

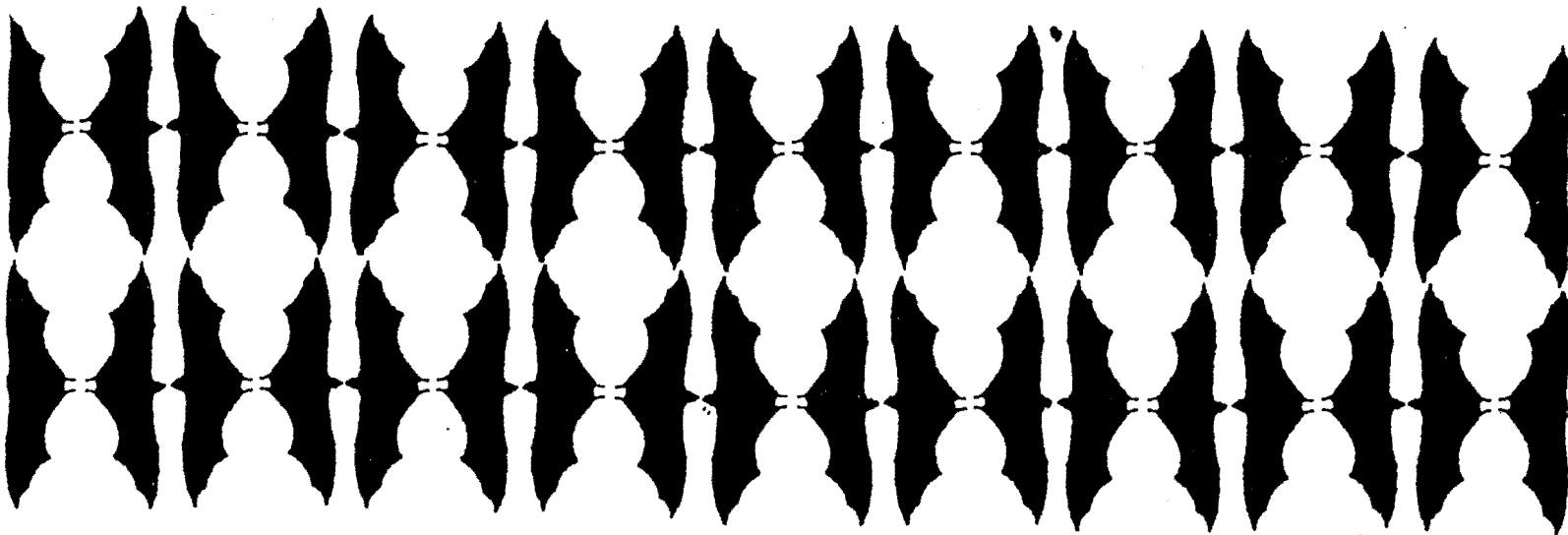
FRUIT BAT STUDIES: *PTEROPUS SAMOENSIS* AND *PTEROPUS TONGANUS* 1995-1996.

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SUMMARY

Pteropodid bat populations have declined within the recent past from commercial hunting and as the result hurricanes. Population monitoring in American Samoa during 1995-1996 indicates approximately 1,000 *Pteropus samoensis* live in the territory. Surveys in Western Samoa show that the low numbers reported after the 1991 hurricane have not increased. The *P. tonganus* population is slowly increasing and colonies now roost places that are very difficult for people to get to.

INTRODUCTION

The Samoan flying fox, *Pteropus samoensis samoensis*, is a moderate sized fruit bat of the Samoan archipelago. Unlike most other bats in the genus *Pteropus*, *P. samoensis* roosts singly in mature native forest and is active both nocturnally and diurnally. During the day, bats are highly visible as they soar above valleys and ridge tops. The white collared or Tongan flying fox, *P. tonganus* is similar in size and difficult to distinguish in flight from *P. samoensis* (Craig, Trail et al. 1994). It is easy for inexperienced observers to mistake the identity of flying bats and to attribute inflated population numbers to *P. samoensis*.

In response to declines of *P. samoensis* and *P. tonganus* after Hurricanes Ofa and Val, surveys were initiated by DMWR to monitor the population size. This report covers research conducted 1994-1996. The goal was to determine the population status of bats in American Samoa and to assess the recovery of populations in Western Samoa after hurricane Ofa and Val. Home range foraging area and activity patterns were examined by radio telemetry and field observations. Mating behaviors and the timing of reproduction was monitored in the field. Roost movements of *P. tonganus* 1986-1996 were investigated as part of the long range monitoring program. Populations of both Pteropodid species on Tutuila, Manu'a islands and Western Samoa are considered one continuous population although there is no information whether the populations on each island are distinct and non-interbreeding population or if, in fact, there is movement

between the islands. The amount of inter-island movement by fruit bats is being measured examining differences in the mitochondrial DNA of individuals.

METHODS

Population status

Population surveys for *P. samoensis* on Tutuila island were conducted monthly at six sites (Fig. 1; Appendix 1). Surveys began at first light and continued for the next two hours. Data were collected during eight ten-minute sample periods, separated by five minute breaks, for a total of eight samples at each site per month. Zeiss 10x40 and 10x50 binoculars are used to distinguish between *P. samoensis* and *P. tonganus*. All survey areas were of valleys with an unimpeded forest view. Surveys were conducted only when there was little or no rain and wind. A map was drawn of each site dividing the valley into sections that followed the topography. Whenever a bat was observed in flight it was followed until it roosted, was lost within the vegetation, or flew out of the area. The valley section where each bat was lost from view was noted. Multiple individuals were counted from a section only if more than one bat was seen simultaneously or bats were observed in widely different parts of the same section. Consequently, survey counts give a minimal number of bats observed. The area of each survey was determined from a USGS survey map and the mean number of *P. samoensis* observed per hectare was calculated. An estimate of the population on Tutuila island was obtained by expanding the combined means from all survey sites to the forested habitat of the island. The amount of variation possible in any one daily survey was investigated during 15 consecutive days at the Leone site (Fig. 1) in November 1996. The same protocol was for these surveys as for monthly surveys.

A survey of the Manu'a islands was conducted 1994 and 1996 at six sites on Ta'u (Fig. 2), three sites on Ofu and four sites on Olosega (Fig. 3 and Appendix 1). The methodology for these surveys follows the 1992 DMWR protocol, four 20 minute count periods are used with a 10 minute break between counts. Counts are begun either at first light or approximately 3 hours before dark.

A survey of Western Samoa was done in July 1995. We did a single 30 minute count at each of site 17 sites on 'Opolu (Fig. 4) and 6 sites on Savai'i (Fig. 5) previously surveyed by Wilson and Ebring (1992, Appendix 1).

Pteropus samoensis has been described as active throughout the day by several authors (Cox 1983) (Craig, Trail et al. 1994) (Wilson and Engbring 1992). If this is indeed true, population surveys need not be conducted at dawn. We investigated the diurnal activity of *P. samoensis* by counting the number of bats in flight in the Amalau valley during ten minute periods, at ten minute intervals from dawn until dusk over five day periods in January, March, July and October 1995 (Fig. 1).

The *P. tonganus* population was monitored by quarterly visits to all known communal roosts on Tutuila. *Pteropus tonganus* typically roosts in large aggregations that remain at the same site for several months or years. We tried to observed all known colonies within a week. Counts are made both on land (from roads and other vantage points) and from the ocean in a small boat. Daytime population estimates at roosts were augmented by exit counts at dusk when bats leave the roost to forage. Because of dense vegetation of some roosts, these exit counts give us a better estimate of *P. tonganus* populations than daytime roost counts.

Observations

Observations of roosting *P. samoensis*, aggressive or territorial behaviors (attacks, chases, bites), were made during the 288h of monthly surveys (Altmann 1974). Copulations, mating behavior and scent marking were observed opportunistically throughout the day. Female *P. samoensis* carrying young were noted during monthly survey as pups were clearly visible on females. Very young pups appear about the size of a walnut, a small round lump, older pups were classed as 2/3 or 3/4 of adult size.

During *P. tonganus* roost counts 1989-1996, the number and species of trees in 29 colonial roosts was noted. Slope and distance to the nearest house was computed using US geological survey maps.

Captures

Bats were caught to obtain samples for genetic testing, for radio telemetry and to obtain size data. Bats were captured by setting mist nets (210 denier/2 ply) in or around fruiting trees. Two methods of setting of nets were used. 1) A line was thrown over a tree or over a high branch and one end of the net was attached to the line. After the net was raised, a telescoping fiberglass pole (Hastings Non-conductive Measuring Rod, Forestry Suppliers) was erected at a distance from the tree and the loose end of the net was secured to the pole. 2) Using Munz's (1991) technique nets were restrung so that they hung vertically rather than horizontally. A slingshot was used to shoot a line over a high branch allowing the net to be pulled into the tree.

We recorded body weight, forearm length, and reproductive condition for each bat captured or brought into DMWR. Age was estimated from the degree of toothwear. Juveniles had extremely sharp canines and molars, and did not have completely ossified finger joints. Young adults had sharp canines and molars. Mature adults showed signs of wear on molars, blunted or broken canines. Old adults had well worn molars, canines were frequently broken and the break had been worn smooth. Three neonatal *P. tonganus* were brought into DMWR in 1996-1997. Body weight and forearm length were measured every second or third day until they were released.

A 0.5 cc blood sample or biopsy puncture of wing tissue was collected from all bats. Plasma and red blood cells were separated and stored in blood preservative. Wing punches and tissues were collected from dead bats, (heart, liver, kidneys, and muscle) preserved in DMSO. Bats on the Manu'a islands and Fiji were netted specifically for this project. Mitochondrial DNA is being analyzed by Dr. G.F. McCracken, University of Tennessee.

Radio telemetry

Radio telemetry was used to document the home range, foraging area, and activity patterns of *P. samoensis*. A 7g Holohill radio (model RI-2) was attached as a collar by a section of tygon tubing and secured with cotton crochet yarn threaded through both the radio and the tubing. The cotton yarn rotted after ca 2 months, releasing the radio from the bat. The location of radio tagged bats was monitored continuously day and night with Telonics receivers and H antennas. The location of the bats was noted at 10-15 minute intervals and plotted on a map of the island.

Hunter surveys

As part of an interview survey of perceived changes in local fisheries, one hundred people were interviewed in on Tutuila between August 1994 and April 1995 (A. Green personal communication). One to four people from 50 of the 64 villages on Tutuila were interviewed. Interviews were conducted in Samoan in the home of the villagers as free-form conversation. Each person was asked how many dead bats they had seen in the village within the past year. The interviews did not distinguish between *P. samoensis* and *P. tonganus*.

RESULTS

Pteropus samoensis

Population status

The Samoan bat, *P. samoensis*, was most frequently seen in the mature native forests of Tutuila. Greatest number of individuals seen repeatedly on the north coast in the U.S. National Park of American Samoa, between the villages of Afono and Vatia and along the Alava ridge. A small number of bats were seen regularly in poorly forested areas where hurricane damage has reduced the forest to low secondary growth. Bats were not observed in the remnant lowland forest at Ottoville, in the Tafuna plain.

The number of *P. samoensis* observed during morning surveys in 1996 decreased by 70 sightings from the 1995 surveys (Table 1). Using an estimate of 69.9 km² of upland forest habitat taken from (Cole, Whitesell et al. 1988), the number of *P. samoensis* on Tutuila during for 1995 was estimated at 924 and in 1996 at 854. The survey data for 1995-1996 is given in Appendix 2.

Table 1. *Pteropus samoensis* surveys on Tutuila, 1995-1996.

Tutuila sites	Area surveyed km ²	1995 bats/km ²	1996 bats/km ²	95+96
★ Amalau	0.2139	47.57	39.22	→ 45.3
Maloata	0.3403	8.59	12.11	
Aoa	0.613	5.52	3.96	
Leone	0.2043	10.55	11.65	
Malaeimi	0.939	1.98	2.18	
Nu'uuli	0.5757	3.55	3.75	
		22.76	17.96	33.55 = 4.71 bats/km ²

Differences among the six sites were pronounced during both years (Fig. 6). Amalau valley had the largest number of bats as well as the greatest annual variation. The Malaeimi valley site was the largest area but consistently had the least number of bats. This valley is actively hunted. At Amalau and at Leone, bats moved through the area using the ridges as corridors. The number of bats using these sites as home range areas may be much less than the number of bats observed during morning surveys. At Nu'uuli the low bat densities may be directly due to poor forest cover and the large areas of secondary growth. The 15 surveys made at the Leone site had a range of 19-32 bats observed during all eight count periods any one day (Fig. 7). Survey data is given in Appendix 3.

Manu'a surveys

Surveys done in 1994 and 1996 show little change in the small population of *P. samoensis* on the Manu'a islands (Table 2). Based on our hiking and observations the

current forested area of the Manu'a islands was adjusted from Cole, et al (1988) to ca half of the forested area prior to Hurricane Tusi in 1987. Survey data is given in Appendix 4.

Table 2. Manu'a *Pteropus samoensis* surveys

	Total Upland Forest Area km ²	Survey Area km ²	1994	1996
Ta'u	9.29	1.07	76 71	42 39
'Ofu	1.63	0.25	10 40	6 24
'Olosega	.76	0.21	19 90	26 123
All Manu'a	11.68	1.52	105	74

Western Samoa

The small number of *P. samoensis* seen on 'Opolu (Table 3) has not changed since the 1993 surveys done by Wilson and Ebring (1993). Much of the remaining forest of 'Opolu is secondary growth or coconuts. On Savai'i, we found bats only in the Asau Forestry Reserve where we were able to get into a large tract of forest.

Table 3 Western Samoa surveys 1995

	Survey Area km ²	Aug 1986* Bats/ km ²	Aug 1989* Bats/ km ²	Jan 1993* Bats/ km ²	July 1995 Bats/ km ²
'Upolo	27.52	2.1	0.83	0.18	0.21
Savai'i	9.93	1.5	0.7	0.6	1.1

*surveys by Wilson and Ebring

Diurnal Activity

Pteropus samoensis were active throughout the day during five days of observations in January (Fig. 8). While still active all day, fewer bats were seen in flight during the March counts. A distinct mid-day slump in activity was evident in June although numbers of bats in flight at dawn and dusk remained high. In October, the mid-day decrease in activity had shifted to early afternoon. These results show that *P. samoensis* is active diurnally however the number of bats observed flying at different times of the day varied throughout the year.

Reproduction

Copulations were observed from August through December (Fig. 9). All copulations were between a single male and female although several females had a dependant juvenile. Pairs are easily visible during October and vocalizations that may be pair-bonding were common. Young hung close to the mating pair and later hung on the female, wrapped by wings. Males had no interaction with the juvenile.

Pteropus samoensis were observed carrying young in all months of the year ^{except Feb} (Fig. 9) although most young were seen March-September. Young bats, distinguished by their smaller size and clumsy flight, were first observed flying in June. Large juveniles were commonly seen hanging on adult females in October. It is likely that the young bats were still nursing.

Territorial behaviors

We observed 13 instances of scent marking by 11 males and two females. All but four observations were between September and December, when mating activity was most obvious. Bats rubbed head and neck over branches, fruit, or leaves. Males frequently marked several times, at different locations in the same tree or marked a series of trees.

Chases were commonly seen when one bat flew out from a roost in or near a fruiting tree, pursuing a bat that had flown close by. Of the 167 chases observed during morning surveys 1995-1996, 23 ended when the defending bat bit the interloper on the feet or back. Once the interloper dropped a fruit when bitten. We observed three bats grappling with their feet and falling through the air for several seconds before breaking apart. In 23 instances, the defending bat tried to bite the interloper but wasn't successful and in 26 chases the defending bat ended the chase without attempting to bite. Chases lasted between 1-4 minutes. We tried to follow where both bats went after a chase but most were lost from view before they roosted. We were able to follow 34 defending bats back to the same location they had been roosting before the chase.

Pteropus samoensis that were roosting in a fruiting tree defended the tree from other bats by clapping their wings together. We observed seven instances where a bat repeatedly wing clapped when another bat approached or roosted nearby. Bats also flicked their wings in a rapid movement partially open then closed, when another bat roosted nearby. In most of the observations of wing clapping, bats also flicked their wings.

Bats followed after other bats in a slow flight that was not a chase. 'Follows' typically ended when both disappeared into the forest. Most follows were seen during August and October (Fig. 10). In August, smaller juvenile bats followed adults, presumably the mother. During October, when pair-bonding was occurring, males followed females. We observed one lengthy 'follow' that ended when both bats landed in a tree and mated.

Captures

A total of 19 *P. tonganus* and 2 *P. samoensis* were captured in mist nets. Three injured, one dead adult *P. tonganus*, and three neonatal young were brought into DMWR by the public. We obtained additional size data for *P. samoensis* from the collections of the American Museum of Natural History, The National Natural History Museum, and The Museum of Comparative Zoology. Adult *P. samoensis* and *P. tonganus* were found to be similar in forearm length and body weight (Fig. 11). The growth rate for three neonatal *P. tonganus* is presented in Fig. 12. Neonatal bats weighed ca 50-60g and had a forearm length ca 60mm. Juveniles began to fly between 50-60 days old but were not capable fliers until 80-90 days old. This result is consistent with our observations of the first young *P. samoensis* flying ca three months after pups were first seen.

