this were: direct mortality during the event; their habitat and food was destroyed which led to them either dying or leaving the affected area; increase in hunting by people (which was made easier by the bats being on the ground). People who were interviewed on the east coast of Santo reported this area was not badly affected by the cyclone. People in these places reported an increase in bats in their area after the cyclone.

Effect on insectivorous bats
83.1% of respondents said they did not think that the cyclone had any effect on insectivorous bats. The reasons cited for why they thought this, was that they were safe in the caves or that they could move. Those that thought they were affected suggested that the insectivorous bats that live in hollows in trees lost their habitat or that the vegetation around the cave was destroyed. One person said that the cave the bats were in flooded.

In the Banks questionnaire only 3 people each answered the question for N. macdonaldi and insectivorous bats, so they have not included in the analysis, although all the responses indicated that these bats were increasing.

Caves
During the Sanma questionnaire, the interviewees were asked about caves. 234 people (76.0% of the respondents) said they know of caves in the area and identified up to 6 caves. 321 caves were identified but some of these may have been identified by multiple interviewees. 88.5% of the caves were said to have bats living in them. 57.6% were said to have birds (swiftlets) living in them. The interviewees were also asked if there were any other animals living in the caves. Below is a list of the other animals that were identified as cave dwellers.
<table>
<thead>
<tr>
<th>Assumed Native</th>
<th>Introduced / feral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ants</td>
<td>Lizard</td>
</tr>
<tr>
<td>Cockroach</td>
<td>Prawn</td>
</tr>
<tr>
<td>Crab</td>
<td>Snake</td>
</tr>
<tr>
<td>Eel</td>
<td>Spider</td>
</tr>
<tr>
<td>Fish</td>
<td></td>
</tr>
</tbody>
</table>

People in the Sanma survey were asked if they used the caves. 47.5% said they did use the caves and 52.5 % said they didn’t. The following is a list of uses that the community have for caves, in no particular order:

- Shelter – from cyclones, during rainy season or tsunami
- Tourism
- Cooking, picnics and barbeques
- Water source, especially in the dry season
- Harvesting of bats, swiftlets, crabs, prawns or eels
- Store and dry timber
- Collect guano
- Path to gardens
- Resting point on long walk
- Swimming
- Recreation visiting cave of playing with bats.

A third of those that use the caves said that there was a difference in the bats before and after the cave use. Mostly this was due to the bats leaving the cave because of the disturbance. Fire and smoke appeared to be a significant cause of bats leaving the caves and, in a few instances, this was because of disturbance from tourism.

People were also asked if they used the caves for shelter during cyclone Harold. 11.7% said they did. When asked what happened to the bats some said there were not bats in the cave they used, some said that the bats moved into a deeper part of the cave, some said the bats left and some said that the people chased the bats away, some by using smoke from fires lit in the caves. Most said they only used the cave for one or two nights and in those where the bats left, they returned once the people had left the cave.

**Bats and tourism**

In the Banks Islands, 28% of the people interviewed (115 people) said that tourists visited their village. 87.5% said that they have less than 100 in a year and none over a thousand. 50.9% of those that have tourism said that there are activities involving bats. 5 were bat tours, 12 cave tours to caves with bats, 45 were nature-based tours
(bush and villages walks, visits to off-shore islands, birdwatching) and 2 were handicrafts.

In Sanma, just over a third of the interviewees (37.3%) said that tourists visited their village. 64% of those that said the do have tourists reported they have less than 100 tourists visit in a year and only 1.6% have over 1000 tourists per year. Of those who do have tourism, one third (33 people) said that there was a tour in the village that involved bats. 19 were cave tours, 9 were visits to flying fox roosts and 7 were nature-based tours (bush walks, birdwatching, waterfall or river tours). In a separate question which was only asked in the Sanma questionnaire, 22 people said they took tourists to see caves. Of those only 9 said that they gave instructions to the tourists on how to behave. 4 had measure in place to reduce disturbance of bats, mostly to not make loud noises and one restricted the use of torches. 6 had some health measures in place. These consisted of washing hands after visit, taking care not to slip and wearing shoes.

**Conservation or Tabu areas**

In the Banks, 40.2% of interviewees (166) said that they know of a conservation or tabu area near where they lived. Most knew of one area. Five gave details of two tabu areas. The majority of these conserved areas were marine with only 40% having a terrestrial component. Of the people that reported a conservation area with a terrestrial component, 24% said that there were not rules that related to bats. 68% said that hunting of flying foxes was not allowed inside the area and 38.7% said that the cutting of trees was forbidden. Six responses indicated other rules to protect flying foxes; no hunting allowed at roosting sites, or a custom process had to be followed before a people could go into the areas for the purpose of hunting. The conservation areas were drawn onto paper and transferred to Google Earth once the questionnaire team returned from the field. Alison Derry mapped the Banks areas on our behalf. Figure 42 shows the conservation areas in the Banks Islands.

In Sanma, only 15.1% of the respondents (45 people) said that they know of tabu or conservation areas where they lived. 43 people gave information about the conservation or tabu area to the interviewers. 30% of the respondents said that the tabu areas were marine only. Of the responses about tabu areas with a terrestrial component (30), 80% said there were rules that precluded the hunting of bat (sometimes as a blanket rule of not hunting of any animal, sometimes bats are specifically mentioned). In 77% of the responses people said cutting of trees was disallowed.

The figures cited above relate to the number of responses about conservation areas. It should be noted that several interviewees may have spoken about the same conservation areas. This is particularly true of well-known conservation areas of Vatthe, Loru and Lake Letas.
Figure 42: Conservation areas mapped for Banks Islands
Discussion

Bat sightings and differentiating species

Bats are seen frequently in both of the survey sites. There are differences between how frequently the different species or types of bats are seen and some differences in how frequently some bats are seen in the different sites. The two survey areas have different geography, both physical and in terms of the human population; Santo, in Sanma province, is the largest island in Vanuatu. It has a large agricultural sector and has the second largest urban centre in the country, Luganville. The Banks islands are small remote islands with a low human population to the north of Sanma. The geographical differences are likely to affect the number and possibly the behaviour of bats on the islands and therefore could affect the number of sightings. This may be the reason that there is a difference in how often people encounter bats, but that cannot be ascertained from the results of this survey and more research would be needed to establish the relationship.

The pacific flying fox is very commonly seen on both survey sites. The endemic fruit bats are also seen commonly. Local knowledge can tell us that the endemic flying foxes are sighted but cannot tell the species apart for the reasons given earlier. There is much debate about whether the Banks Flying Fox is seen on other islands in Vanuatu. No genetic studies have been undertaken to understand the relationship between the Banks flying fox and the Vanuatu flying fox or within the sub-species of the Vanuatu Flying fox. Therefore, scientific studies involving capturing the bats for metamorphic measurements and genetic testing is needed to further refine our knowledge of the distribution of these two flying foxes and to establish the taxonomy and the threat status of the endemic flying foxes of Vanuatu. As the endemic flying foxes are seen less often than the pacific flying fox, it would seem that they are less populous than P. tongonas. However, there could be other explanations such as they are more cryptic or use the shared habitat less often. Scientific research is needed to ascertain a population size and trend for these species.

The number of people reporting sightings the N. macdonaldi is lower than for the fruit bats. In the Banks this is in contrast to our mist net surveys where N. macdonaldi was the most frequently caught bat and caught in the most locations. The reasons for the difference could be that the Fiji Blossom Bat expresses more cryptic behaviour than the other bats or uses habitat that overlaps with human activities less often. Therefore, no conclusion on their relative abundance compared to the other bats can be drawn from the questionnaire survey. Again, scientific studies would be needed to determine this.

The number of people reporting insectivorous bat sightings is higher in Sanma province than in the Banks Islands. This is an expected result as the extensive limestone cast cave system and the larger land mass would suggest a highly suitable
habitat for insectivorous bats. More species of insectivorous bat have been reported in Sanma in the scientific literature than any other group of islands in Vanuatu. Six species have been reported. However, in our survey most people (92%) only recognised 1 or 2. This is not surprising. The bats are small and generally fly fast at night whilst living in cracks or holes in the rocks or trees in the day. Therefore, it is not easy to tell the difference between species and the interaction with humans is less than the fruit bats. The fruit bats also eat fruit and therefore can be seen as a pest and therefore they are thought about more than the microbats that do not share the same food supply as humans. Our focus species for our project is *Mops breguellae*, the Fiji Mastiff Bat which does have a distinctive characteristic. It is the only insectivorous bat that has a tail. Some of the people interviewed, unprompted, reported seeing small cave-dwelling bats that have tails. This suggests the presence of the Fiji Mastiff Bat. Whilst many of the community members are very knowledgeable, some obviously confuse the animals, particularly those living in caves. Some of the descriptions given of the insectivorous bats are most likely to be describing the Fiji Blossom bat that also lives in caves and has a rat-like tail, and some the swiftlets that inhabit the same caves. For example, a description of an “insectivorous bat” was that it is black, with a tail like a bird, has a white chest, has feathers and it flies during the day. The information gleaned from the surveys is very useful as the majority is likely to be arcuate but does need to be interpreted with the limitations in mind and backed up with scientific studies. This is particularly true for the responses related to the species that are difficult to tell apart from sightings alone.

**Perceptions of bats**

When people were asked about why they thought bats are, or are not, important, most people in the Banks islands gave positive responses. In Samna however the most common response was a negative one, in that people were concerned about bats raiding food in gardens. The population density is higher in Sanma with more land used as agricultural plantations and farms or for subsistence farming particularly around the south and east coast of Santo where this survey was concentrated. If there is less virgin forest for the bat to use, then they may raid gardens and crops more often in Sanma than in the Banks. In Sanma some people mentioned disease as a reason whereas this was not mentioned as a reason for importance in the Banks. The questionnaire survey was done in the Banks islands just prior to the Covid19 pandemic and the survey was conducted in Sanma after the global pandemic had been declared but before Covid had entered Vanuatu. It is generally understood that Covid19 originated from bats. This may have influenced the results if the survey and be a reason for the negative perception of bats by some people in Sanma.

It appears that there is a stronger connection to culture in the Banks islands compared to Sanma, with the majority of people in the Banks saying the bats were important to their culture and only just over half saying that they are not important in Sanma. Less people were aware of bats in arts and stories in Sanma as well. One possible
explanation is that Sanma, with the urban centre of Luganville and more commercial enterprise and development the forest and biodiversity is becoming less relevant to the population. Another is that the Banks has always had a stronger connection to bats than the people in Sanma and this could be because of geography or other reasons. With no previous survey to compare, it is uncertain if this is a trend or a stable situation. No conclusion can be derived from this survey alone and more social science research would be needed to understand if the connection between bats and the people is being eroded in Sanma or if that is the way it has always been.

**Bat behaviour and ecology**

The results of the survey show that the different species of bats in Vanuatu behave in different ways. The Pacific Flying Fox (*P. tongonas*) is a large bat that tends to roost in large groups, often making significant noise as the interact with each other. This is the most common bat encountered, this may be because there are more of them or that they are more obvious to people because they are large, congregate in groups and are noisy. Descriptions of how they tend to fly suggest they fly above the canopy more often which could also make them easier to see. In contrast the endemic flying foxes, tend to roost mostly alone and sometimes in small groups, which would make them less easy to observe. Their flight pattern is describes as flying through the forest under the canopy which would mean they are less likely to be seen from further away than bats flying above the canopy. The Fiji Blossom bat is the least encountered of the Megabats in both the Banks Islands survey and the Sanma survey. Again, this may be because their numbers are lower, but it could also be explained by differences in behaviour. These bats roosting in caves and therefore are not as easy to see as the tree roosting bats. In the Sanma survey, we enquired about the time of day that the different species were seen. *N. macdonaldi* is most often seen at night and rarely during evening or morning, which implies it is more active in the night and therefore less likely to encounter humans than if it were active in the light hours. Interestingly the endemic fruit bats are seen more often during the day than *P. tongonas*.

The survey has identified where people see bats. This is a measure of human bat interaction rather than of habitat usage by the bats. As humans spend more time in their gardens and villages they are more likely to encounter bats there and therefore the relative number of sighting will be higher there than places where humans do not frequent so often. The majority of people see the bats in the bush, but significant sightings occur in places where people live and work – the villages, gardens and plantations. These are habitats are shared with people. This survey shows that bats do use the shared habitats frequently. The wildlife human interface is therefore significant, and this could have negative implications for bats as the threats from humans are likely to be greater in the shared habitat than the forest. But there is potential and also potential implications for human health with the potential for disease to spill-over from bats to people.
In Banks the majority of encounters appear to be in the bush. In Sanma more people reported seeing bats in the villages than in the bush and proportionally more see them in the villages in Sanma compared to the Banks. This may be because, with a larger human population, there is more land used for habitation, so the bats are more commonly encountered there. As there is more agriculture and it tends to be in the inhabited areas, the bats could be attracted to the crops.

It is not unexpected that more people see bats in caves and in plantations in Sanma as the province has a significant limestone cast cave system and a stronger agricultural sector and therefore more land assigned to plantations and farms compared to the Banks Islands.

The bats use a number of different plants to roost in or forage on. The community members gave us the names of 142 different plants (although some of them could be synonyms for the same species in the different languages of the islands). We identified 61 of them to at least genus, if not species level. Some interviewees said that the fruit bats would use any large tree to roost on and would eat any fruit in season. Some plants were cited by the interviewees much more commonly than others. The Nabanga (*Ficus spp*) as well as the fruiting trees, both cultivated and wild, were the most often listed as being used by the fruit bats.

The “Melek tri” (*Antiaris toxicaria*) and the nabanga were reported as trees used by insectivorous bats to roost in. The insectivorous bats are generally thought of as cave dwelling but 31 people who see microbats (12%) identified trees that the insectivorous find hollows in which to roost. To date, the few scientific studies that have been conducted on insectivorous bats tend to concentrate on caves. This result would suggest that the bats also use trees in the forest and widening the surveys to include the forest habitat may reveal they use this habitat more than our currently knowledge suggests.

Although many of the interviewees said they had seen female bats carrying pups, particularly of *P. tongonas*, many could not identify a time of year when they notice this. The months that were identified were spread throughout the year, with small peaks which are unlikely to be statistically significant. It maybe that there is not a distinct season for breeding or that the people have not noticed. Less people see the endemic flying foxes with pups and even less the Fiji Blossom bats, this could be for a number of reasons. A couple of possibilities are that the bats are even more cryptic and stay away from humans more when they have pups or they breed less often than *P. tongonas*. Even less people could identify a time when bat breed. No conclusion can be drawn about the timing of reproduction from this survey, but it does highlight that more research is needed.
Threats to bats

Population trends
In the Banks *P. tongonas* is perceived to be increasing. Similar numbers of people think the endemic fruit bats are increasing and decreasing with 20% thinking they have stayed the same. This suggests the population is overall probably stable, although there may be some regional differences. This would need to be backed up with scientific studies.

In Sanma insectivorous bats are perceived to be increasing, but the fruit bats are perceived to be decreasing although more people were unsure of the trend for the Fiji Blossom bat. The questionnaire in Sanma was conducted a year after the category 5 Tropical Cyclone Harold which had a significant impact on the vegetation in the southern part of Sanma province. Close to three-quarters of the interviewees in Sanma thought that the cyclone had affected the fruit bats and over 80% thought it had no effect on the insectivorous bats. This is likely to have influenced the perception of bat numbers even though many cited over hunting as a cause of the decline. More studies would be needed to assess if the bats numbers perceived to be increasing again as the habitat recovers.