Radio Telemetry

Two small adult male *P. samoensis* caught in the Amalau valley were fitted with radio collars and followed November 1995-February 1996, until the collars fell off. As the previous attempts at radio tracking *P. samoensis* yielded little information, the locations of the two bats was monitored both night and day. Both bats returned before dawn to the same home range, or roost, during the two months they were monitored. The home range

of the two bats covered ca 7 - 10 ha. The bats moved within the home range during the day between a small number of trees although they did not fly long distances (Fig. 13). Frequency of movement increased in late afternoon as the bats began to forage. During 150 hours of monitoring one individual moved more during the night than during the day (Fig. 13).

Roosting Patterns and Group Size

Most observations of roosting *P. samoensis* were of a single male with no other individual in the same tree or visible in nearby trees. Single males were most commonly seen hanging from dead branches in ridge top trees. A smaller number of females were also observed on dead branches. Most observations of bats roosting on dead branches were in the first two hours after dawn. Bats appeared to prefer exposed sites, at least in the early morning. When sunlight first fell upon roosting bats, they spread their wings and faced into the sun. Bats folded their wings after several minutes and moved into the shade when temperature increased. Bats were not observed on dead branches on windy or rainy days or during the middle of the day.

Roost branches were used repeatedly by same animal. An mature male *P. samoensis*, distinguished by a broken left wingtip, roosted on the dead branches in a *Syzygium inophylloides* in the Amalau valley. This individual was observed roosting in the same location from January 1995 – April 1997. The bat moved between a small number of trees throughout the day (Table 4).

Table 4. Roosting observations of a male *Pteropus samoensis*, Oct. 13, 1995

Time Observed	Location
622-703	Top of <i>Inocarpus fagifer</i>
806-817	Dead <i>Termanalia</i>
1018-1034	Top of same <i>Inocarpus fagifer</i>
1139-1300	Dead branch in <i>Syzygium inophylloides</i>
1352-1400	Same branch in <i>Syzygium inophylloides</i>
1611-1750	Top of same <i>Inocarpus fagifer</i>

Single females were typically observed within the tree canopy rather than exposed in the sun. Although we have fewer observations of roosting females, they also used a series of roosts repeatedly. Most observations of two bats were of a female with volant young. Adult sized young were distinguished from other bats only after they crawled onto the female and hung covered by her wings. Male-female pairs were most frequently seen between August and November.

Six different aggregations of *P. samoensis* varying in size from 6 to 60 individuals have been seen (Table 5). Groups were transitory lasting no longer than a few days. Both males and females were seen in three of the groups.

Table 5. Groups of *P. samoensis*

Dates	Location	# Individuals	Sex
Dec 1995?	Amalau	6	Males and females
May 13, 1996	Amalau	11	
April 1997	Amalau	10	
October 10-11, 1996	Amalau	50-60	Males and females
Feb. 1997	Sita Bay	5	

10/20/95 Old Ridge
10/20 Amalau = 21
11/5 " = 6
5/13 = 6

A large group of ca 60 bats was present in the Amalau valley for at least 2 days in October 1996. *Pteropus samoensis* landed in the trees within the first hour after dawn at the south-eastern side. Approximately 80 *P. tonganus* roosted in trees adjacent to the *P. samoensis*, after most *P. samoensis* had roosted. A second roost of ca 100 *P. tonganus* was ca 300m from the *P. samoensis*. The *P. samoensis* began to leave the roost at midday, all had departed by 1600h. We observed no interactions among the roosting bats during the day. Fights between *P. samoensis* and *P. tonganus* occurred when the *P. tonganus* arrived in the morning and tried to displace some of the *P. samoensis*. A number of *P. samoensis* relocated to other branches but none flew from the roost trees.

Pteropus tonganus

Population status

The *P. tonganus* population on Tutuila has increased steadily to ca 6,000 individuals from the population low of ca 1,500 individuals following Hurricane Val in 1991 (Fig. 14).

We located two large *P. tonganus* roosts on Ta'u, one on Lepue crater, the other in a small crater near Judds crater. Approximately 1,000 individuals were counted at each roost although the counts were done several months apart. It is likely that we were counting the same individuals that had moved. A single roost of several hundred bats was present on Ofu and second roost was located on Olosega but neither of these roosts is in a location where we can see into it or count bats as they exit. It is likely that the *P. tonganus* move between the Ta'u, Olosega and Ofu as fruit becomes available in different locations.

Roosts

Between 1987-1996 *P. tonganus* colonies were observed at 6² different locations (Table 6). Nine roosts were used for five or more years although only one roost, at Olomoana Mountain, was used each year. The most frequently used sites included the roosts at the greatest distance from human habitation (Siliaga point) and the steepest slope (Nu'uomanu rock) but not the highest elevation (Mt Pioa). All of the 13 roosts used in 1996 were far from human habitation or in accessible locations (Table 6). Three inland roosts are at high elevations (278m, 442m, 167m). The one roost on the south coast was in a protected site at Fagatele bay. All other roosts were on the north coast of Tutuila on steep slopes or cliff faces above the ocean (Fig. 15).

A total of 22 tree species were used as roosts (Table 7). Trees used as roosts were common forest species that attain large size with the exception of *Hybiscus tiliaceus*, a secondary growth species utilized at two sites. Eighteen species (78%) of trees used to roost in were also used for food.

Table 7. Tree species used by *Pteropus tonganus*. Parts eaten F = flowers, L =leaves, N =nectar and flowers; (*)= DMWR observation, (1) (Cox 1983), (2) (Mickleburgh, Huston et al. 1992), (3) (Rainey, Pierson et al. 1995).

Species	Samoan Name	Parts Eaten	# Roosts	# Trees
<i>Barringtonia asiatica</i>	futu	F, N (*)	15	26
<i>Calophyllum inophyllum</i>	fetau	F (*)		20
<i>Dysoxylum maota</i>	maota	F (1)	12	37
<i>Erythrina variegata</i>	gatae	L, N (*)	12	17
<i>Rhus titiensis</i>	tavai	F (*)	9	25
<i>Alphitoni zizypoides</i>	toi	F (*)	9	45
<i>Ficus obliqua</i> and <i>F. prolixa</i>	aoa	F (*)	8	10
<i>Planchonella samoensis</i>	mamalava	F (*)	6	15
<i>Myristica spp.</i>	'atone		5	17
<i>Dysoxylum samoense</i>	tufaso	F (1)	4	5
<i>Canaga odorata</i>	moso'oi	F (*)	2	30
<i>Syzygium inophylloides</i>	asi	F, N (*)	2	5
<i>Pisonia grandis</i>	pu'a vai		2	3
<i>Fagraea berteriana</i>	pualulu		2	2
<i>Hibiscus tiliaceus</i>	fau		2	2
<i>Diospyros samoensis</i>	'au'aui	F (*)	1	1
<i>Termanalia richii</i>	malili	F (4)	1	1
<i>Inocarpus fagifer</i>	ifi	F, L (*)	1	1
<i>Carnarium vitiense</i>	ma'ali	F (3)	1	1
<i>Neonuclea forsteri</i>	afa		1	1
<i>Artocarpus altilis</i>	ulu	F (*)	1	1
<i>Garuga floribunda</i>	vi vao	F (3)	1	1
<i>Stirculicia fanaio</i>			1	1

Within the roost area, bats frequently moved to different trees. At 14 sites where data was collected at consecutive visits, bats were observed hanging in the same tree species (n=6). Presumably, the same trees were used repeatedly.

Genetics

Very high levels of genetic diversity and high levels of heterozygosity were found in the *P. tonganus* samples. Given the small number of samples, the amount of genetic diversity is impressively large, with one locus showing 7 alleles and the other locus 4 different alleles. Allele frequencies for locus #1: $f(A) = 0.08$, $f(b) = 0.33$, $f(c) = 0.25$, $f(d) = 0.08$, $f(e) = 0.08$, $f(f) = 0.08$, $f(g) = 0.08$. Allele frequencies for locus #2: $f(a) = 0.04$, $f(b) = 0.50$, $f(c)$

0.50, $f(c) = 0.38$, $f(d) = 0.08$. The average heterozygosity of *P. tonganus* at these loci is $H = 78\%$ (78% of the loci examined in these bats were in the heterozygous state).

Hunting

15% of people interviewed (15 people from 12 villages) said they knew of bats that had been brought into their village within the past year. The number of bats varied from "a few" to "many". No distinction was made between *P. samoensis* and *P. tonganus*.

In October 1994 "several hundred" *P. tonganus* were shot at the Olomoana mountain roost and eaten by the line crew of the American Samoan Power Authority after a road had been built to the top of the mountain. The colony abandoned the roost site and split into smaller groups. One group of ca 150 bats roosted briefly on Lemafa ridge, between Aoa and Masausi. Olomoana mountain was not used as a roost until early 1995. This instance of roost abandonment seems to be a direct result of the hunting.

Few instances of bat hunting have been investigated by DMWR and no one has been apprehended with dead bats. Gunshots that are reported by the public are impossible to pinpoint after the fact and are frequently attributed to killing pigs. Several people we have spoken with readily acknowledge they shoot bats claiming their 'right' to hunt superceded the law.

DISCUSSION

The current *P. samoensis* population on Tutuila is larger than previously estimated by DMWR however the number of bats seen during surveys has not increased during the past two years. The larger population size may be a result bats emigrating from other islands to Tutuila after the hurricanes but it is likely that the earlier population estimates of by Craig, Trail et al. (1994) were low. When it is completed, population analysis project using RAPD analysis of DNA sequences should be able to identify the frequency of inter-island movement. A very small population is present on Manu'a. The 1995 survey of Western Samoa found no change in the population since the 1993 surveys done by

Wilson and Ebring (1993). Although our 1995 surveys suggests that the population has not increased we visited only a few sites on Savai'i. As with the Manu'accounts, surveys are done too infrequently to give a fair estimation of the population.

A great deal of effort has been put into *P. samoensis* surveys but there are a number of problems with interpreting the data. During any 10 minute period, bats are seen 1) moving through the survey area, 2) moving with the area, roosting for short times then flying to a different roost, 3) entering the area, and 4) leaving the area. During different counts some of the same individuals are seen repeatedly and it is difficult to distinguish new individuals from those that have left the area. The number of bats seen during any count depends on how frequently bats fly. Undercounting the number of bats because they do not fly is also a possibility. Radio tracking showed that some bats have returned to their home range well before dawn and would not be counted during a survey. Craig, Trail et al. (1994) recognized undercounting as a potential problem and doubled the number of bats seen to account for the any non-flying individuals.

The *P. tonganus* population shows a good start at recovery from the low numbers after Hurricane Val. Before the hurricanes colonies and several years after, colonies were found at sites that were difficult for people to reach, such as on cliff faces that drop into the ocean or in forested ravines. In the years immediately following the hurricanes, colonies changed roost sites frequently and some roosts were located very close to people. It is likely that *P. tonganus* roost at locations where they will have the least amount of contact with people. Although we have evidence that hunting caused bats to abandon one roost, other roosts that were located near people, such as Olavalu crater, have been deserted. In Tonga, where hunting bats is uncommon, there are large *P. tonganus* roosts on the main road and within the village of Kolovai. In Suva, Fiji, one colony lives in the front yard of a house on Queen Elizabeth Drive, a major thoroughfare. Bats are protected from hunting at both of these roosts. It seems reasonable to assume that the isolated locations of *P. tonganus* colonies is in response to human disturbance and hunting.

The two pteropodid species differ in a number of ways that make *P. samoensis* slower to recover from hurricanes and more vulnerable to hunting than *P. tonganus*. While *P. tonganus* reproduces throughout the year, *P. samoensis* has young only once a year, between April and July. As pups remain with the mother past the time when mating occurs, bats probably do not mate until at least one year old. This delay of reproductive age is found in all other pteropodid species that have been studied (Pierson and Rainey 1992). Both *P. samoensis* and *P. tonganus* defend fruiting and flowering trees. Aggressive behaviors and territoriality seems to be in response to foods but may also be directed at rivals during mating. *Pteropus samoensis* does not home from other individuals, suggesting that the population would not be limited by inter-specific aggression.

RECOMMENDATIONS

The population monitoring programs for both bat species should be continued. We are collecting data that is extremely valuable as a long range management tool. The large amount of variation in the data for the 1992-1994 surveys, when many people observed bats, has been eliminated by having one person responsible for the bulk of the field work. The methodology is now well established and, hopefully, will be followed in the future.

Population analysis by genetic is incomplete. To finish the project, more samples from Manu'a and Western Samoa are needed. The easiest time to capture bats is in July when they feed on kapoc, *Ceiba pendantra*, flowers. An effort should be made next July to net bats in Ofu village and in Tafua Tai, Savai'i.

We are slowly getting good telemetry data for both species. Mature bats are more difficult to catch than juveniles but as the population increases they should be easier to net. More bats of both sexes should be followed, in particular we nothing of the behavior of adult females.

The daytime flight of *P. samoensis* make them an easy target for a hunter. Illegal hunting continues in the territory without any significant effort to limit it. The slow reproductive rate and the small but persistent hunting pressure may be keeping the population at its present level. Many people are unaware of the distinction between the two species and see the increase in the *P. tonganus* population as a signal to hunt *P. samoensis*. Without some type of enforcement and an increased public awareness campaign, the *P. samoensis* population will continue to remain too low to be out of danger of extinction.

Acknowledgements

Chris Solek and Ailao Tualelei helped with field work. *Pteropus samoensis* specimens were measured by the curators of the American Museum of Natural History, The National Natural History Museum, and The Museum of Comparative.

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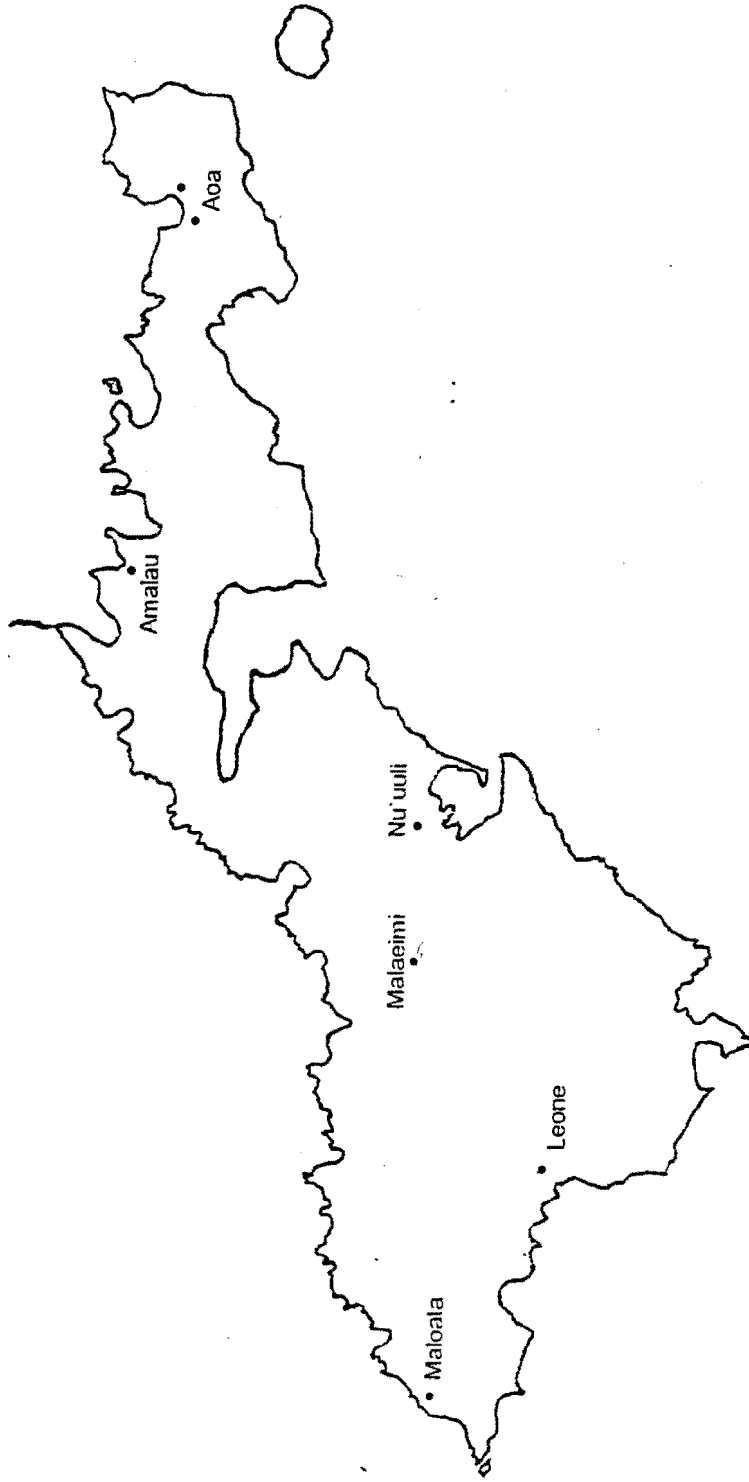
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Fig. 1. *Pteropus samoensis* survey sites, Tutuila island.