Hunting
Around two thirds of the people interviewed in both survey sites say that they hunt flying foxes. But most hunt several times a month or less, and half the hunters in the Sanma said that they caught less than 20 bats in the previous 12 months. This would suggest that hunting pressure is not high, but studies are needed to verify this. Most prefer to catch the Pacific flying fox and it is common for they hunters to say they don’t like the smell or taste of the endemic flying foxes. So it seems that the hunting pressure on the endemic bats is lower still, certainly in the Banks where much less people reported hunting the endemic bats. In Sanma more people said that they hunt Vanuatu flying fox. They also report seeing them more often and this may explain the higher hunting level, (which is still lower than the hunting level for the Pacific flying fox). Without a measure of population size, calculating a sustainable take is impossible. But without that knowledge taking the precautionary approach it would seem sensible to discourage the hunting of the endemic flying foxes and to monitor the numbers of Pacific flying foxes to detect a decline an allow for early intervention to reverse the drop in numbers.

Most people hunt flying foxes for food. Most of the flying foxes are eaten within the village. A small number of people sell the flying foxes but generally it is to the local area for a low price.

The most common methods for hunting flying foxes and insectivorous bats use projectiles that can target the bat that the hunter wants to catch. Some less-discriminating methods are also used by a small, but significant, minority of hunters. Fishing line and hooks and traps and snares do not discriminate between species and
therefore not any one species of bat can be targeted. Both the Pacific flying fox and the endemic flying foxes will be caught if they fly into the lines. There is also the potential of by-catch of birds for example barn owls. This method of hunting is stressful and painful for the bats especially if the lines are left unaccompanied overnight. These methods of hunting would induce far more suffering than using a projectile that targets a particular bat at the time the hunter throws it.

Only 17% of people interviewed said that they target insectivorous bats for hunting and of those more than half said that they had caught under 100 bats in the last 12 months. Again, this appears to be low hunting pressure however more research is needed to establish whether it is having an unsustainable effect on the insectivorous bat population and in particular if it is affecting the Fiji Mastiff bat, which is classed as endangered. As most hunting happens in the caves, where many bats roost together the is the possibility a high number of bats from one colony can be killed at one time. As mentioned earlier, the local people generally do not differentiate between species of insectivorous bats. It is not known how many colonies there are of the Fiji Mastiff Bat or if they are co-mingled with other bats or if they roost on their own. Therefore, targeting a cave where the Fiji Mastiff bat lives could potentially affect the populations. Again, research is needed to ascertain whether the Fiji Mastiff Bat is being hunted and the what the hunting pressure is on insectivorous bats generally.

Possibly more of a concern is that very close to half the interviewees said they know of children killing insectivorous bats for fun. With the population increasing there are growing number of children and therefore this take could be increasing. It is also a concern that bats are kept in captivity for children to play with or captured as pups and fed until they are bigger and eaten. It is not known if the bats in Vanuatu carry any diseases, but bats have been shown to be carriers of various viruses around the world. If they do harbour a potentially zoonotic pathogen, putting animals under stress by keeping them captive, particularly if they are young, makes it more likely that a pathogen such as a virus is shed by that animal. Children could also be more susceptible to catching of spreading any pathogen passed to them. Therefore, it would be a prudent public health measure to stop the practice of children playing with bats and keeping bats captive in or near the home.

Land use and climate change
A very high proportion of respondents said that land is being cleared for subsistence gardens and a high proportion for agriculture (more so in Sanma than the Banks). Many people believe this affects the bats particularly the flying foxes. In Vanuatu generally land clearing particularly for kava has been raised as a concern for the environment. This study shows that the local communities do believe it is affecting their biodiversity. If it is not feasible to stop the clearing of land, one possible mitigation measure could be to encourage the communities and farmers to leave the larger emergent trees when clearing a new plot and make sure any fire doesn’t damage the truck. This would leave some habitat for bats and other fauna so the area will retain at
least some of the ecosystem services afforded by the bats, such as seed dispersal and pollination. Also, in the face of climate change, where extremes weather such as droughts and storms are expected to become more severe and last longer, leaving trees will likely afford some protection to the crops that the farmers want to grow.

The community perceived a decline in flying foxes after cyclone Harold devastated the habitat in the southern part of Sanma. In the aftermath, there were stories circulating on social media of increased hunting of flying foxes as people’s crops and livestock suffered losses and the bats are easier to hunt as the forest canopy is lost and the bats are often found foraging on the ground. This is the time when the bats are most vulnerable and when the forest would benefit most from their seed dispersal. One conservation measure that could be taken is to put a tabu on hunting all flying foxes in the aftermath of a cyclone to allow the population to recover and in turn assist the forest to recover as well.

Caves
As the southern and eastern part of Sanma is geologically limestone cast, it is not surprising that over three quarters of the people surveyed know of caves in their areas. Most (88.5%) have bats in them. Just under half of the respondents say they use caves and a third of those say that the cave activity affects the bats, but some just temporarily. Some of the activities may increase in the future for example if shelter is needed more often because of higher rainfall events. Some activities may reduce in the future, for example one respondent said that they used to collect water from the cave until a water supply and tap was installed in their village. More research would be needed to assess whether the activity is having a detrimental effect on the bat populations. However, there are some measures that could be put in place by chiefs and landowners, following the precautionary principle whilst waiting for the research to be done. Depending on the cave and its usage, people could be asked to reduce noise and light when in the cave, and not chase the bats out of the cave. If it is necessary to have a fire, try to keep it as close to the entrance as possible so as to reduce the smoke going into the cave. Restricting the access to the cave by livestock may be beneficial to the bats. Identifying which caves are used by the Fiji Mastiff bat, which is endangered, could lead to more restriction on those caves, whilst leaving other caves that are used by bats not on the IUCN Red List of threatened species, for use by the local population. Guidelines for tourism practices in caves would also help to reduce disturbance.

Tourism
The number of tourist visits to much of the areas surveyed is small. There are notable exceptions in Sanma particularly those on the southeast and east coast of Espiritu Santo which attracts high numbers of tourists with many accommodation and tour businesses operating in the area. A high proportion of the tourism activity involves bats; about half the tours in the Banks and a third of the tours in Sanma. In the Banks
on the majority of the tours, bats could be seen as part of the general natural environment rather than on a bat specific tours. In Sanma a higher proportion are cave visits and trips to flying fox roosts. This difference is not surprising given the geology of the land and the high number of caves in Sanma.

Tourism, particularly visits to caves with bats, has the potential for detrimental effects on the bats and potential risks to human and bat health. It is a concern that less than half the tours to caves involve any sort of briefing on how to behave in the tour or how to reduce risk to people or bats. A guideline for cave visits, for all visits, but particularly for tourist tours, would be of benefit.

Conservation areas and tabus
In the Banks most of the tabu areas are marine with only some covering terrestrial areas. Of the responses about tabu areas with a terrestrial component just under a quarter did not indicate any protections for bats. Two thirds indicated that hunting of bats was not allowed in the areas and just over one third that cutting down of trees was forbidden. For the Sanma survey the conservation areas have been mapped and this was overlaid with the areas where people say they see the endemic flying foxes. As can be seen from figure 43, there is not much overlap. This suggests that there is little conservation for the endemic flying foxes afforded by protected areas in the Banks Islands, with Lake Letas conservation area on Gaua the exception. (Gaua is the most southerly island of the Banks group). Whilst there are numerous sightings of a small red-brown flying fox on the island of Gaua, the Banks flying fox has yet to be confirmed on the island by a scientific study and therefore, until proven otherwise these flying foxes are assumed to be the Vanuatu Flying Fox. Therefore, as the knowledge currently stands, there appears to be very little overlap between conservation areas (register or unregistered) and the range of the Banks Flying Fox. Having said that tabu areas are not the only instrument to protect fauna. Some chiefs have prohibited the hunting of the endemic flying foxes in all their lands without the land being declared and conservation area. There are also significant areas of land where people rarely go, and therefore the anthropogenic threats to the bats are limited. The latest census (2021) revealed 10,266 people live in the Banks islands group, which is 780 Square kilometre in total area.