The map shows Ta'u Island with the following features:

- Coastline:** Cape Papetele (top left), Tudu Point (top right), and various smaller points like Lata Pt, Lata Pt, and Lata Pt.
- Interior Features:** Lata Mountain (central peak), Judds Crater (top left), and various creeks and points.
- Labels:** TA'U I S L A N D, Lata Mountain, Judds Crater, and various geographical names.
- Scale:** A scale bar is located at the bottom left, indicating distances in miles.
- Orientation:** The map is oriented with the island's coastline on the left and right, and the interior features in the center.

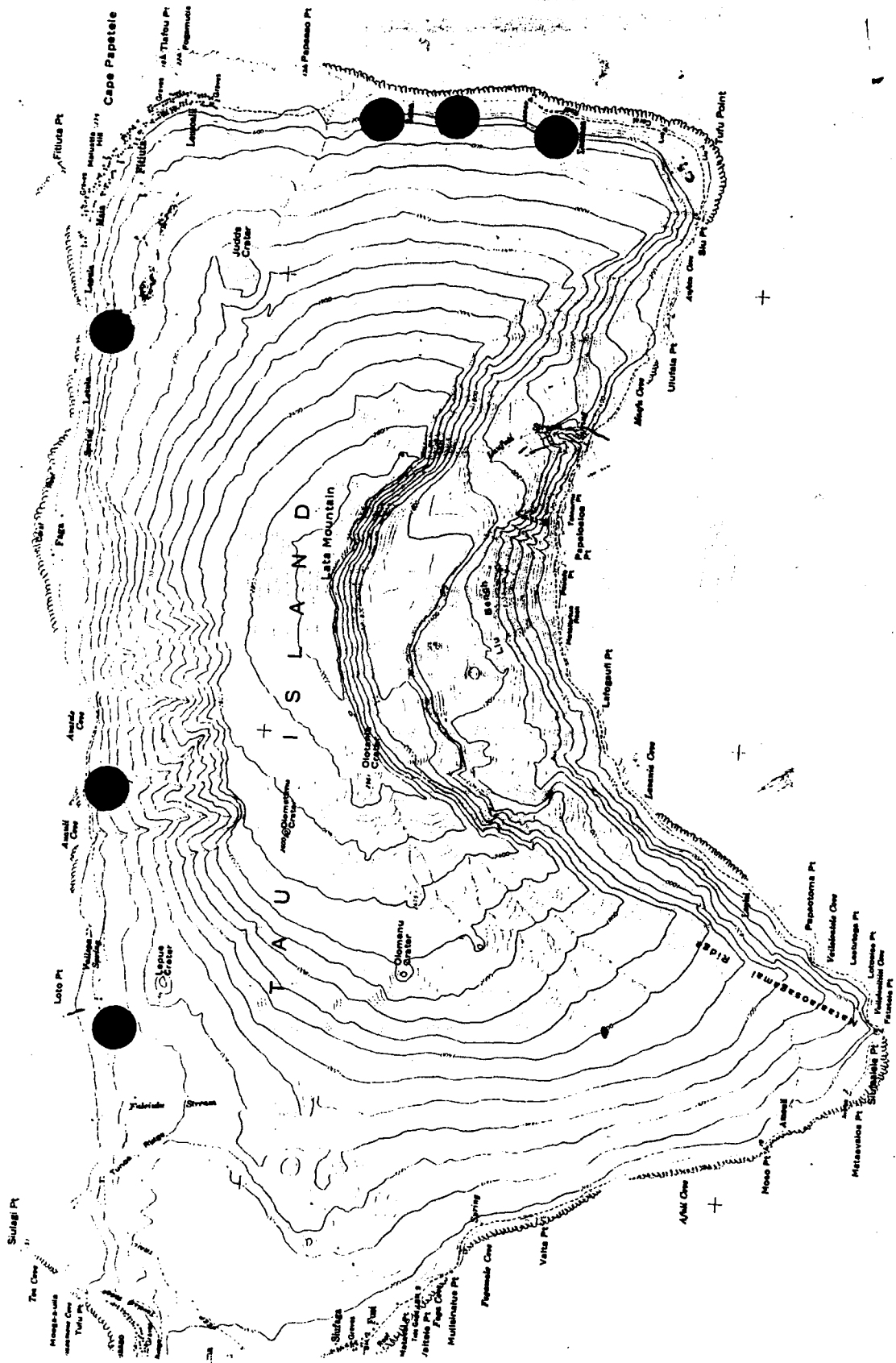


Fig. 3 *Pteropus samoensis* survey sites, 'Ofu and 'Olosega islands

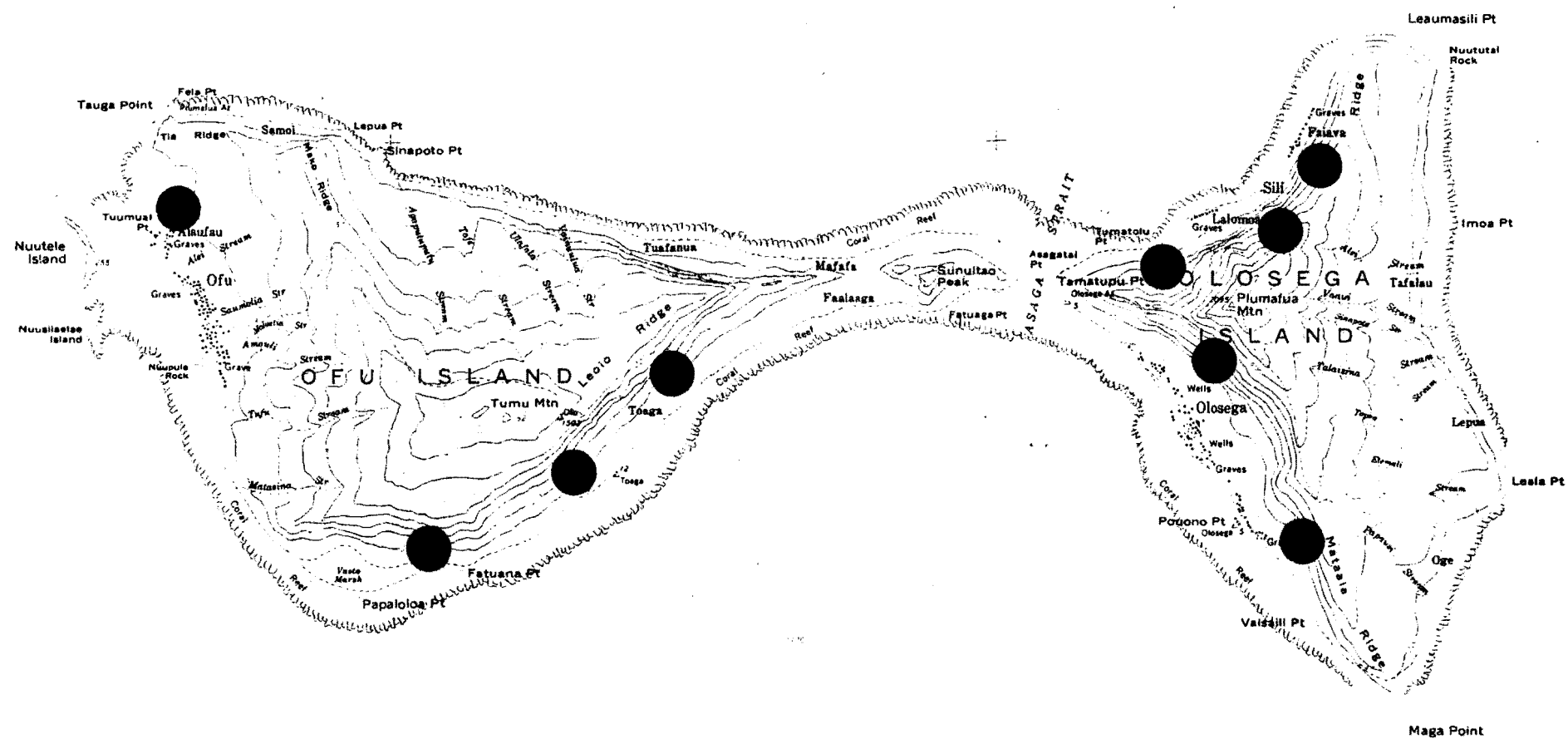


Fig. 4. *Pteropus samoensis* survey sites on 'Opolu Island, Western Samoa



Fig. 5. *Pteropus samoensis* survey sites on Savai'i Island, Western Samoa

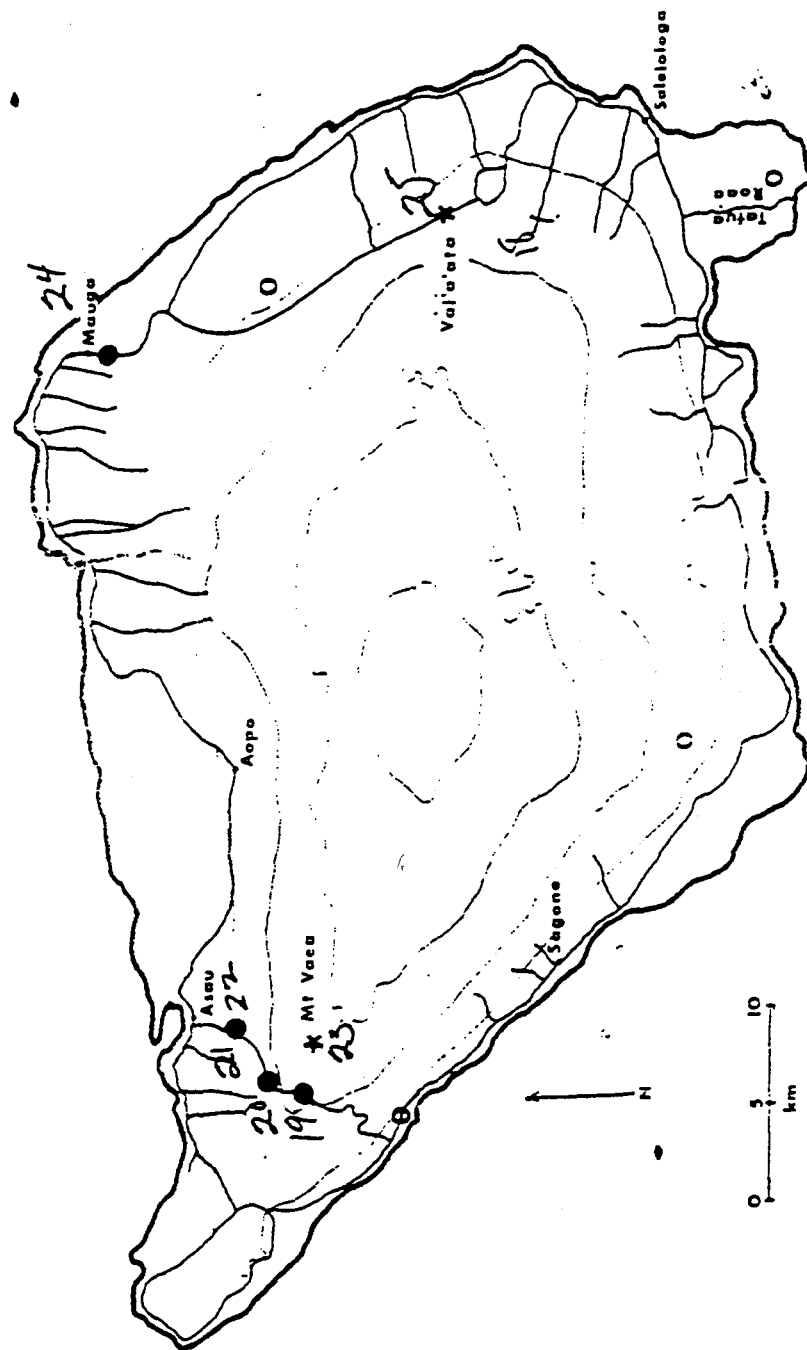


Fig. 6. *Pteropus samoensis* survey results, Tutuila island.

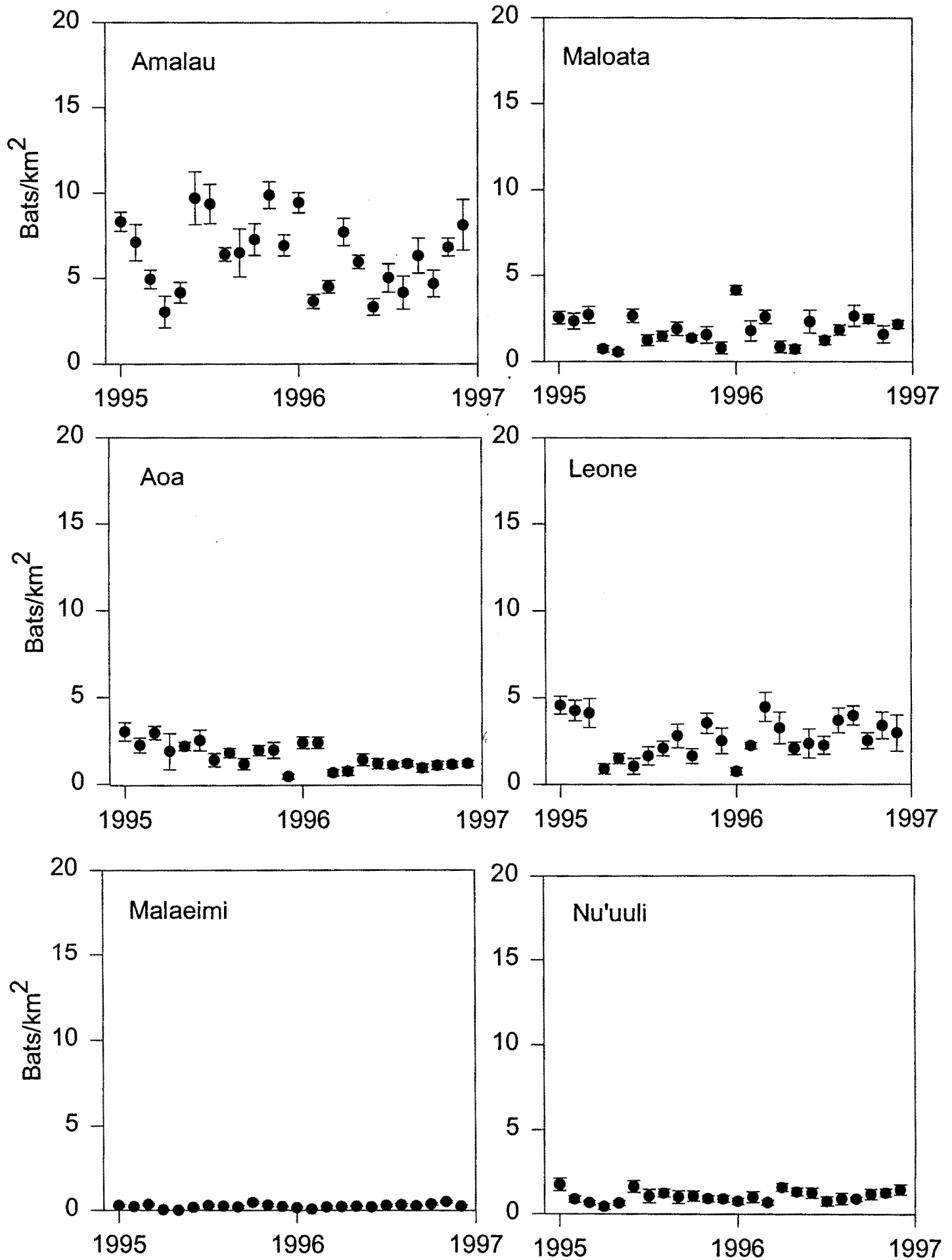


Fig. 7. Variation (mean and s.e.) in *P. samoensis* counts
Leone valley

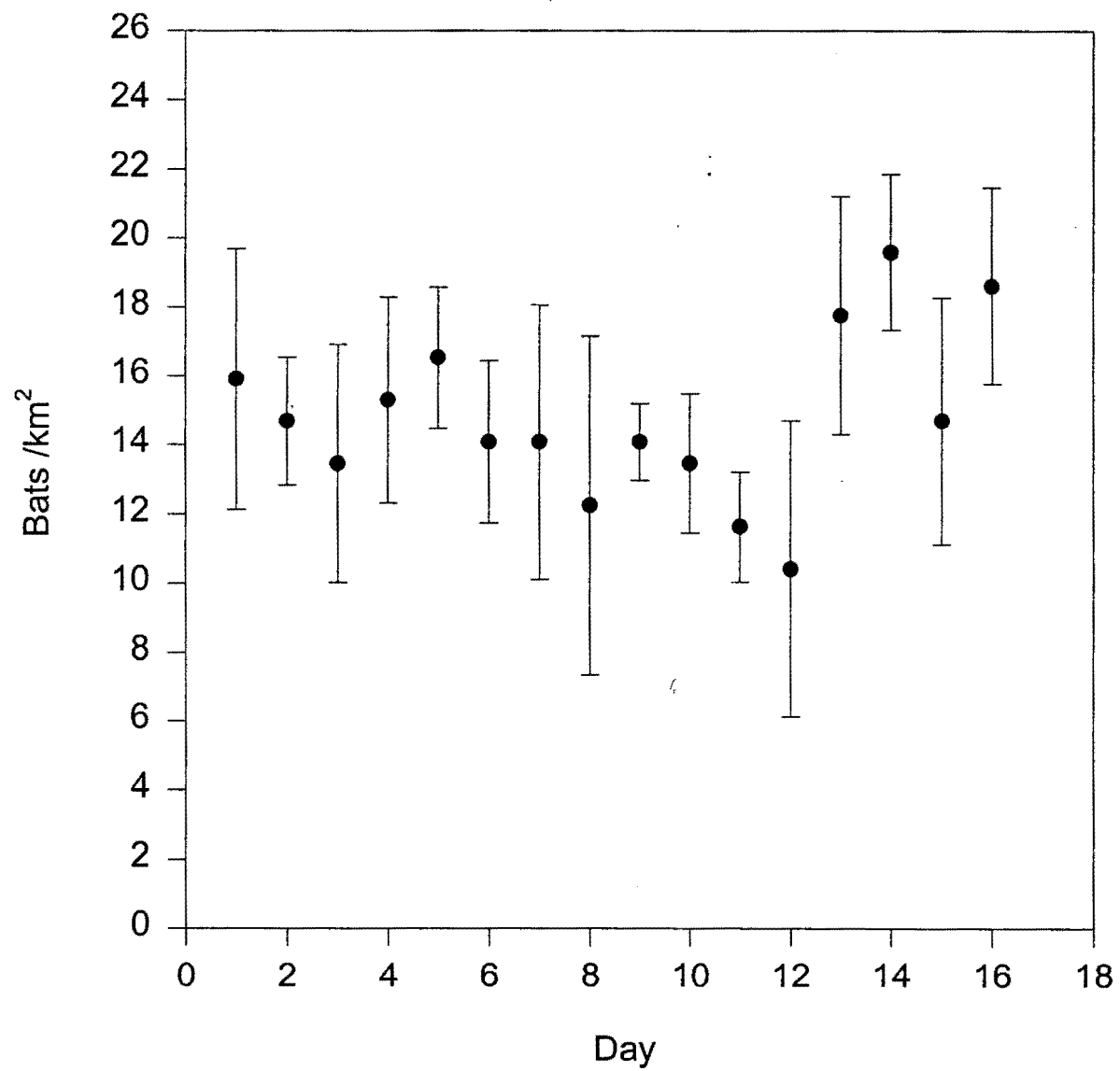


Fig. 8. *Pteropus samoensis* diurnal activity (mean and s.e. for five days per month)
Amalau Valley

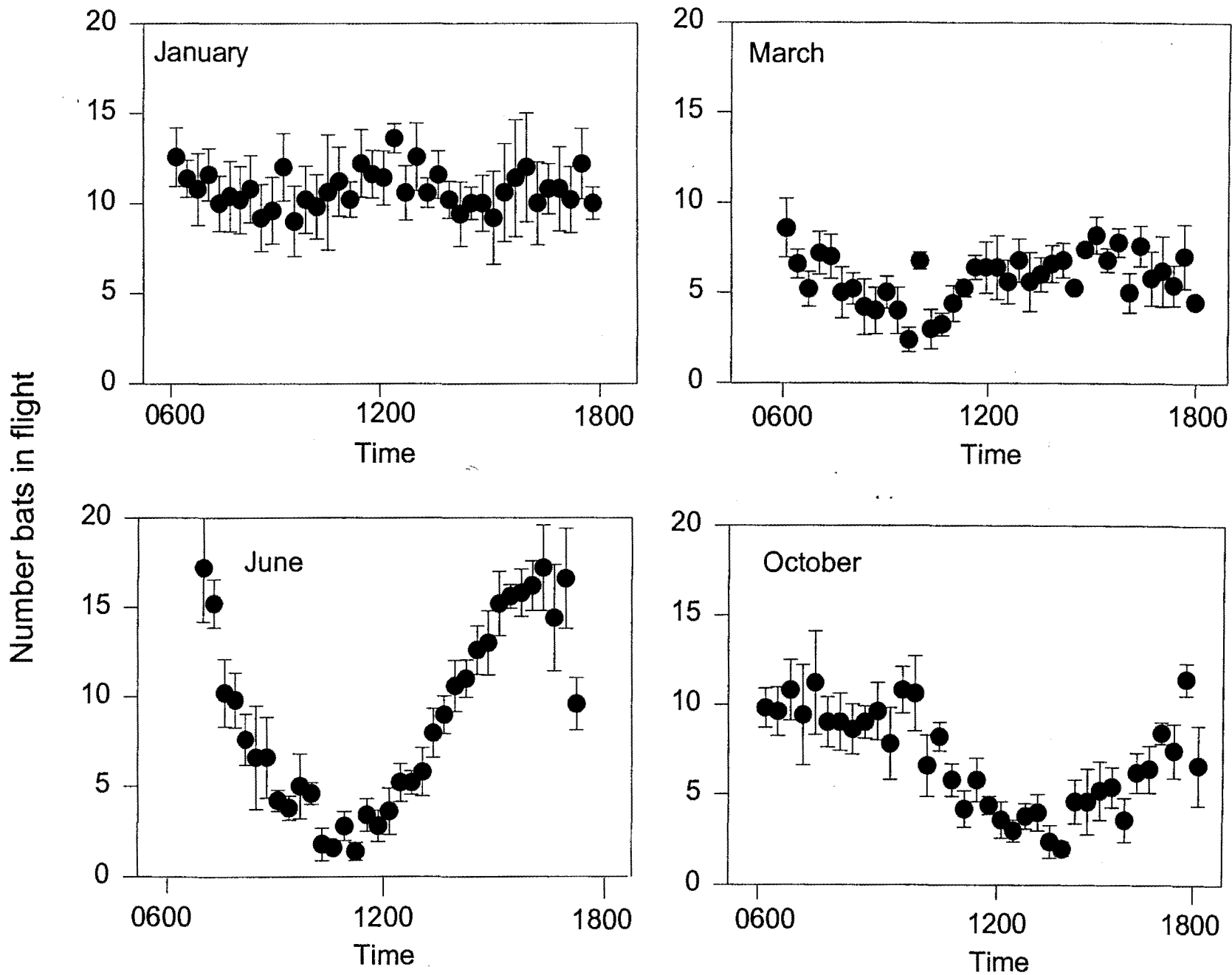


Fig. 9. Observations of female *Pteropus samoensis* carrying young, 1995-1996

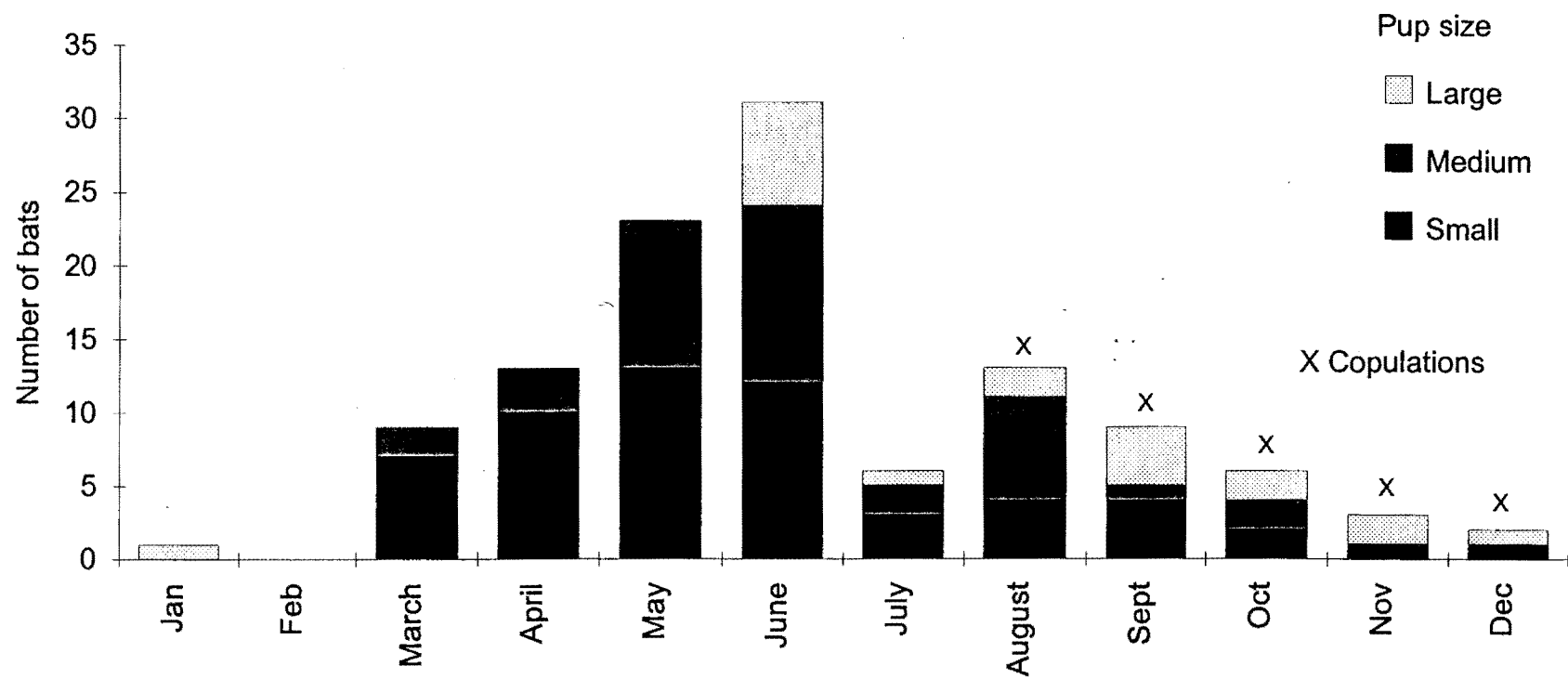


Fig. 10. *Pteropus samoensis* chases and follows, 1995-1996.

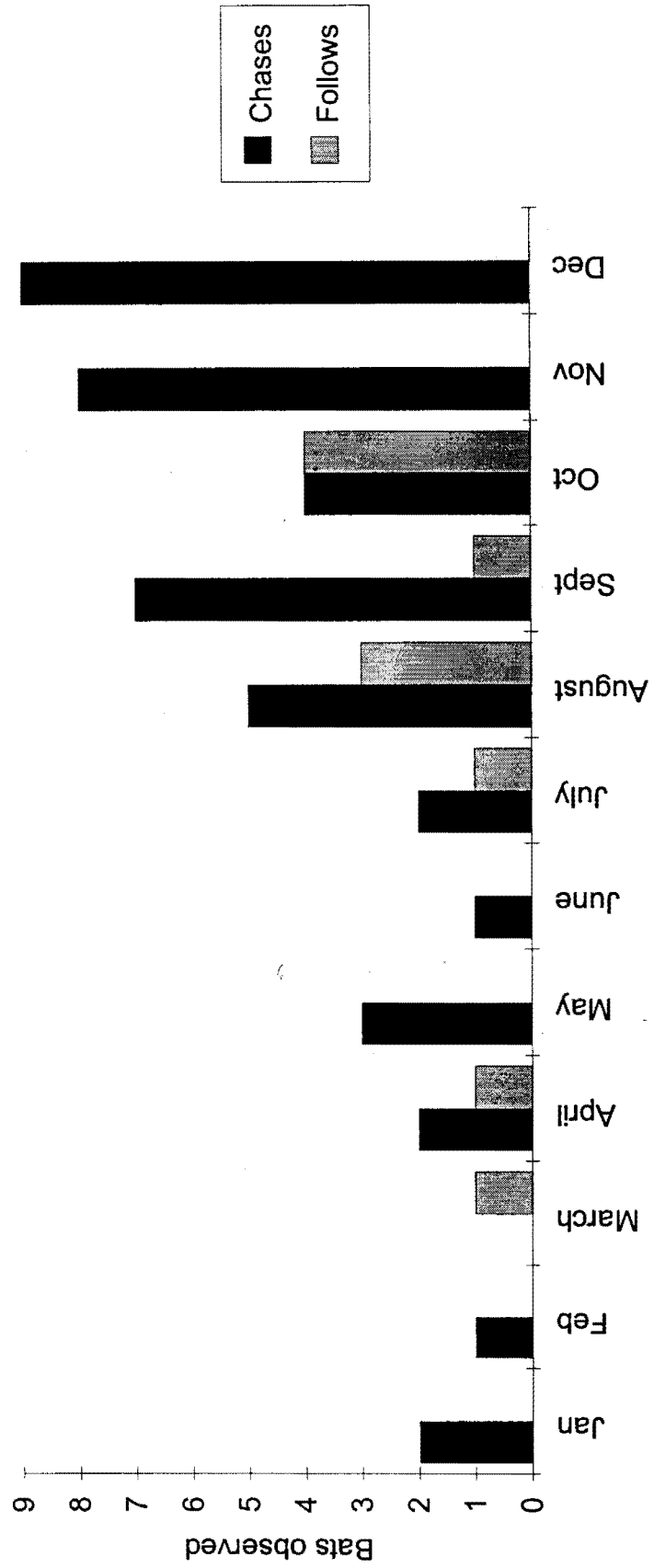
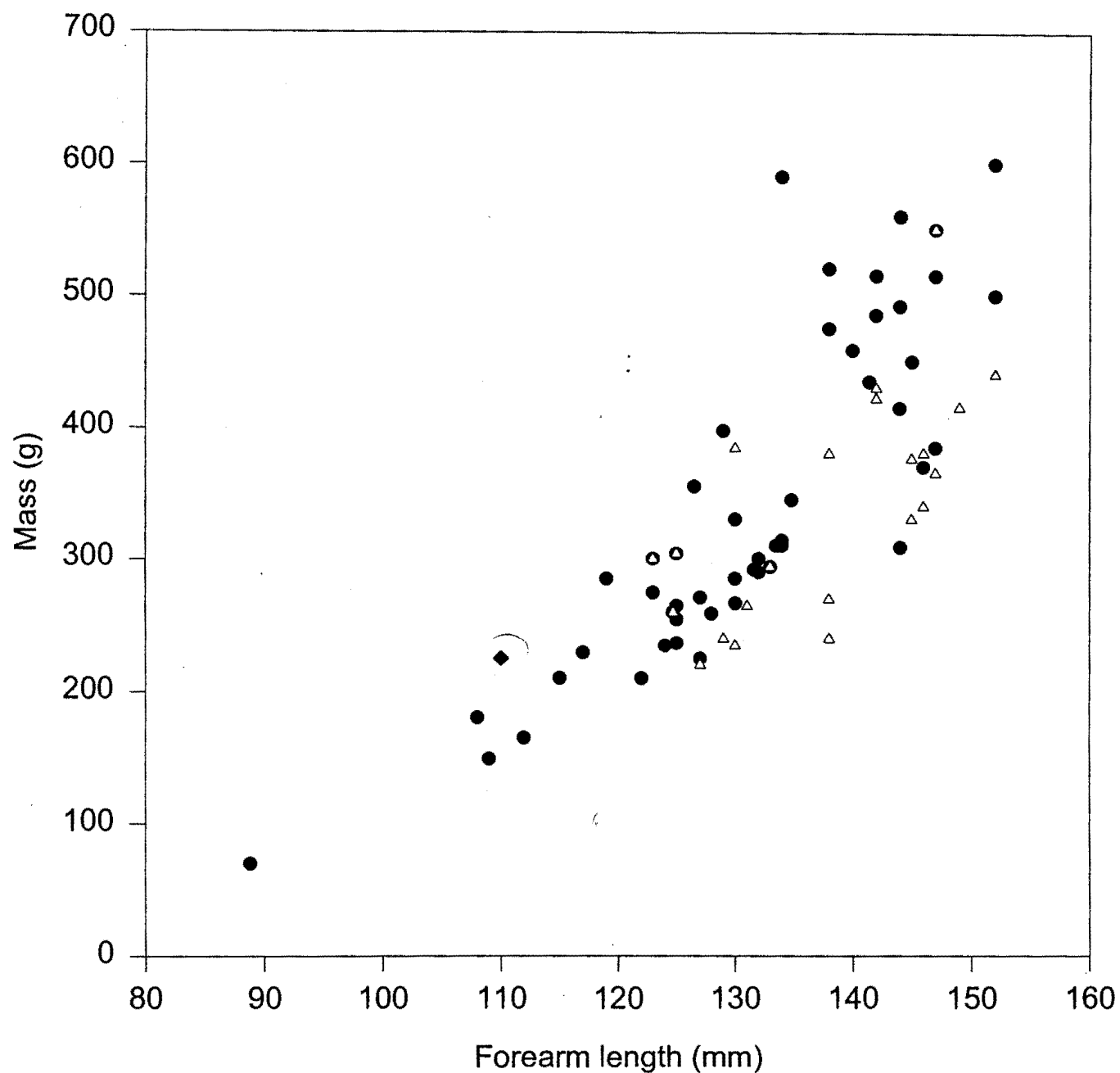


Fig. 11 Mass/forearm size of *Pteropus tonganus* and *Pteropus samoensis*



- *P. tonganus* n=53
- △ *P. samoensis* n=24
- ◆ Captive *P. tonganus* pup age 3 months

Bats netted in Samoa by Banack, Brooke, Grant. Museum specimens from American Museum of Natural History (n=2), Museum of Comparative Zoology (n=2), Smithsonian (n=2).