In Sanma province only a small proportion of the people said there was a tabu or protected near where they lived. When present, the majority (80%) included protection for the bats from hunting. Most also had rules that would protect bat habitat by disallowing tree cutting within the area. This suggests that if there are conservation areas and the rules are enforced, bats will be protected within the boundaries of the conservation area. The areas for the Sanma survey are yet to be mapped.
FIGURE 43: AREAS OF ENDEMIC FLYING FOX SIGHTINGS OVERLAPPED WITH CONSERVATION AREAS IN THE BANKS ISLANDS
Recommendations

The results of this questionnaire have shown that gaps in the knowledge about bats in Vanuatu still exist. Recommendations can be made for future research to answer some of the questions that have arisen or not be answered fully by the questionnaire survey. Several recommendations can be made that are likely to improve the conservation status of threatened species of bat in the Banks Island and in Sanma province. Because these recommendations are based on the results of this questionnaire survey, there is increased confidence that the measures will have a positive effect. Several concerns have been raised by this survey about potential health hazards, and animal welfare issues, particularly in relations to tourism practices, hunting techniques and keeping bats in captivity. The following recommendations, if adopted by the communities, will help to alleviate some of these concerns.

Research and monitoring

There are many studies that could be undertaken to increase our knowledge of bats in Vanuatu. However, this survey has highlighted some of the most pressing knowledge gaps, particularly for the threatened species. The questions we feel that are the most urgent to answer are as follows:

- What is the range of the Banks Flying Fox?
- How are the Banks flying fox and the Vanuatu flying fox related?
- How distinct are the subspecies of the Vanuatu Flying Fox?
- Where is the critical habitat of the Fiji Mastiff Bat?
- How big are the populations of all the threatened species of bats in Vanuatu?
- What is the threshold for sustainable take of Pacific Flying Foxes?
- How do cyclones and land clearing affect flying foxes?
- Do human activities in caves affect cave bats?
- What is the relationship between bats and Ni-Vanuatu culture and is it being eroded by development, modernisation and urbanisation?

We believe the following will be needed to answer these questions:

- Scientific studies using mist net surveys to capture endemic fruit bats for metamorphic measurements and sampling for genetic testing
- Observational studies to determine populations size and range for endemic fruit bats
- Observational studies, acoustic monitoring, and capture studies to determine a population size and critical habitat for the Fiji Mastiff Bat. The focus areas for insectivorous bat studies should be widened to include forest sites and not only focused on caves.
- Develop a long-term monitoring plan monitoring to understand the population trend of all threatened bat species. This will act as a baseline to determine effects of climatic events such as cyclones.
- Develop plan to monitor Pacific Flying Fox to understand if the harvest is sustainable.
Conservation actions
The survey has highlighted some of the threats to bats that exist in the two survey areas. It also showed that, although some people in the community have a great deal of knowledge about bats, there are generally gaps in knowledge such as of the number of different insectivorous bats species present. There is also a lack of understanding of potential health implications for interactions with bats. The following recommendations will address those threats and knowledge gaps:

Hunting
- Stop the use of indiscriminate methods for hunting such as fishing line and hooks, snares and traps.
- Target only the Pacific Flying Fox (*P. tongonas*) and discourage the hunting of the endemic flying foxes.
- Monitor the numbers of Pacific Flying Foxes to detect a decline and allow for early intervention to reverse any decrease in numbers.
- Place a tabu on hunting flying foxes after cyclones when they are at their most vulnerable and the forest would benefit most from their ecosystem services.

Land use
- Create conservation areas which include important habitat for the endemic flying foxes.
- Ensure measures to protect both the flying foxes and their habitat are included in the conservation area management plans.
- Limit the amount of land cleared for gardens and agriculture.
- Any clearing should follow a land use plan for the area, avoid important bat habitat and reduce the fragmentation of habitat particularly flyways used by bats.
- If land is cleared, the large trees should be left standing, particularly those used by bats such as banyans, melek and breadfruit trees.

Awareness raising and education
- Awareness campaigns to increase general knowledge of bats targeting all members of the community.
- Education to support the links of bats to local culture.
- Awareness campaigns on hunting methods and monitoring, targeting those that hunt flying foxes.
- Awareness raising campaign on health and safety and animal welfare measures, targeting the tourism operators and employees and the Department of Tourism staff.

Public health and animal welfare measures
Bats have the potential to carry diseases which could be passed to people. We do not know if the bats in Vanuatu carry any of these pathogens. There is also the potential that people can pass disease to bats either by shedding a virus, for example Covid19, or by carrying a pathogen from their home country, for example white nose syndrome. If the Vanuatu bats are susceptible to these pathogens, it could cause disease in the
bats, which is of particular concern for the bats threatened with extinction. The survey has highlighted several practices that cause stress and pain to bats: hunting using fishing line and hooks, keeping bat in captivity and children playing with bats. Not only do these practiced raise animal welfare issues, but when wild animals are stressed the likelihood of shedding potentially zoonotic pathogens is increased. The following recommendations will reduce the chance of transmission of disease between bats and people and vice versa as well as improve the welfare of bats.

- Stop the practice of children playing with bats
- Don’t keep bats in captivity
- Develop guidelines for cave visits including for tourism operations
- Stop the use of fishing line and hooks for capturing bats
- Reduce disturbance to bats at roosting sites

Conclusion

Significant amount of information has been gathered about bats in the Banks Islands and in Sanma Province. Bats are seen commonly. In the Banks the general consensus is that they are not in decline. In Sanma, even though the perception that the number of flying foxes has decreased, they are still seen very commonly, including the endemic, threatened bats. The decline may be due to the recent cyclone and monitoring in the next few years will identify if the decline has reversed or if it is a trend that needs extra measures to address. The survey has identified behaviours and ecological needs of bats that differ between the species. This knowledge will assist conservation managers to implement measures to conserve bats. Bats are hunted but it appears that the hunting pressure is not extremely high. Monitoring of the hunting and the populations of bats will determine if the take is sustainable. Tourism involving bats is relatively common, but it appears to be generally low impact. But this survey has highlighted some concern over practices that may increase health risks and disturbance to bat roosts. Some animal welfare concerns have also been raised by the results of the survey.

Questionnaire surveys such as this cannot replace scientific studies. For example, because it is hard to distinguish the two endemic species of flying fox (*Pteropus fundatus* and *Pteropus anetianus*) the range of the Banks flying fox is still in question. But the information gathered on what threats are present, particularly those that are due to human bat interactions, can be interpreted with confidence. Questionnaires can collect a lot of information over a short period of time and over a large area and this can help to direct where the follow-up scientific studies should concentrate, and the responses assist with forming the questions that the studies are designed to answer. Whilst waiting for the follow up studies to happen, the questionnaire survey results do give confidence to recommendations for conservation actions that can be taken to protect bats, particularly the threatened species, in the interim.
Recommendations have been made for further studies, conservation measures that can be implemented and how health and welfare concerns can be addressed.