Fig. 12 Growth rates of three juvenile *Pteropus tonganus*

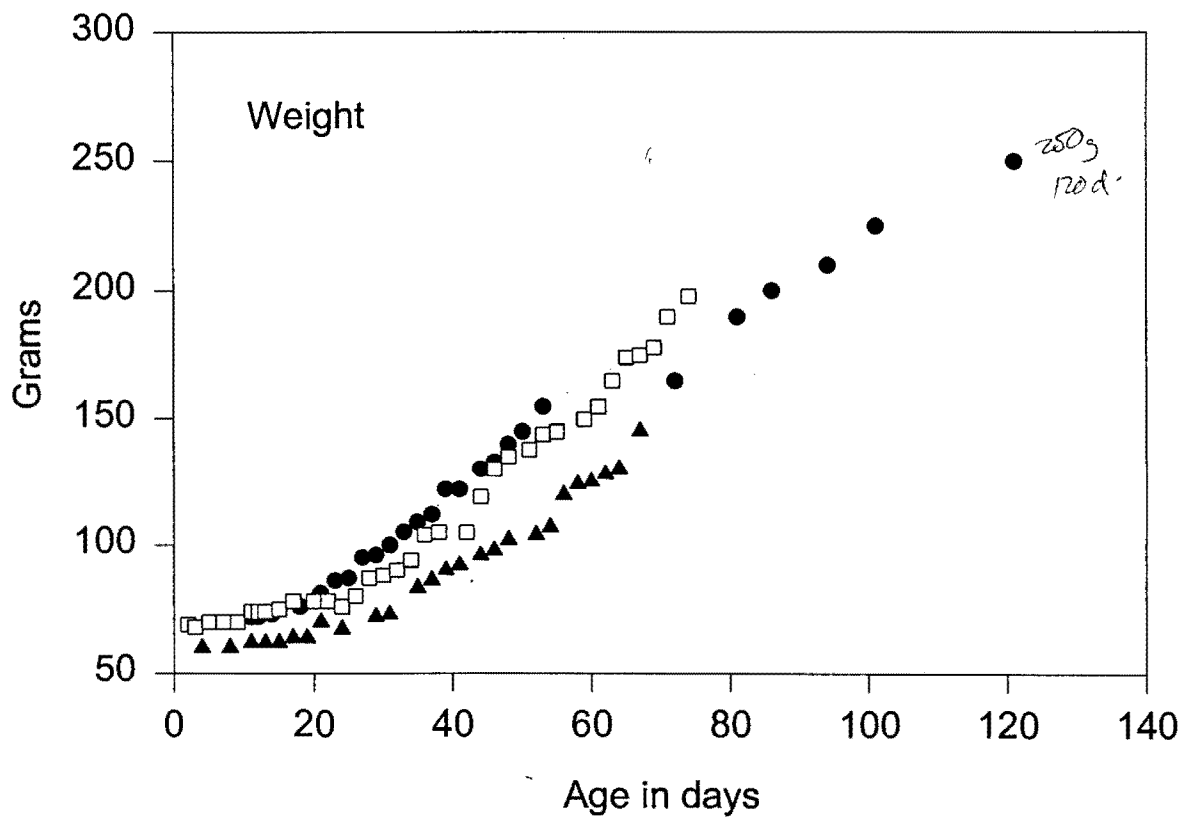
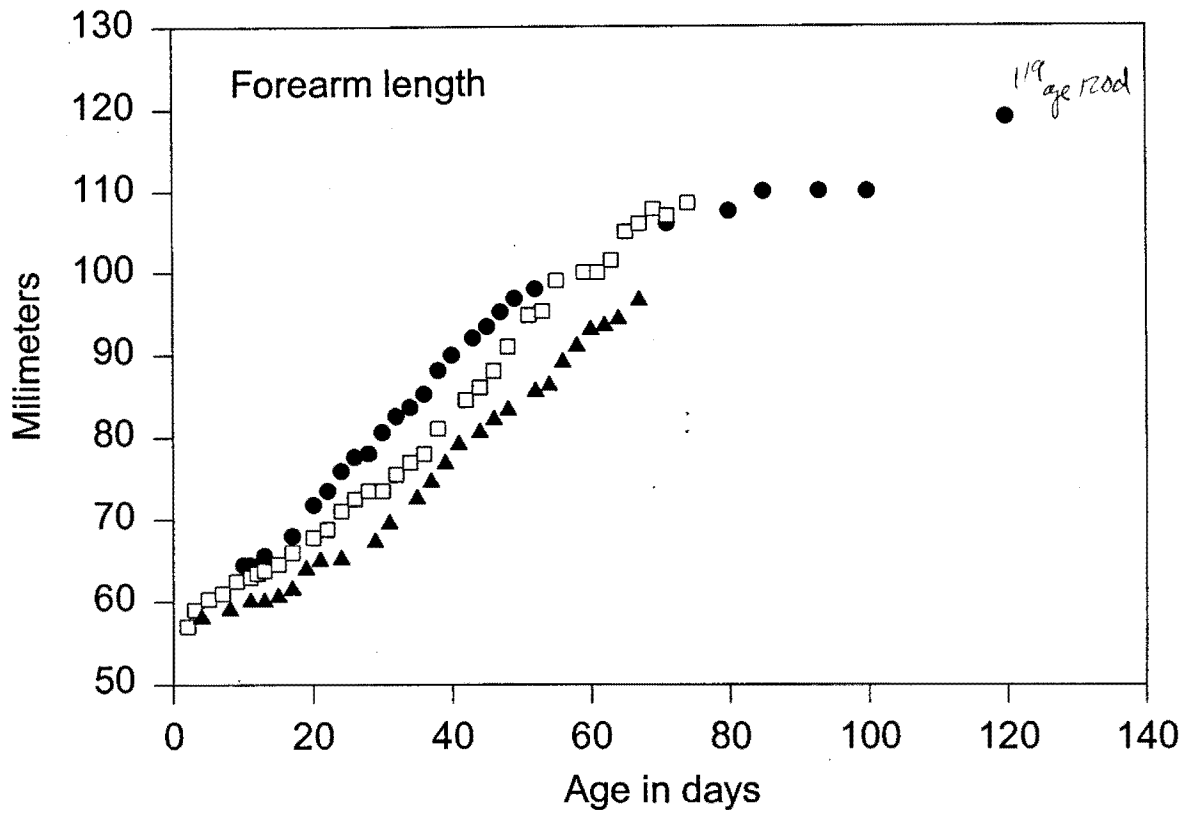


Fig. 13a. *Pteropus samoensis* day time telemetry fixes
Dec. 7&8, 1995

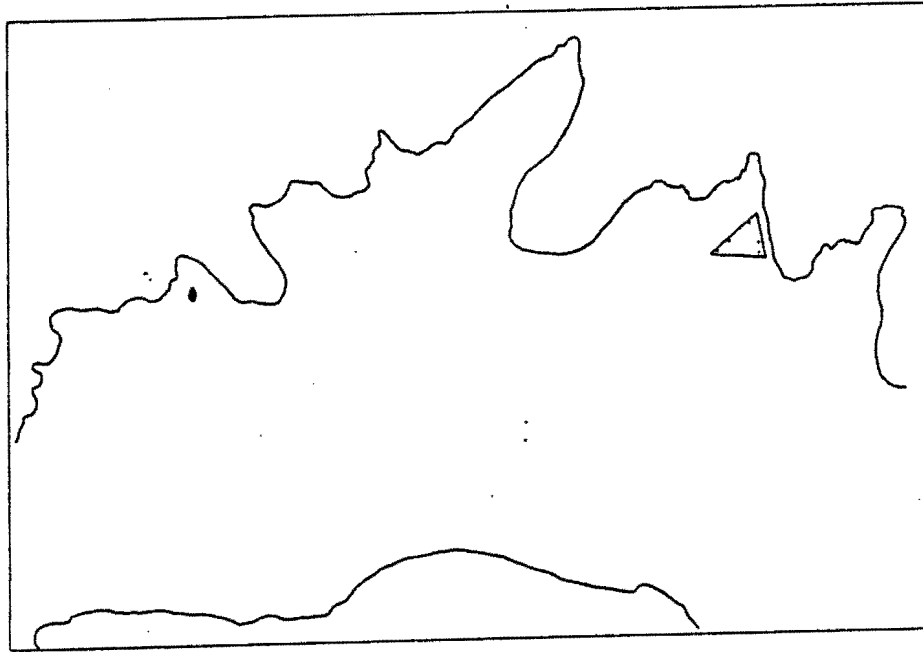
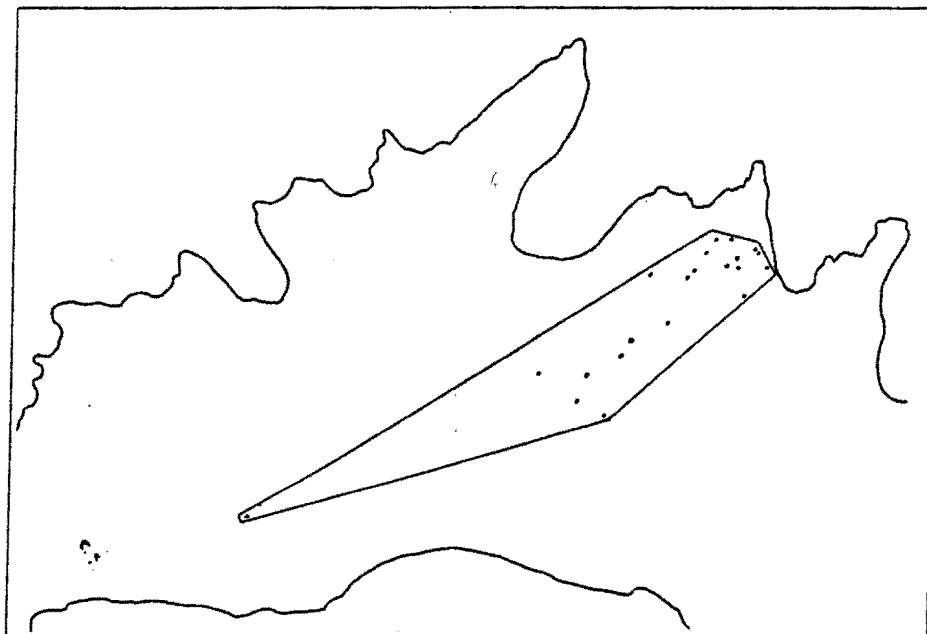
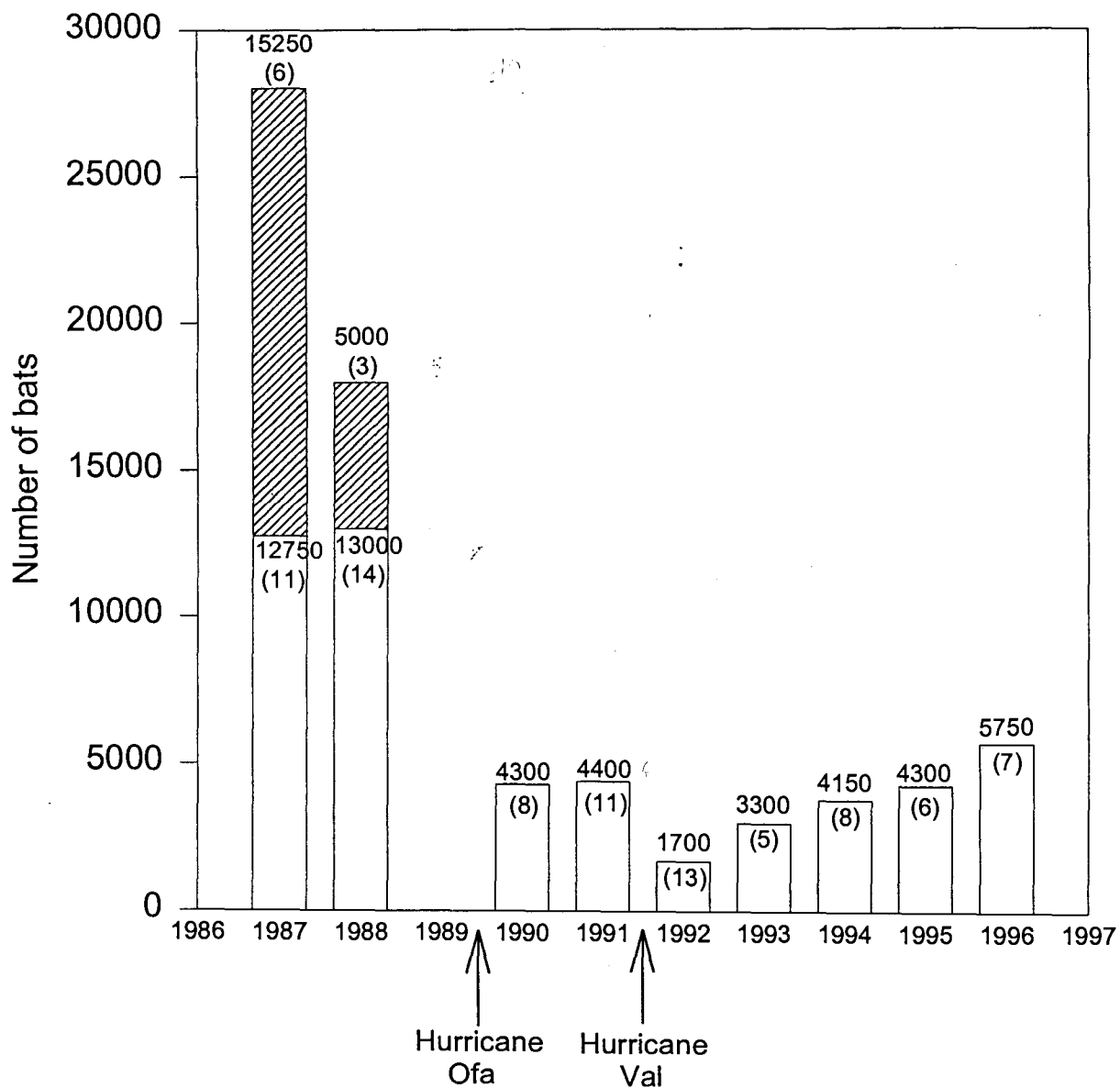


Fig. 13b. *Pteropus samoensis* foraging range for the nights
Dec 3-4 and Dec.5-6, 1995.



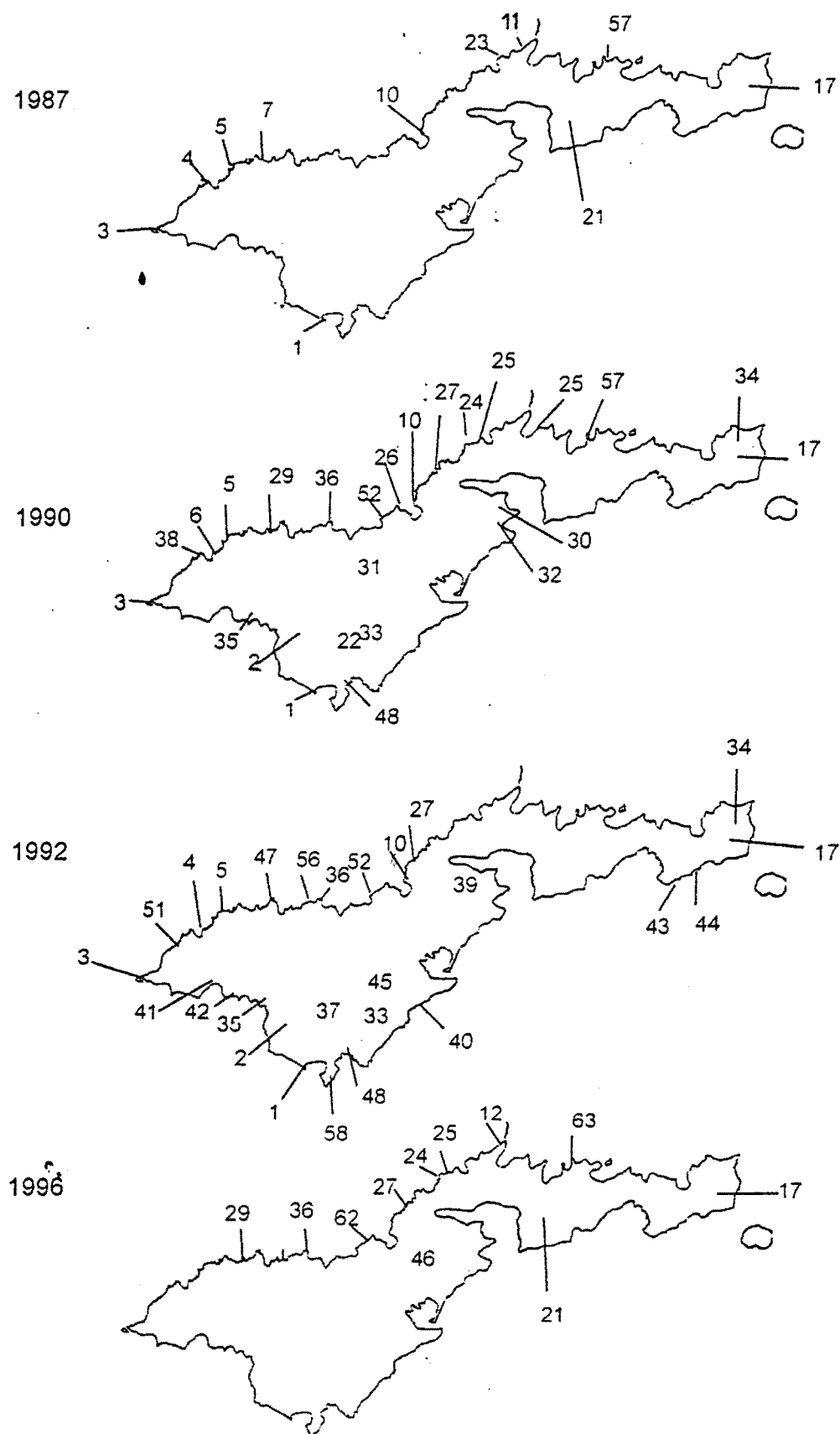
————— 1,000 m

Fig. 14. *Pteropus tonganus* population estimate from roost counts, Tutuila island, 1987-1996



Observed bats (# colonies counted)
 Estimated number of bats (# colonies not visited but known)
 Population estimate
 (number of colonies)

Fig. 15. *Pteropus tonganus* colony sites, Tutuila Island, 1987-1996.
Site numbers on Table 6.



Appendix 1

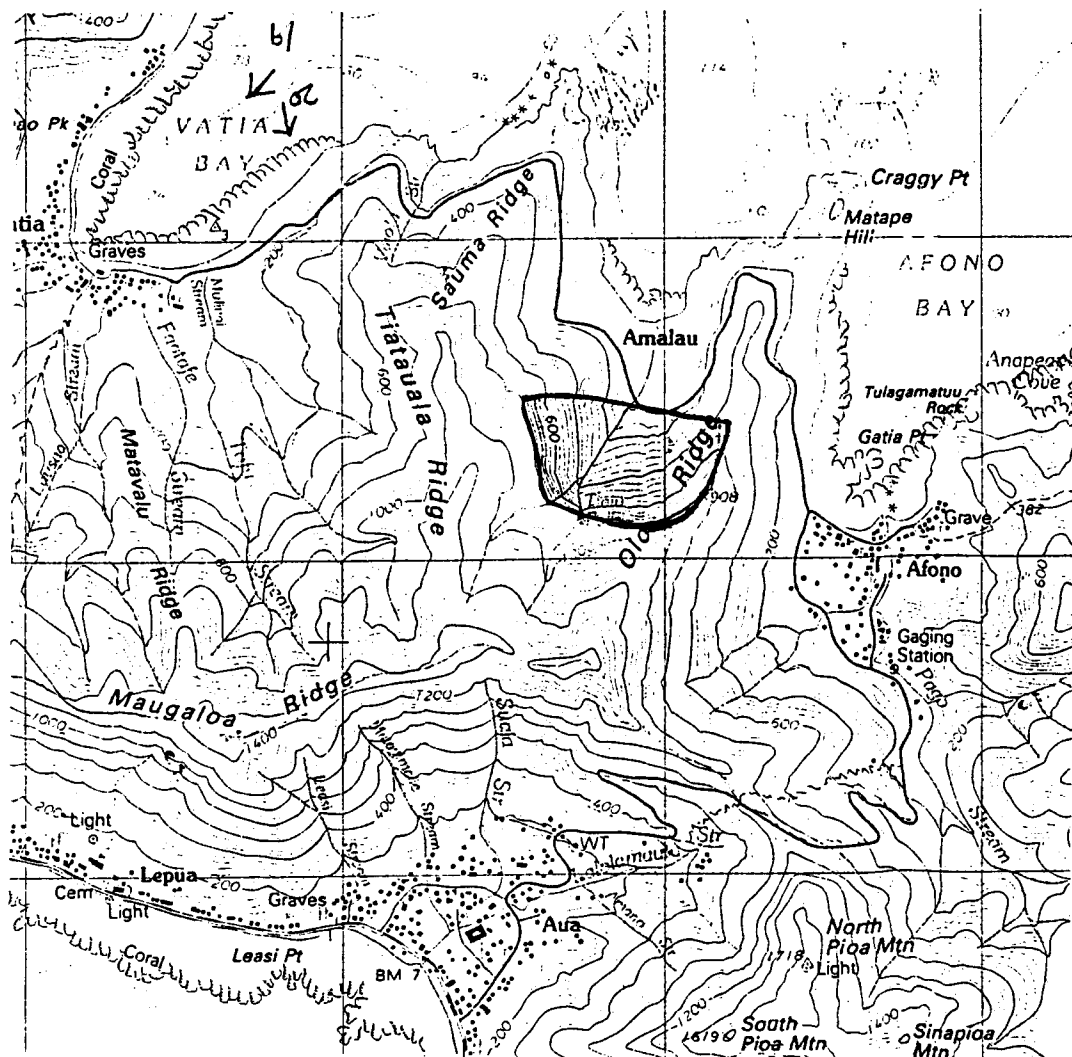
Pteropus samoensis Survey Sites Tutuila Island

Amalau

Site #1

Location of observation point: north of roadside at the lowest point along road in Amalau valley. Banana plantation on north side of road.

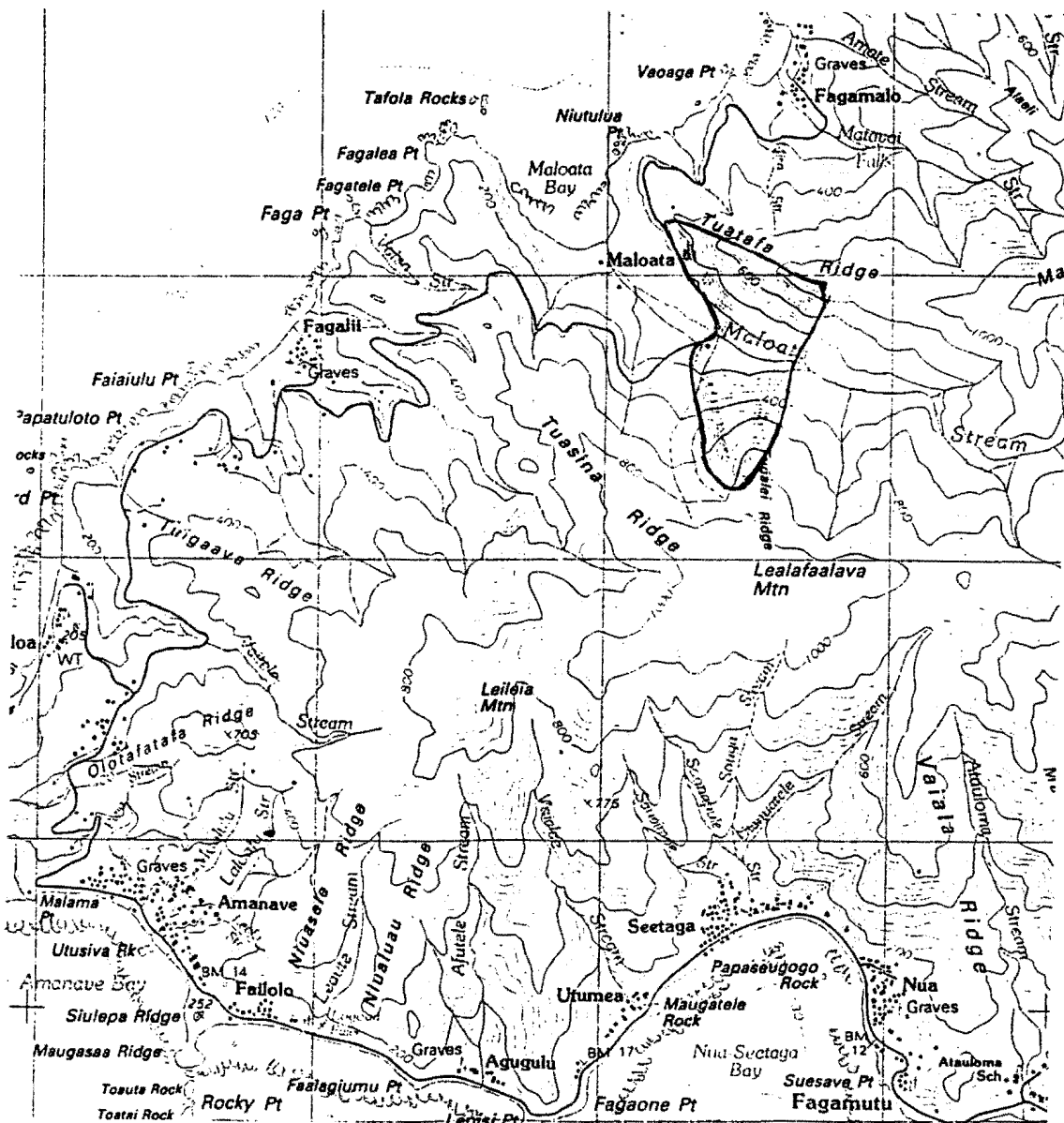
Area observed (see map below): 0.2139 km² hectares on south side of road. A semi-circular area is observed using the east-west running road as the northerly boundary. The valley is edged by Olo ridge to the east, Tiaiu fall to the south, Sauma and Tiataula ridge to the west. Observations are made of bats within the valley and directly above the ridge but not in the distance above the ridge to the west.



Site #2

Location of survey point: on west side of the road across from the Gurr family driveway.

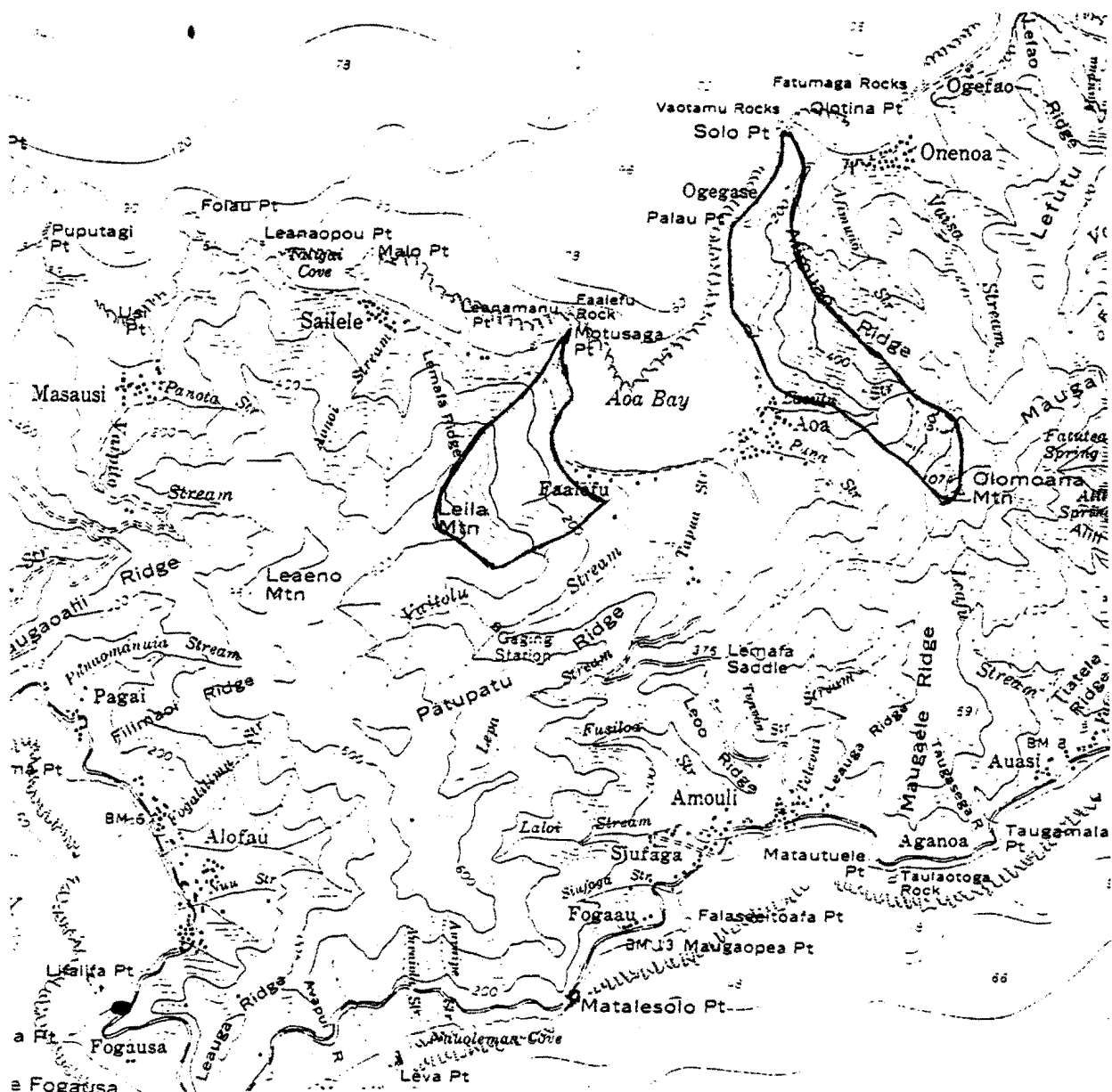
Area observed (see map below): 0.3403 km² that include Tuatafa ridge to the north, up the Maloata stream valley to the east, and to the top of Fugalei ridge to the south behind the Gurrs house.



**Aoa
Site #3**

Location of survey point: the stonewall in from of the Aoa elementary school.

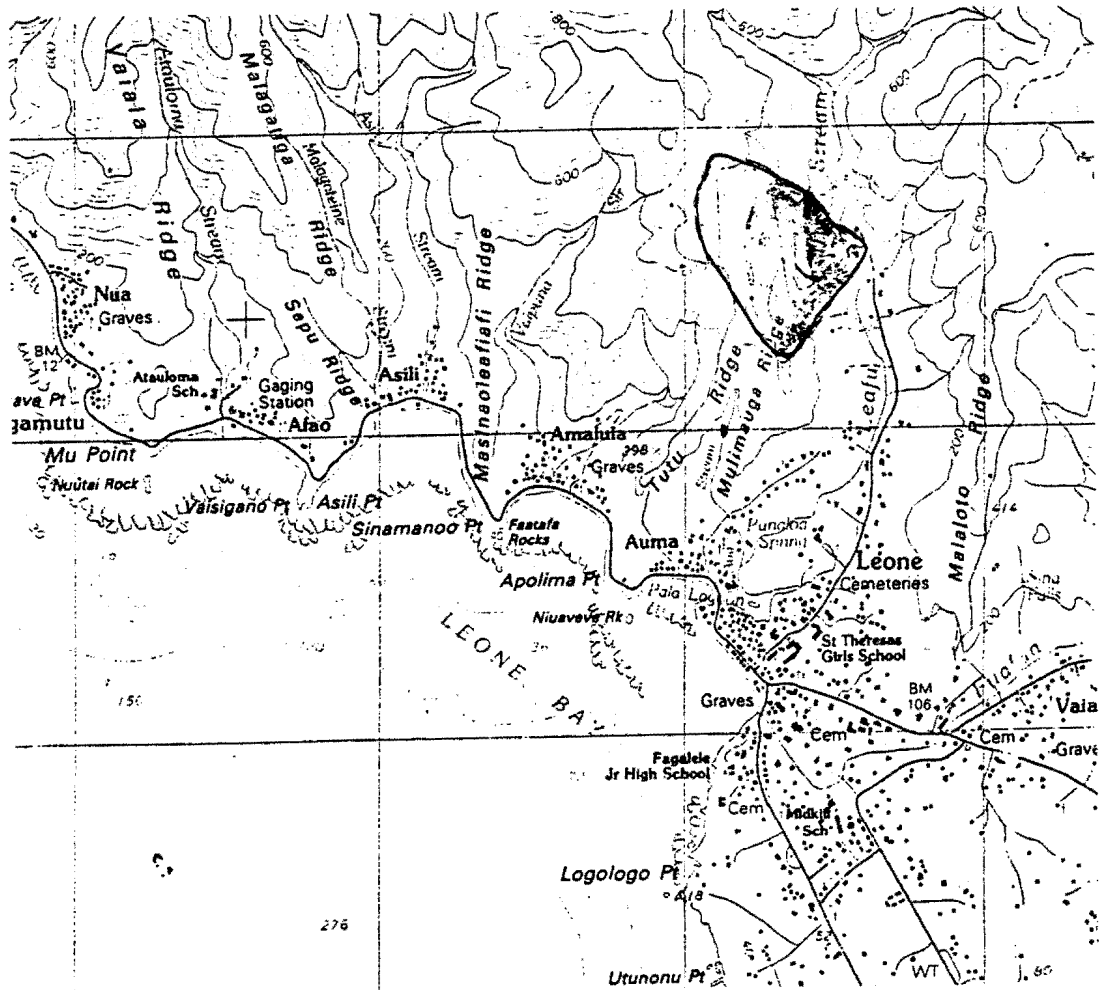
Area observed: (see map below): 0.613 km² in two separate areas. At the eastern side of the valley from Solo point to the north, including the hillside and ridge of Afimua ridge to the top of Olomoana Mountain. The western side from Motusaga point on the north along the side of Lemafa ridge encompassing three hill tops.