**Next Steps**

We would like to extend the scope of this questionnaire survey to other areas of Vanuatu. To do this more efficiently, we would like to modernise the collection of the information to reduce the time take to conduct the surveys and to analyse the information gathered.

We would also like to conduct research to address the gaps and questions that this survey has raised as outlined above.

We would like to continue to raise awareness of the importance of bats and the measure than can be taken to protect and conserve them.

We have already started working with the communities in the Banks and Sanma to implement the recommendations that have come out of this survey, and we would like to continue to work particularly with those communities that have showed enthusiasm throughout our project, for bat conservation in their areas.

**Funding**

The “Conservation of the Endemic Flying Foxes of Torba and Temotu in Vanuatu and the Solomon Islands” and the “Identifying and protecting important habitat for the Fiji Mastiff bat and the Banks Flying fox in Vanuatu” projects were funded by the Critical Ecosystem partnership Fund (CEPF). The Critical Ecosystem Partnership Fund is a joint initiative of l’Agence Française de Développement, Conservation International, the European Union, the Global Environment Facility, the Government of Japan and the World Bank. A fundamental goal is to ensure civil society is engaged in biodiversity conservation. The projects were implemented between July 2017 and December 2021.

**Acknowledgements**

We would like to thank the communities of the Banks Islands and Sanma province for participating in the surveys and willingly giving us information that they hold on the bats and bat habitat of Vanuatu. We would also like to thank them for their interest bats and their enthusiasm to implement measure to ensure their survival.

We would like to thank Alison Derry and the Australian Volunteer Programme. Alison assisted us as a remote Australian Volunteer and helped us to create maps of the data collected from our Banks Islands survey, enabling the data to be display visually making it easier to understand.
Questionnaire survey statement

This must be read to every person interviewed.

The Vanuatu Environmental Science Society is conducting a survey on bats across the Sanma province. The purpose of this survey is to find out what is known about the bats, where and how they live on your island. The survey will also gather information about people using bats including hunting and tourism and about whether they are stable increasing or declining.

There are no right or wrong answers to these survey questions. Gender and age range of participants and general location will be indicated in the survey reports, individuals will not be personally identified in any discussion of the study. However, results of the survey will be shared with the Vanuatu government departments and publicly. By taking part in this survey questionnaire, you are agreeing to allow your responses to be used in this study. Please tell us if there is any information you would like kept confidential.

Thank you very much for taking the time to answer the questions.

---

**Checklist for after survey**

<table>
<thead>
<tr>
<th>Items</th>
<th>Survey number filled in</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Questionnaire survey</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Species information sheet for each species</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Maps</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Other</th>
<th>Survey number filled in</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of village or place where bats were sighted marked on map</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Species noted in legend</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conservation area marked on map</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caves or trees where bats live marked on map</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Bat Survey Questions

Interviewer Name: _______________________    Date: _________________

Island: _________________________________ Village: ___________________________

Mark village on map. □

Tick the box after the questionnaire statement been read to the interviewee. □

Do not read the answers, just circle the appropriate answer after interviewee has given their response.

Interviewee Background

1. Name: ___________________________________________

2. Age:    11-20            21-30           31-40          41-50             51-60             61-70                 71 and above

3. Gender:  Male            Female

4. Church:  Anglican    |    SDA    |   Catholic    |    Presbyterian    |    Jehovah’s Witness
             Other    Please specify: ______________________________

5. What is your job?  Fisher | Hunter | Gardener | Teacher | Student | Church worker | Housewife | Health worker
                    | Carpenter | Local government | NGO/CSO | Shop keeper | handicraft | Tourism |
                    Other    Please describe: ___________________________________________

6. Do you see bats?    Yes   No

7. How often do you see bats?   Everyday   |   Every week   |   A few times a month   |   A few times a year

8. Where do you often see bats?  Garden | Bush | Mangroves | Village or house | Hill or mountain | Plantation |
                                         | Coast, shore or cliff   | Lake or river   | Cave   | Offshore island
                                         Other: Please describe: Do not write place names ______________________________

9. Do you think bats are important for the environment?  Yes   No

10. How would you rate the importance of bat on the environment?

    Of little importance                  Highly important
    1   2   3  4  5  6  7

    Please explain why you think bats are important or not important: _______________________________________
    ______________________________________________________________________________________________
    ______________________________________________________________________________________________

Microbats

Show pictures of microbats

11. Do you see Microbats?    Yes   No

12. How many different kinds of microbat do you see? What do you call them? Can you describe them? (Write name and description in the table. Do not show bat pictures to interviewee).

<table>
<thead>
<tr>
<th>Name of bat (local)</th>
<th>Description (e.g. colour, size etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
</tr>
</tbody>
</table>

If the interviewee sees more than one kind of micro-bat ask Question 13, if not go to Question 14.

13. Which microbat do you see most often? ________________________________________________________

    Which microbat do you see least often?

14. How often do you see microbats?   Every day | Every week | A few times a month | A few times in a year

15. Where do you see them? (circle all that apply).    Garden | Bush | Mangroves | Village or house | Hill or mountain

                    | Plantation – What crop? _________ | Coast, shore or cliff   | Lake or river   | Cave   | Offshore island
                    Other: Please specify: _______________________________________________________

Mark where you see the bats on the map. Note species in legend and survey number on the map. □

16. What are the bats doing when you see them?  In tree hollows | In Caves | Flying | Feeding

    Other activity: Please describe: ___________________________________________________________

Mark where you see the bats on the map. Note species in legend and survey number on the map. □
17. How often do you see the bat sleeping/resting? Every day | Every week | few times a month | few times a year | Don’t see sleeping. (If don’t see them sleeping, move to 23).

18. Can you describe the habitat or type of place where micro bats sleep or rest? (No place names)

If mentioned above mark any trees or caves where bats are regularly seen on the map and note in legend

19. How many bats do you think live there?
   Less than 10 | 10 to 20 | 20 to 50 | 50 to 100 | 100 to 1000 | Over 1000

20. Are the bats sleeping alone, in pairs or in groups? Alone | Pairs | Small Groups | Large group

21. If you see them sleeping in trees, what is the name of the tree or plant they sleep in? (write down all that are mentioned)

22. Do the bats change where they sleep or use the same place throughout the year?
   Change | Same place | Don’t Know

23. If they change the place they sleep, why do you think they move?

24. Where do you see microbats flying? Don’t see them fly | Garden | Bush | Mangroves | Coconut Plantation Other: Please describe

25. How often do you see microbat flying? Every day | Every week | A few times in a month | A few times in a year

26. What time of day do you see them flying? Day time | Evening | Night-time | Morning

27. Are the bats flying alone, in pairs or small groups? Alone | Pairs | Small Groups | Large group

28. Can you describe their behaviour when flying?

29. Do you see the bats flying in big groups? Yes | No (If don’t see them flying, move to 30).

30. Have you ever seen a pup and its mother? Yes | No
   If yes, how often? Every day | Every week | A few times a month | A few times in a year
   Which direction are they going?

31. Have you notice bats mating/breeding? Yes | No
   If yes, what months? circle all that apply Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Not sure

32. Any other comments about Microbats?

Caves

33. Are there any caves in your area? Yes | No

34. Put the name of each cave in the table below. For type of cave Show pictures of cave types and ask: “Which of the following most resembles the cave?” For the animal columns record whether these animals are present.