Leone Site #4

Location of survey point (see map below): a 198 ° view to the west, from the wall in front of the So'ooto house. The So'ooto house is located on the road that follows the Leafu stream.

Area observed: (see map below): 0.2043 km² of valley and ridge west of the Leafu stream. The valley includes two houses and plantation land as well as ridge forest. A hill to the southwest is the southern limit, the view is blocked by near vegetation. The road to that continues north to the waterfall is the northern boundary of the site.

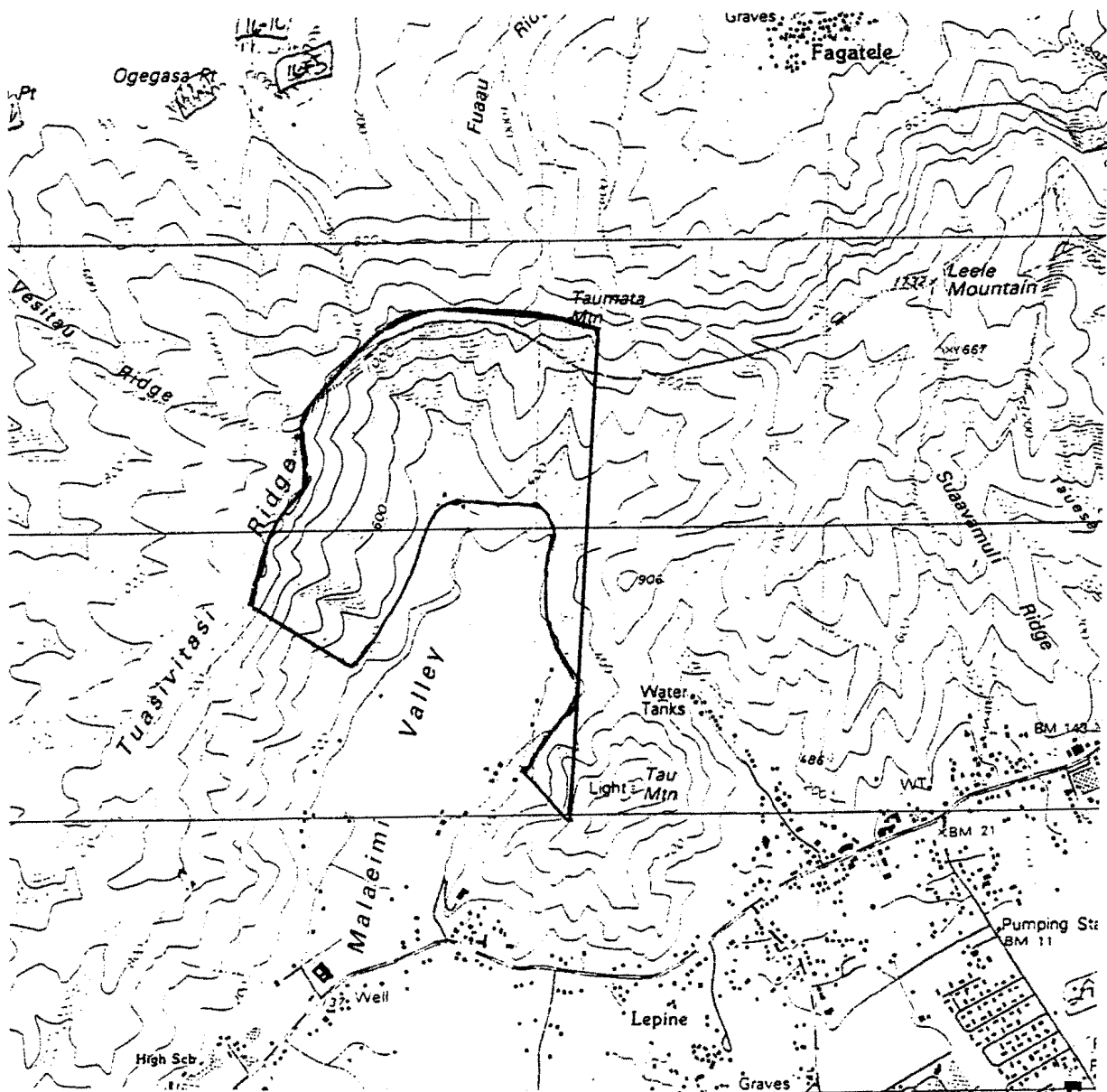


Malaeimi

Site 5

Location of survey point(see map below): the side of the road across from a small house on the eastern side.

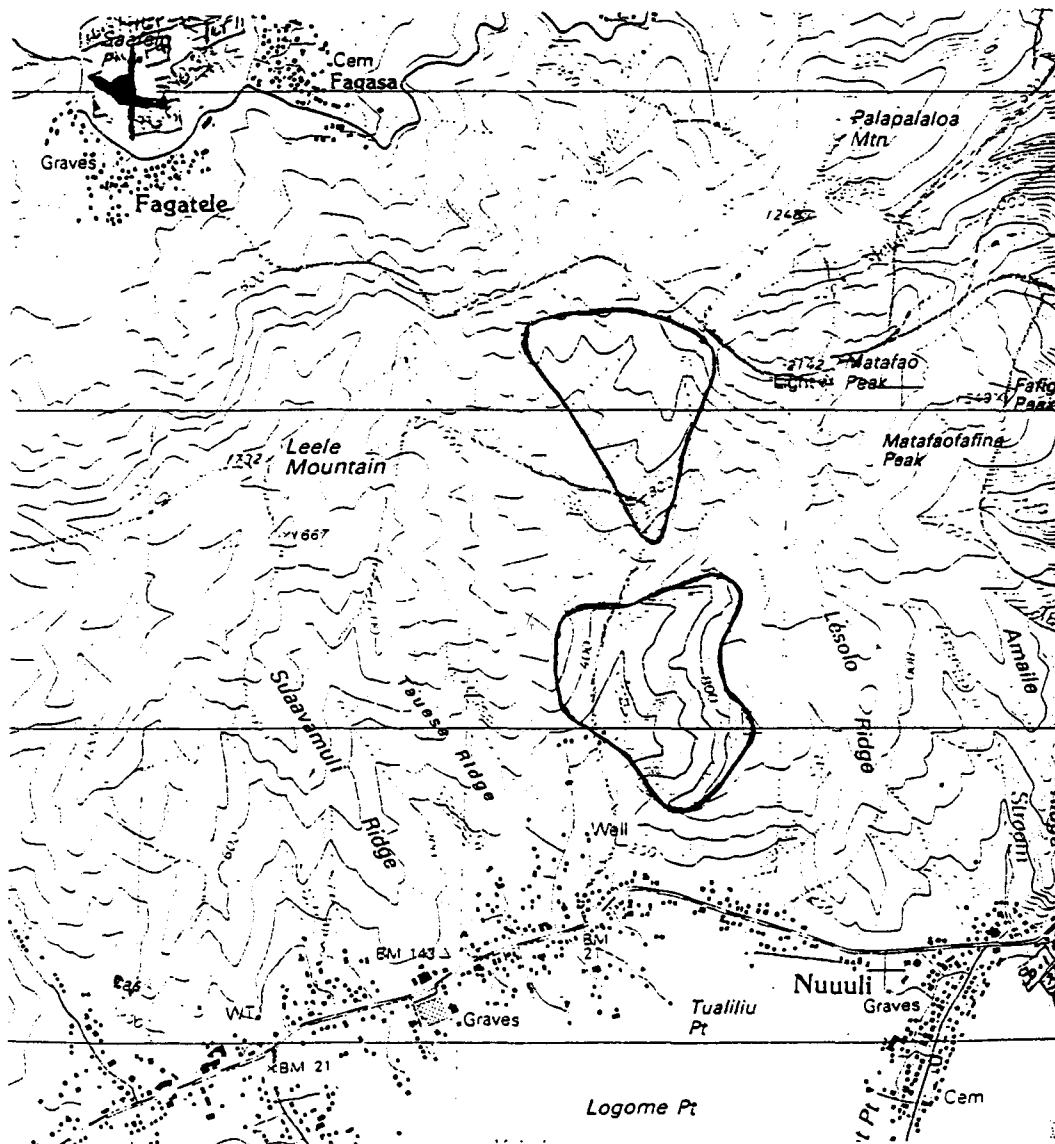
Area observed: (see map below): 0.939 km² from the Tuasivitase ridge on the western side, north to Taumata mountain. The view directly east of the lower part of Tau Mountain is obscured to the northeast by low vegetation. The valley area to the west is not visible as its slightly lower than the survey point.



Nu'uuli Site 6

Location of survey point(see map below): from the from yard of Aito Sunia's house, at the end of the road.

Area observed: (see map below): 0.575 km² from the Tuasivitasi ridge to the west, up the Leele stream valley to the north. The western side of Matafau peak formed the northeastern limit of the site. A high ridge in back of Aito Sunia's house continues south until the low vegetation blocked the view.



Manu'a Islands

Ta'u

The precise location of survey points will vary slightly as roadside vegetation grows and covers the view.

Lepula

Site #1

On the road from Fitiuta to Ta'u village, along the road where a broad view of hillside and ridge is visible.

Avatele Cove

Site #2

On the road from Fitiuta to Ta'u village, looking back toward Fitiuta where there is a view of the rugged hillside above Avatele Cove.

Loto Point

Site #3

On the road from Fitiuta to Ta'u village facing toward Fitiuta. The view of the hillside includes the Lepue crater and ridge above it in the distance. This is a very wide view, overlapping with the Avatele Cove site.

Saua south

Site #4

From the dirt road that leads from Fitiuta into the National Park, at the end of the valley visible in Site #5

Saua north

Site #5

At the first road into the beach from the dirt road that leads from Fitiuta into the National Park.

Luamau

Site #6

In the National Park, the next location where hillside is visible after Saua south.

Letula

Site #7

On the road from Fitiuta to Ta'u village, the same hillside as seen at the Lepula site.

'Ofu

Hotel

Site #8

The hillside directly I back of the Vaota Lodge, seen from the grass in front of the main building.

Toaga east

Site #9

A section of cliff seen from the beach or road in the National Park.

Toaga west

Site #10

The hillside in back of a "hurricane house", the only fale on the road from 'Ofu to 'Olosega across from the National Park.

'Ofu harbor

Site #11

Hillside in back of the harbor area seen from the road at the harbor. This is no longer used.

'Ofu village

Site #12

Hillside in back of 'Ofu village viewed across from the church. This site no longer used.

'Ofu harbor/village

Site #13

Hillside above the harbor and village seen from the end of the breakwater in 'Ofu harbor.

'Olosega

Sili West

Site #14

Hillside above the occupied houses in Sili village.

Sili east

Site #15

Hillside above the east end of Sili village

'Olosega Village

Site #16

Hillside above 'Olosega village viewed in front of the church.

'Olosega dump

Site #17

Hillside above the dump, at the end of the road past 'Olosega village

Tamatupu point

Site #18

Near the start of the road into Sili vilage, a bowl and surrounding area high on the hillside.

Western Samoa

'Opolu

Vailima

Site #1

From the parking lot of the botanic garden at Robert Louis Stevenson House. The view of forest is towards Mt Vaea.

Bahai Temple

Site #2

At the entry way to Bahai Temple and parking lot on the Cross Island Road. View toward the east of the river valley and first ridge.

Tiavi

Site #3

7.8 miles from start of Cross Island Road in Apia. Open view to both sides of road.

Tiavi Falls

Site #4

Falls overlook off Cross Island Road

Mt Tafua north

Site #5

0.5 miles north of turn from cross road from Apia. (Road meets with south coastal road). View to mountain.

Mt. Tafua south

Site #6

0.3 miles south of turn from cross road from Apia. View over cattle pasture.

Faleaseela

Site #7

Side road into the village from the north.

Falefa

Site #8

North side of hill from road through village.

Falevao

Site #9

Hill to north from bridge on road.

Lemofa

Site #10

0.6 miles west of three corners

Poutouti

Site #11

West side of road facing mountain and valley

Vaipu

Site #12

From Richardson Road, turn north on side road 11.3 miles west of start of road from the east coast. 0.3 miles down side road to view toward the north.

Richardson #1

Site #13

8.7 miles west on Richardson Road from the east.

Richardson #2

Site #14

7.0 miles west from the start of road.

Mt. Savaii

Site #15

Across from Richardson #2, view to the south.

Richardson #3

Site #16

Just past village at top of hill.

Mt. Tiatala

Site #17

0.3 miles west of Richardson #3.

Savai'i

unnamed site,

Site #18

A side road from Salelologa. GPA coordinates -13 42.12 south -172 15.44 west.

Asau

Site #19

3.1 miles in on dirt road to Forestry station

Asau

Site #20

4.8 miles from turn onto dirt road to Forestry station.

Asau

Site #21

7.4 miles on dirt road, past gravel quarry, facing northerly toward the ocean.

Asau

Site #22

Same location as site #21 but facing east toward the hillside

Mt Vaea

Site #23

Top of Mt Vaea at the radio tower

Mauga

Site #24

East of Magua village, overlooking the lava flows.

Appendix 2. *Pteropus samoensis* survey data 1995-1996

	year	count	month	site	ps/km		year	count	month	site	ps/km
Amalau	1995	16	1	1	74.80		1996	12	1	1	56.34
=.213km2	1995	10	1	1	46.75		1996	11	1	1	51.64
	1995	9	1	1	42.08		1996	14	1	1	65.73
	1995	13	1	1	60.78		1996	14	1	1	65.73
	1995	14	1	1	65.45		1996	16	1	1	75.12
	1995	11	1	1	51.43		1996	16	1	1	75.12
	1995	12	1	1	56.10		1996	16	1	1	75.12
	1995	11	1	1	51.43		1996	10	1	1	46.95
	1995	16	2	1	74.80		1996	3	2	1	14.08
	1995	9	2	1	42.08		1996	8	2	1	37.56
	1995	16	2	1	74.80		1996	4	2	1	18.78
	1995	7	2	1	32.73		1996	5	2	1	23.47
	1995	10	2	1	46.75		1996	7	2	1	32.86
	1995	6	2	1	28.05		1996	6	2	1	28.17
	1995	13	2	1	60.78		1996	5	2	1	23.47
	1995	5	2	1	23.38		1996	4	2	1	18.78
	1995	5	3	1	23.38		1996	7	3	1	32.86
	1995	7	3	1	32.73		1996	9	3	1	42.25
	1995	8	3	1	37.40		1996	5	3	1	23.47
	1995	8	3	1	37.40		1996	8	3	1	37.56
	1995	11	3	1	51.43		1996	5	3	1	23.47
	1995	8	3	1	37.40		1996	6	3	1	28.17
	1995	4	3	1	18.70		1996	5	3	1	23.47
	1995	6	3	1	28.05		1996	7	3	1	32.86
	1995	13	4	1	60.78		1996	9	4	1	42.25
	1995	5	4	1	23.38		1996	13	4	1	61.03
	1995	3	4	1	14.03		1996	17	4	1	79.81
	1995	5	4	1	23.38		1996	13	4	1	61.03
	1995	3	4	1	14.03		1996	12	4	1	56.34
	1995	2	4	1	9.35		1996	8	4	1	37.56
	1995	3	4	1	14.03		1996	7	4	1	32.86
	1995	1	4	1	4.68		1996	10	4	1	46.95
	1995	2	5	1	9.35		1996	9	5	1	42.25
	1995	6	5	1	28.05		1996	8	5	1	37.56
	1995	6	5	1	28.05		1996	7	5	1	32.86
	1995	3	5	1	14.03		1996	8	5	1	37.56
	1995	8	5	1	37.40		1996	9	5	1	42.25
	1995	9	5	1	42.08		1996	12	5	1	56.34
	1995	8	5	1	37.40		1996	7	5	1	32.86
	1995	6	5	1	28.05		1996	9	5	1	42.25
	1995	15	6	1	70.13		1996	8	6	1	37.56
	1995	22	6	1	103		1996	3	6	1	14.08
	1995	23	6	1	108		1996	7	6	1	32.86
	1995	20	6	1	93.50		1996	4	6	1	18.78
	1995	18	6	1	84.15		1996	6	6	1	28.17
	1995	7	6	1	32.73		1996	3	6	1	14.08
	1995	11	6	1	51.43		1996	3	6	1	14.08
	1995	8	6	1	37.40		1996	5	6	1	23.47