<table>
<thead>
<tr>
<th>Name of Cave</th>
<th>Describe the cave</th>
<th>Type of cave</th>
<th>bats?</th>
<th>birds?</th>
<th>other animals?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

Mark the cave entrances on the map with an X. Put name of cave on map / legend

35. Do you use the cave? Yes | No
   If yes, what for?

36. How often do you use the cave? Every day | Every week | A few times in a month | A few times in a year | Less than once a year

37. Have you notice any difference in the bats before and after using the caves? Yes | No
   If yes, please explain
38. Do you use the cave to shelter during cyclones? Yes  |  No
What happens to the bats when you do? __________________________________________________
____________________________________________________________________________________

39. Any other comments on caves? ______________________________________________________
_____________________________________________________________________________________

**Threats to microbats** the following questions relate to micro bat species

40. Do you think the number of micro bats has decreased, increased or stayed the same?
Decreased  |  Increased  |  Stayed the same
41. Why do you think so? Please explain__________________________________________________
_______________________________________________________________________________________

42. Have you noticed any difference in the number of bats before and after cyclone Harold?  Yes  No
Please explain ____________________________________________________________

43. Do you hunt microbats (if no go to question 60)  Yes  |  No
44. Which kind(s) of micro bats do you hunt?
45. In the past 12 months how many microbats you have caught?
Less than 10  |  10 to 20  |  21 to 100  |  101 to 1000  |  More than 1000
46. Do you catch more or less microbats than 10 years ago?
Catch less bats now than 10 years ago  |  Catch more bats now than 10 years ago
47. How often do you hunt microbats?
Every day  |  Every week  |  Several times a month  |  A few times a year
48. What do you use to hunt microbats?
Slingshot  |  Bow and arrow  |  Stones  |  Wood  |  Gun  |  Fishing line & hook  |  Bush knife  |  Traps or snares  |  Bamboo poles  |  Smoke  |  Nets  |  Other Please specify:
49. Where do you prefer to hunt microbats? Habitat Type Do not write place names
Garden  |  Bush  |  Mangroves  |  Village or house  |  Hill or mountain  |  Plantation  |  Coast, shore or cliff  |  Lake or river  |  Cave  |  Offshore island  |  Other Please specify:
50. What are the bats doing when you hunt them? Sleeping  |  Flying  |  Feeding  |  Other: Please specify: ____________
51. Is there a best time of the year you hunt micro-bats? Yes  No
If yes, what months? Jan  |  Feb  |  March  |  April  |  May  |  June  |  July  |  Aug  |  Sept  |  Oct  |  Nov  |  Dec  |  Don’t know
52. What do you do with the microbats you hunt? Circle all that apply
Eat  |  Collect their teeth  |  Sell them for money  |  Other Please specify: ______________________________
53. If you hunt the bats for meat who eats the meat? Hunter  |  Household  |  Family  |  Friends  |  Village  |  Visitors  |  dogs  |  Other – please specify: _________________________________________________________________________
54. Do you use any other body parts of bats? Yes  |  No
If yes, what part? and what for?
what part? and what for?
what part? and what for?
what part? and what for?
55. If you sell bats, who do you sell it to? Villagers  |  Market  |  Other. Please specify: ___________________________
56. For what price? _______________________________________________________
If the interviewee has identified more than one kind of micro-bat ask questions 58 and 59, if not go to Q 60
57. Which bats is the easiest to hunt? _________________________________________________
58. Which bats do people most often eat? ________________________________________________
59. Have you seen children or youth kill bats for fun? Yes  |  No
What do they use to kill them? _______________________________________________________
60. Has land been cleared for small gardens? (subsistence)  Yes  |  No
If yes, do you think it has an effect on micro-bats? Yes  |  No
Please explain. _______________________________________________________
61. Has land been cleared for agriculture or livestock? (commercial)  Yes  |  No
If yes, what crops or livestock? ______________________________________________________
If yes, do you think it has an effect on micro-bats? Yes  |  No
Please explain _______________________________________________________

62. Have you seen bats kept in captivity?  
   Yes | No 
   If yes, please describe: ____________________________________________________________

Conservation Information (all bats)

63. Are there any protected areas or local taboos on your island?  
   Yes | No | Don’t Know
   If yes, please fill in the conservation information sheet at the back of this questionnaire. Please mark and name the area that it is protected on the map and note in legend

Fruit Bats

64. How many different kinds of Fruit bats do you see? What do you call them? Can you describe them? (Write name and description in the table. Do not show bat pictures to interviewee yet).

<table>
<thead>
<tr>
<th>Name of bat (local)</th>
<th>Description (e.g. colour, size etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
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<td>4.</td>
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</tr>
</tbody>
</table>

65. Which Fruit bat do you see most often? ____________________________________________________________
   Which Fruit bat do you see least often? ____________________________________________________________

66. Do you hunt fruit bats  
   Yes | No | If no, go to question 69

67. Which fruit bats is the easiest to hunt? __________________________________________________________

68. Which fruit bats do people most often eat? _______________________________________________________

69. Please identify from these pictures the bats you see. (Show pictures of bats to interviewee. For each species of flying fox seen, please fill in a species information sheet and circle the species name below.)
   Banks flying fox | Vanuatu flying fox | Pacific flying fox | Fijian blossom bat | Other: Please specify______________

Bats and Tourism Information – all bats (microbats and fruitbats)

70. Do tourists visit your village / area?  
   Yes | No | If no, go to question 69
   If yes, how often?  
   Every day | Every week | Several times a month | A few times a year
   In total how many visitors do you have every year?  
   <10 | 10 to 50 | 50 to 100 | 100 to 1000 | > 1000

71. Do you have any tourist activities that involve bats (Fruit bats or microbats) in your community?  
   Yes | No
   If yes, please describe in table below.

<table>
<thead>
<tr>
<th>Describe the activity</th>
<th>Number of tourists that take part in this activity per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity 1:</td>
<td></td>
</tr>
<tr>
<td>Activity 2:</td>
<td></td>
</tr>
</tbody>
</table>

72. Do you take tourists to see caves?  
   Yes | No

73. Is this to show them the cave or to see the bats?  
   Caves | Bats | Both

74. Do you give instructions to the tourist on what to do in the cave?  
   Yes | No
   If yes, please describe  
   .................................................................................................................................................................................................................................................................................................................................

75. Do you take any measures to reduce disturbance of the bats?  
   Yes | No
   If yes, please describe  
   .......................................................................................................................................................................................................................................................................................................................................
76. Do you take any precautions to protect tourist’s health when visiting caves?  
   Yes    |    No

If yes, please describe __________________________________________________________________________
____________________________________________________________________________________________

Bats in Vanuatu Culture

77. Are bats important in your culture?    Yes    No

78. Please explain.____________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________

79. Do you know any custom stories, songs, belief, myths, sand drawings or other arts etc related to bats?  
   Yes        No

If the interview answers yes, read them this statement: This question is based on your traditional knowledge about bats. Your stories will be written down or your art described in writing. This way the story or art will be preserved. This is a way to help protect your culture, identity and knowledge.

Are you happy to share your stories or art? If the teller of the story or art agrees, please read them the following options and tick which ones the teller agrees to – please tick all that apply.

- [ ] I give permission to share the story or art.
- [ ] I give VESS permission to use the story or art in any awareness activities and publications.
- [ ] I give VESS permission to share the story or art on VESS website, Facebook page or other social media.
- [ ] I give VESS permission to deposit the story or description of art at the Vanuatu Cultural Centre
- [ ] I give VESS permission to record the story or art but not to share it.
- [ ] I am not the owner of the story or art, but the owner gives VESS permission to share the story and use the story in any activities and social media.

Write the story or describe the art below. If you take a video / photo of the art or story, please make a note that you have done so here. Once the story or art is completed please ask the teller to read it and sign at the bottom that the above permissions are valid.

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Name: ___________________________  Signature: _________________
Village: __________________________  Date: _____________________
Island: ___________________________

Any other information or comments about bats or caves ________________________________________________
_______________________________________________________________________________________________
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<table>
<thead>
<tr>
<th>Conservation Area Information Sheet</th>
</tr>
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<tbody>
<tr>
<td>Survey Number:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current or not current</th>
<th>Name of dept where registered</th>
<th>Registered VRN</th>
<th>Management Plan completed/draft (C or D)</th>
<th>Traditional Land / Leased land (T or L)</th>
<th>Area (ha)</th>
<th>Management Plan completed (C or D)</th>
<th>Registered (Y/N)</th>
<th>Name of dept where registered</th>
<th>Current or not current</th>
<th>Land, Sea or Both</th>
<th>Year established</th>
<th>Rules of the area</th>
<th>History of the area</th>
<th>Specific rules for bats including caves</th>
<th>Who manages the area (chief, env. committee, community?)</th>
<th>Who supports (Govt, NGO)</th>
<th>Name of supporting agency</th>
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Species Information Sheet – Fruit Bats

Note to interviewer: Do not read the answers, just circle the appropriate answer after interviewee has replied.

A. Scientific name (Interviewer to fill in answer A only based on which photo the interviewee identify as this species):
   ______________________________________________________________________________________________

B. Local name: _________________________________________________________________________________

C. What do they look like? ________________________________________________________________________
   ___________________________________________________________________________________________

D. How often do you see the bat?  Every day | Every week | A few times a month | A few times in a year

E. Where do you see them?  (circle all that apply)
   Garden | Bush | Coconut Plantation | Mangroves | Cave | Village | Mountain | Coast | Lake or river | Offshore island | Other: Please specify: ________________________________________________________________________

   Mark and write name of village or place where you see the bats on the map (note species in legend and survey number on the map)

F. What are the bats doing when you see them?  Hanging in trees       In Caves           Flying       Feeding
   Other activity: Please describe: ___________________________________________________________________________________________

G. How often do you see the bat sleeping/resting?  Every day | Every week | few times a month | few times a year | Don’t see sleeping  
   If don’t see resting, move to (N)

H. Can you describe the habitat or place where this bat sleep or rest?  (No place names)
   ___________________________________________________________________________________________
   __________________________________________________________________________________________

I. How many bats do you think live there?
   Less than 10    |   10 to 20   |   21 to 50   |    51 to 100   |   101 to 1000   |   Over 1000

J. Are the bats sleeping alone, in pairs or in groups?  Alone | Pairs | Small Groups | Large group

K. If they sleep in trees what is the name of the tree or plant they sleep on?  (write down all that are mentioned)
   ___________________________________________________________________________________________
   __________________________________________________________________________________________

L. Do the bats change where they sleep or use the same place throughout the year?
   Change   |       Same place   |   Don’t Know

M. If they change the place they sleep, why do you think they move? ______________________________________
   ______________________________________________________________________________________________

N. Do you see this species of bat feeding?  Yes | No  
   If no go to question U

O. Where do you see these bats eating?  Garden | Bush | Mangroves | Plantation – What crop? _______________
   Other: Please describe ______________________________________________

P. How often do you see this bat feeding?
   Everyday  |   Every week   |   A few times in a month   |   A few times in a year

Q. What time of day do you see them feeding?  Day time | Evening | Night-time | Morning | (circle all that apply)

R. Are the bats feeding alone, in pairs or groups?  Alone | Pairs | Small Groups | Large group

S. Can you describe their behaviour when feeding? ____________________________________________________
   __________________________________________________________________________________________

T. What do they feed on and when?  (list all the plants or trees or other food that are mentioned & prompt for all)

<table>
<thead>
<tr>
<th>Plant or tree name</th>
<th>What months</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Jan</td>
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<td></td>
<td>Jan</td>
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<td></td>
<td>Jan</td>
</tr>
<tr>
<td></td>
<td>Jan</td>
</tr>
<tr>
<td></td>
<td>Jan</td>
</tr>
</tbody>
</table>

U. Do you see the bats fly in large groups?  Yes | No
   If yes, how often?  Everyday  |   Every week   |   A few times a month   |   A few times a year
   which direction do they come and go to?

V. Have you ever seen a pup and its mother?  Yes | No
   If yes, what months? Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec circle all that apply

W. Have you notice bats mating /breeding?  Yes | No

Survey Number: ____________________________
**X. Have you noticed any difference in the number of bats before and after Cyclone Harold?**

- **Yes**
- **No**

Please explain ____________________________________________________________________________

**Threats**

**Y. Do you think the number of these bats has decreased, increased or stayed the same?**

- **Decreased**
- **Increased**
- **Stayed the same**

Why do you think so? Please explain ____________________________________________________________________________

**Z. Do you hunt this species of bat?**

- **Yes**
- **No**

**AA. Why do you hunt them?**

- **For food**
- **For Fun**
- **Pest**
- **to sell - Live or dead**
- **Other**

Please explain ____________________________________________________________________________

**BB. In the past 12 months how many bats have you have caught?**

- **Less than 10**
- **11 to 20**
- **More than 20**

**CC. Do you catch more or less bats than 10 years ago?**

- **Catch less bats now than 10 years ago**
- **Catch more bats now than 10 years ago**

**DD. How often do you hunt bats?**

- **Every day**
- **Every week**
- **Several times a month**
- **A few times a year**

**EE. What do you use to hunt bats?**

- **Slingshot**
- **Bow and arrow**
- **Stones**
- **Wood**
- **Gun**
- **Fishing line & hook**
- **Bush knife**
- **Traps or snares**
- **Bamboo poles**
- **Nets**
- **Other**

Please specify: ____________________________________________________________________________

**FF. Where do you prefer to hunt this flying foxes?**

- **Habitat type**
- **Do not write place names**

- **Garden**
- **Bush**
- **Mangroves**
- **Plantation**
- **Caves**
- **Village**
- **Hill or Mountain**
- **Coastline**
- **Lake or river**
- **Offshore island**
- **Other**

Please specify: ____________________________________________________________________________

**GG. What are the bats doing when you hunt them?**

- **Sleeping**
- **Flying**
- **Feeding**
- **Other**

Please specify: ____________________________________________________________________________

**HH. Is there a best time of the year you hunt flying foxes?**

- **Yes**
- **No**

If yes what months? Jan | Feb | March | April | May | June | July | Aug | Sept | Oct | Nov | Dec | Don’t know ____________________________________________________________________________

**II. What do you do with the bats you hunt?**

- **Circle all apply**

- **Eat**
- **Collect their teeth**
- **Sell them for money**
- **Other**

Please specify: ____________________________________________________________________________

**JJ. If you hunt the bats for meat who eats the meat?**

- **Hunter**
- **Household**
- **Family**
- **Friends**
- **Village**
- **Visitors**
- **dogs**
- **Other**

Please specify: ____________________________________________________________________________

**KK. Do you use any other body parts of bats?**

- **Yes**
- **No**

If yes, what part? and what for? ____________________________________________________________________________

**LL. Do you sell this kind of fruit bat?**

- **Yes**
- **No**

For what price? ____________________________________________________________________________

**MM. If yes, who do you sell it to?**

- **Villagers**
- **Market**
- **Other**

Please specify: ____________________________________________________________________________

**NN. Has land been cleared for gardens?**

- **Yes**
- **No**

If yes do you think it has an effect on this kind of bat? Please explain. ____________________________________________________________________________

**OO. Has land been cleared for agriculture or livestock?**

- **Yes**
- **No**

If yes, what crops and livestock? ____________________________________________________________________________

**PP. If yes, do you think it has an effect on these bats?**

- **Yes**
- **No**

Please explain. ____________________________________________________________________________

**QQ. Have you seen bats kept in captivity?**

- **Yes**
- **No**

If yes, please describe. ____________________________________________________________________________

**RR. Any other comments about this species of bat?**

__________________________________________________________________________________________
Appendix B: Plants that interviewees identify as being used by bats in the survey sites

Local names were given during the survey and noted down on the survey form. Common and scientific names were assigned to them by the VESS team once the returned to from the field as far as was possible. The grid indicates which species of type of bat was reported to use the plant and for what purpose.

<table>
<thead>
<tr>
<th>Local Name</th>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>alvidonia tree</td>
<td>American tree</td>
<td>Pandanus tectorius</td>
</tr>
<tr>
<td>American tree</td>
<td>Arvao</td>
<td>Pandanus tectorius</td>
</tr>
<tr>
<td>Arvao</td>
<td>Banana</td>
<td>Musa</td>
</tr>
<tr>
<td>Atapwava</td>
<td>Banana</td>
<td>Musa</td>
</tr>
<tr>
<td>Banana</td>
<td>Benwar tree</td>
<td>Castanospermum australe</td>
</tr>
<tr>
<td>Big leaf</td>
<td>Merremia</td>
<td>Merremia peltata</td>
</tr>
<tr>
<td>Bin tri</td>
<td>Bean tree</td>
<td>Castanospermum australe</td>
</tr>
<tr>
<td>Birbir</td>
<td>Lantern tree</td>
<td>Hernandia nymphaefolia</td>
</tr>
<tr>
<td>Blak wud</td>
<td>Black wood</td>
<td>Diospyros samoensis</td>
</tr>
<tr>
<td>Blakwam</td>
<td>Tree fern</td>
<td>Cyathea lunulata</td>
</tr>
<tr>
<td>Blu wota</td>
<td>Rosewood</td>
<td>Pterocarpus indicus</td>
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<td>blue nafier</td>
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<td>blue nator</td>
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<td>boiboi</td>
<td>Bongasu</td>
<td>Boro</td>
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<tr>
<td>Name</td>
<td>Type</td>
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<td>lai tree</td>
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<td>lau fruit</td>
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<tr>
<td>Lif blong pig</td>
<td>Devil's Ivy</td>
<td>Epipremnum pinnatum</td>
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<td>Likeo tree</td>
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<tr>
<td>Malagbor</td>
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<td>Malakave</td>
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<tr>
<td>malsas tree</td>
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<tr>
<td>Manggo</td>
<td>Mango</td>
<td>Mangifera indica</td>
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<tr>
<td>Markumo</td>
<td>Metrosideros</td>
<td>Metrosideros collina</td>
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<tr>
<td>Mas tree</td>
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<tr>
<td>Melek tree</td>
<td>Milk tree</td>
<td>Antiaris toxicaria</td>
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<tr>
<td>memevo</td>
<td>Begonia</td>
<td>Begonia vitiensis</td>
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<tr>
<td>Meriri</td>
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<tr>
<td>Mill tree</td>
<td></td>
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<tr>
<td>Nabalango</td>
<td>Fig tree</td>
<td>Wild fig</td>
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<tr>
<td>Nabanga</td>
<td>Banyan tree</td>
<td>Ficus glandifera</td>
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<tr>
<td>Nabange</td>
<td>Football fruit</td>
<td>Pangium edule</td>
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<tr>
<td>Nabangura</td>
<td>Beach mahogany</td>
<td>Calophyllum inophyllum</td>
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<td>Nakatambol</td>
<td>Dragon plum</td>
<td>Dracontomelone vitiense</td>
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<td>Nakauka</td>
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<td>Nakavika</td>
<td>Malay rose apple</td>
<td>Syzygium malaccense</td>
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<td>Naleanga</td>
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<td>Namalaus</td>
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<td>Garuga floribunda</td>
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<td>Namambe</td>
<td>Tahitian chestnut</td>
<td>Inocarpus fagifer</td>
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<td>Namatal</td>
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<td>Keinhovia hospita</td>
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<td>nanaga tree</td>
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<td>nanatu</td>
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<tr>
<td>Nandai</td>
<td>Wild nutmeg</td>
<td>Myristica inutilis var.papuana</td>
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<tr>
<td>Nandao</td>
<td>Pacific litchee</td>
<td>Pometia pinnata</td>
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<tr>
<td>Nangai</td>
<td>Canarium nut</td>
<td>Canarium nut</td>
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<tr>
<td>Nangalat</td>
<td>Nellet tree</td>
<td>Dendrocnide latifolia</td>
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<td>Nangol</td>
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<td>Natangura</td>
<td>Sago Palm</td>
<td>Metroxylon warburgii</td>
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<td>Natapoa</td>
<td>Indian almond</td>
<td>Terminalia cattapa</td>
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<td>Natongtong</td>
<td>Corky stilt mangrove</td>
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<td>Moluccan ironwood</td>
<td>Intsia bijuga</td>
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<td>Natoyak tree</td>
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<td>Natsetse</td>
<td>Croton</td>
<td>Codiaeum variegatum</td>
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<tr>
<td>Naus</td>
<td>Great hog plum</td>
<td>Spondias</td>
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<td>Navalval fruit</td>
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<td>Navara</td>
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<td>Navarange</td>
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<tr>
<td>Navele</td>
<td>Cut nut</td>
<td>Barringtonia procera</td>
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<td>Navele blong</td>
<td>Fish poison tree</td>
<td>Barringtonia asiatica</td>
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<td>Oktri</td>
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<td>Palm tree</td>
<td>Clinostigma harlandii</td>
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<td>pico flower</td>
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<td>Pinut tri</td>
<td>Sterculia vitiensis</td>
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<td>Popo</td>
<td>Papaya</td>
<td>Carica papaya</td>
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<tr>
<td>Red bin tri</td>
<td>Coral wood</td>
<td>Adenanthera pavonina</td>
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</tr>
<tr>
<td>Red wud</td>
<td>Java cedar</td>
<td>Bischofia javanica</td>
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<tr>
<td>Reo</td>
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<tr>
<td>Samblong</td>
<td>Java plum</td>
<td>Syzygium jambolanum</td>
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<td>sermala</td>
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<tr>
<td>Shark fruit</td>
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<tr>
<td>Soft wood</td>
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<tr>
<td>sowa flower</td>
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<tr>
<td>Stinkwood</td>
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<td>Dysoxylum gaudichaudianum</td>
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<tr>
<td>strong wood</td>
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<tr>
<td>Tairak</td>
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<td>Tamanu</td>
<td>Tamanu</td>
<td>Calophyllum neo-ebudicum</td>
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<td>tangto</td>
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<td>Tarara (red fruit)</td>
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<td>topnan</td>
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<tr>
<td>Turtle tree</td>
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<tr>
<td>Twin fruit</td>
<td>Berrywood</td>
<td>Ochrosia elliptica</td>
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<td>Velavel</td>
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<tr>
<td>Vines/Rope</td>
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<tr>
<td>voruki tree</td>
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<td>vorvor fruit</td>
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<td>vovin natamat</td>
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<tr>
<td>vuruki tree</td>
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</tr>
<tr>
<td>Wael apol tri</td>
<td>Wild apple</td>
<td>Corynocarpus similis</td>
</tr>
<tr>
<td>Wael kava</td>
<td>Wild kava</td>
<td>Macropiper latifolium</td>
</tr>
<tr>
<td>Wael natapoa</td>
<td>Samoan tropical-almond</td>
<td>Terminalia samoensis</td>
</tr>
<tr>
<td>Waet wud</td>
<td>Whitewood</td>
<td>Endospermum medullosum</td>
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</tr>
<tr>
<td>wenut</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wild nut</td>
<td>Cut nut</td>
<td>Barringtonia edulis</td>
</tr>
<tr>
<td>wild palm tree</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wild sablong</td>
<td></td>
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</tr>
<tr>
<td>Wokam</td>
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<tr>
<td>Worwor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>wumleb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red wood (wild navel)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wild blueberries</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C: Maps created by Alison Derry using data from the Banks Island survey