Appendix 2. Pteropus samoensis survey data 1995-1996

	1995	20	7	1	93.50		1996	7	7	1	32.86
	1995	17	7	1	79.48		1996	13	7	1	61.03
	1995	15	7	1	70.13		1996	4	7	1	18.78
	1995	13	7	1	60.78		1996	4	7	1	18.78
	1995	14	7	1	65.45		1996	9	7	1	42.25
	1995	4	7	1	18.70		1996	11	7	1	51.64
	1995	11	7	1	51.43		1996	5	7	1	23.47
	1995	14	7	1	65.45		1996	5	7	1	23.47
	1995	11	8	1	51.43		1996	4	8	1	18.78
	1995	11	8	1	51.43		1996	10	8	1	46.95
	1995	9	8	1	42.08		1996	2	8	1	9.39
	1995	9	8	1	42.08		1996	6	8	1	28.17
	1995	8	8	1	37.40		1996	9	8	1	42.25
	1995	7	8	1	32.73		1996	1	8	1	4.69
	1995	8	8	1	37.40		1996	12	8	1	56.34
	1995	11	8	1	51.43		1996	4	8	1	18.78
	1995	18	9	1	84.15		1996	4	9	1	18.78
	1995	16	9	1	74.80		1996	15	9	1	70.42
	1995	11	9	1	51.43		1996	4	9	1	18.78
	1995	2	9	1	9.35		1996	8	9	1	37.56
	1995	11	9	1	51.43		1996	12	9	1	56.34
	1995	8	9	1	37.40		1996	13	9	1	61.03
	1995	6	9	1	28.05		1996	12	9	1	56.34
	1995	3	9	1	14.03		1996	5	9	1	23.47
	1995	10	10	1	46.75		1996	2	10	1	9.39
	1995	9	10	1	42.08		1996	4	10	1	18.78
	1995	19	10	1	88.83		1996	12	10	1	56.34
	1995	11	10	1	51.43		1996	7	10	1	32.86
	1995	8	10	1	37.40		1996	9	10	1	42.25
	1995	10	10	1	46.75		1996	7	10	1	32.86
	1995	11	10	1	51.43		1996	8	10	1	37.56
	1995	6	10	1	28.05		1996	5	10	1	23.47
	1995	18	11	1	84.15		1996	6	11	1	28.17
	1995	14	11	1	65.45		1996	10	11	1	46.95
	1995	12	11	1	56.10		1996	11	11	1	51.64
	1995	15	11	1	70.13		1996	9	11	1	42.25
	1995	11	11	1	51.43		1996	11	11	1	51.64
	1995	10	11	1	46.75		1996	8	11	1	37.56
	1995	19	11	1	88.83		1996	13	11	1	61.03
	1995	15	11	1	70.13		1996	11	11	1	51.64
	1995	12	12	1	56.10		1996	12	12	1	56.34
	1995	11	12	1	51.43		1996	18	12	1	84.51
	1995	13	12	1	60.78		1996	6	12	1	28.17
	1995	9	12	1	42.08		1996	10	12	1	46.95
	1995	12	12	1	56.10		1996	4	12	1	18.78
	1995	10	12	1	46.75		1996	13	12	1	61.03
	1995	7	12	1	32.73		1996	22	12	1	103
	1995	6	12	1	28.05		1996	9	12	1	42.25
Maloata	1995	3	1	2	8.82	Maloata	1996	11	1	2	32.35

Appendix 2. Pteropus samoensis survey data 1995-1996

=.34	1995	8	1	2	23.53	=.34	1996	8	1	2	23.53
	1995	5	1	2	14.71		1996	10	1	2	29.41
	1995	3	1	2	8.82		1996	6	1	2	17.65
	1995	6	1	2	17.65		1996	7	1	2	20.59
	1995	8	1	2	23.53		1996	8	1	2	23.53
	1995	4	1	2	11.76		1996	8	1	2	23.53
	1995	8	2	2	23.53		1996	9	1	2	26.47
	1995	8	2	2	23.53		1996	2	2	2	5.88
	1995	7	2	2	20.59		1996	3	2	2	8.82
	1995	3	2	2	8.82		1996	9	2	2	26.47
	1995	4	2	2	11.76		1996	0	2	2	0.00
	1995	1	2	2	2.94		1996	1	2	2	2.94
	1995	3	2	2	8.82		1996	5	2	2	14.71
	1995	4	2	2	11.76		1996	1	2	2	2.94
	1995	4	3	2	11.76		1996	8	2	2	23.53
	1995	6	3	2	17.65		1996	3	3	2	8.82
	1995	10	3	2	29.41		1996	3	3	2	8.82
	1995	8	3	2	23.53		1996	5	3	2	14.71
	1995	5	3	2	14.71		1996	3	3	2	8.82
	1995	2	3	2	5.88		1996	9	3	2	26.47
	1995	7	3	2	20.59		1996	5	3	2	14.71
	1995	2	3	2	5.88		1996	6	3	2	17.65
	1995	2	4	2	5.88		1996	8	3	2	23.53
	1995	1	4	2	2.94		1996	0	4	2	0.00
	1995	3	4	2	8.82		1996	3	4	2	8.82
	1995	2	4	2	5.88		1996	6	4	2	17.65
	1995	2	4	2	5.88		1996	1	4	2	2.94
	1995	1	4	2	2.94		1996	2	4	2	5.88
	1995	0	4	2	0.00		1996	2	4	2	5.88
	1995	1	4	2	2.94		1996	0	4	2	0.00
	1995	1	5	2	2.94		1996	0	4	2	0.00
	1995	0	5	2	0.00		1996	1	5	2	2.94
	1995	2	5	2	5.88		1996	1	5	2	2.94
	1995	1	5	2	2.94		1996	1	5	2	2.94
	1995	1	5	2	2.94		1996	0	5	2	0.00
	1995	2	5	2	5.88		1996	1	5	2	2.94
	1995	0	5	2	0.00		1996	4	5	2	11.76
	1995	2	5	2	5.88		1996	3	5	2	8.82
	1995	5	6	2	14.71		1996	1	5	2	2.94
	1995	7	6	2	20.59		1996	4	6	2	11.76
	1995	9	6	2	26.47		1996	0	6	2	0.00
	1995	6	6	2	17.65		1996	9	6	2	26.47
	1995	5	6	2	14.71		1996	4	6	2	11.76
	1995	6	6	2	17.65		1996	1	6	2	2.94
	1995	3	6	2	8.82		1996	2	6	2	5.88
	1995	2	6	2	5.88		1996	10	6	2	29.41
	1995	4	7	2	11.76		1996	8	6	2	23.53
	1995	6	7	2	17.65		1996	1	7	2	2.94
	1995	2	7	2	5.88		1996	4	7	2	11.76

Appendix 2. Pteropus samoensis survey data 1995-1996

	1995	0	7	2	0.00		1996	3	7	2	8.82
	1995	1	7	2	2.94		1996	1	7	2	2.94
	1995	2	7	2	5.88		1996	4	7	2	11.76
	1995	2	7	2	5.88		1996	1	7	2	2.94
	1995	3	7	2	8.82		1996	2	7	2	5.88
	1995	3	8	2	8.82		1996	4	7	2	11.76
	1995	5	8	2	14.71		1996	5	8	2	14.71
	1995	6	8	2	17.65		1996	3	8	2	8.82
	1995	3	8	2	8.82		1996	1	8	2	2.94
	1995	1	8	2	2.94		1996	5	8	2	14.71
	1995	2	8	2	5.88		1996	5	8	2	14.71
	1995	3	8	2	8.82		1996	2	8	2	5.88
	1995	1	8	2	2.94		1996	3	8	2	8.82
	1995	4	9	2	11.76		1996	6	8	2	17.65
	1995	7	9	2	20.59		1996	4	9	2	11.76
	1995	7	9	2	20.59		1996	1	9	2	2.94
	1995	3	9	2	8.82		1996	5	9	2	14.71
	1995	1	9	2	2.94		1996	3	9	2	8.82
	1995	2	9	2	5.88		1996	3	9	2	8.82
	1995	2	9	2	5.88		1996	6	9	2	17.65
	1995	5	9	2	14.71		1996	9	9	2	26.47
	1995	3	10	2	8.82		1996	12	9	2	35.29
	1995	2	10	2	5.88		1996	8	10	2	23.53
	1995	2	10	2	5.88		1996	3	10	2	8.82
	1995	3	10	2	8.82		1996	4	10	2	11.76
	1995	1	10	2	2.94		1996	4	10	2	11.76
	1995	4	10	2	11.76		1996	5	10	2	14.71
	1995	4	10	2	11.76		1996	6	10	2	17.65
	1995	3	10	2	8.82		1996	5	10	2	14.71
	1995	2	11	2	5.88		1996	5	10	2	14.71
	1995	9	11	2	26.47		1996	0	11	2	0.00
	1995	4	11	2	11.76		1996	6	11	2	17.65
	1995	4	11	2	11.76		1996	0	11	2	0.00
	1995	1	11	2	2.94		1996	3	11	2	8.82
	1995	4	11	2	11.76		1996	6	11	2	17.65
	1995	0	11	2	0.00		1996	3	11	2	8.82
	1995	1	11	2	2.94		1996	7	11	2	20.59
	1995	5	12	2	14.71		1996	1	11	2	2.94
	1995	4	12	2	11.76		1996	4	12	2	11.76
	1995	1	12	2	2.94		1996	4	12	2	11.76
	1995	0	12	2	0.00		1996	5	12	2	14.71
	1995	2	12	2	5.88		1996	6	12	2	17.65
	1995	1	12	2	2.94		1996	4	12	2	11.76
	1995	0	12	2	0.00		1996	6	12	2	17.65
	1995	0	12	2	0.00		1996	4	12	2	11.76
Aoa	1995	7	1	3	11.42		1996	2	12	2	5.88
=.61	1995	5	1	3	8.16	Aoa	1996	3	1	3	4.92
	1995	10	1	3	16.31	=.61	1996	3	1	3	4.92
	1995	6	1	3	9.79		1996	6	1	3	9.84

Appendix 2. Pteropus samoensis survey data 1995-1996

1995	5	1	3	8.16	1996	4	1	3	6.56
1995	2	1	3	3.26	1996	3	1	3	4.92
1995	5	1	3	8.16	1996	7	1	3	11.48
1995	2	1	3	3.26	1996	2	1	3	3.28
1995	5	2	3	8.16	1996	5	1	3	8.20
1995	4	2	3	6.53	1996	4	2	3	6.56
1995	7	2	3	11.42	1996	2	2	3	3.28
1995	4	2	3	6.53	1996	7	2	3	11.48
1995	5	2	3	8.16	1996	6	2	3	9.84
1995	2	2	3	3.26	1996	3	2	3	4.92
1995	4	2	3	6.53	1996	5	2	3	8.20
1995	0	2	3	0.00	1996	3	2	3	4.92
1995	7	3	3	11.42	1996	3	2	3	4.92
1995	4	3	3	6.53	1996	1	3	3	1.64
1995	8	3	3	13.05	1996	2	3	3	3.28
1995	4	3	3	6.53	1996	2	3	3	3.28
1995	3	3	3	4.89	1996	2	3	3	3.28
1995	5	3	3	8.16	1996	1	3	3	1.64
1995	7	3	3	11.42	1996	0	3	3	0.00
1995	3	3	3	4.89	1996	0	3	3	0.00
1995	1	4	3	1.63	1996	1	3	3	1.64
1995	4	4	3	6.53	1996	3	4	3	4.92
1995	5	4	3	8.16	1996	1	4	3	1.64
1995	15	4	3	24.47	1996	1	4	3	1.64
1995	0	4	3	0.00	1996	0	4	3	0.00
1995	0	4	3	0.00	1996	0	4	3	0.00
1995	1	4	3	1.63	1996	1	4	3	1.64
1995	0	4	3	0.00	1996	3	4	3	4.92
1995	2	5	3	3.26	1996	1	4	3	1.64
1995	5	5	3	8.16	1996	2	5	3	3.28
1995	4	5	3	6.53	1996	2	5	3	3.28
1995	2	5	3	3.26	1996	1	5	3	1.64
1995	3	5	3	4.89	1996	5	5	3	8.20
1995	5	5	3	8.16	1996	2	5	3	3.28
1995	4	5	3	6.53	1996	1	5	3	1.64
1995	5	5	3	8.16	1996	1	5	3	1.64
1995	5	6	3	8.16	1996	5	5	3	8.20
1995	9	6	3	14.68	1996	5	6	3	8.20
1995	6	6	3	9.79	1996	2	6	3	3.28
1995	5	6	3	8.16	1996	2	6	3	3.28
1995	6	6	3	9.79	1996	2	6	3	3.28
1995	3	6	3	4.89	1996	1	6	3	1.64
1995	1	6	3	1.63	1996	1	6	3	1.64
1995	0	6	3	0.00	1996	1	6	3	1.64
1995	1	7	3	1.63	1996	2	7	3	3.28
1995	6	7	3	9.79	1996	2	7	3	3.28
1995	4	7	3	6.53	1996	3	7	3	4.92
1995	1	7	3	1.63	1996	2	7	3	3.28
1995	1	7	3	1.63	1996	0	7	3	0.00

Appendix 2. Pteropus samoensis survey data 1995-1996

	1995	2	7	3	3.26		1996	1	7	3	1.64
	1995	3	7	3	4.89		1996	3	7	3	4.92
	1995	1	7	3	1.63		1996	2	7	3	3.28
	1995	2	8	3	3.26		1996	3	8	3	4.92
	1995	2	8	3	3.26		1996	1	8	3	1.64
	1995	5	8	3	8.16		1996	3	8	3	4.92
	1995	2	8	3	3.26		1996	1	8	3	1.64
	1995	5	8	3	8.16		1996	3	8	3	4.92
	1995	3	8	3	4.89		1996	1	8	3	1.64
	1995	2	8	3	3.26		1996	3	8	3	4.92
	1995	4	8	3	6.53		1996	1	8	3	1.64
	1995	4	9	3	6.53		1996	0	9	3	0.00
	1995	3	9	3	4.89		1996	4	9	3	6.56
	1995	2	9	3	3.26		1996	1	9	3	1.64
	1995	4	9	3	6.53		1996	2	9	3	3.28
	1995	0	9	3	0.00		1996	2	9	3	3.28
	1995	2	9	3	3.26		1996	2	9	3	3.28
	1995	0	9	3	0.00		1996	1	9	3	1.64
	1995	1	9	3	1.63		1996	1	9	3	1.64
	1995	4	10	3	6.53		1996	0	10	3	0.00
	1995	2	10	3	3.26		1996	2	10	3	3.28
	1995	2	10	3	3.26		1996	2	10	3	3.28
	1995	6	10	3	9.79		1996	3	10	3	4.92
	1995	4	10	3	6.53		1996	2	10	3	3.28
	1995	2	10	3	3.26		1996	5	10	3	8.20
	1995	3	10	3	4.89		1996	4	10	3	6.56
	1995	4	10	3	6.53		1996	4	10	3	6.56
	1995	2	11	3	3.26		1996	5	11	3	8.20
	1995	6	11	3	9.79		1996	3	11	3	4.92
	1995	7	11	3	11.42		1996	3	11	3	4.92
	1995	5	11	3	8.16		1996	3	11	3	4.92
	1995	2	11	3	3.26		1996	3	11	3	4.92
	1995	2	11	3	3.26		1996	5	11	3	8.20
	1995	2	11	3	3.26		1996	2	11	3	3.28
	1995	1	11	3	1.63		1996	1	11	3	1.64
	1995	2	12	3	3.26		1996	1	11	3	1.64
	1995	1	12	3	1.63		1996	6	12	3	9.84
	1995	1	12	3	1.63		1996	1	12	3	1.64
	1995	0	12	3	0.00		1996	4	12	3	6.56
	1995	1	12	3	1.63		1996	2	12	3	3.28
	1995	0	12	3	0.00		1996	3	12	3	4.92
	1995	0	12	3	0.00		1996	3	12	3	4.92
	1995	1	12	3	1.63		1996	3	12	3	4.92
Leone	1995	4	1	4	20.00		1996	2	12	3	3.28
=.20	1995	2	1	4	10.00	Leone	1996	1	1	4	5.00
	1995	4	1	4	20.00	=.20	1996	0	1	4	0.00
	1995	6	1	4	30.00		1996	0	1	4	0.00
	1995	4	1	4	20.00		1996	0	1	4	0.00
	1995	5	1	4	25.00		1996	1	1	4	5.00

Appendix 2. Pteropus samoensis survey data 1995-1996

1995	3	1	4	15.00	1996	1	1	4	5.00
1995	3	1	4	15.00	1996	1	1	4	5.00
1995	3	2	4	15.00	1996	1	1	4	5.00
1995	3	2	4	15.00	1996	2	2	4	10.00
1995	3	2	4	15.00	1996	2	2	4	10.00
1995	1	2	4	5.00	1996	2	2	4	10.00
1995	4	2	4	20.00	1996	3	2	4	15.00
1995	5	2	4	25.00	1996	0	2	4	0.00
1995	5	2	4	25.00	1996	1	2	4	5.00
1995	5	2	4	25.00	1996	1	2	4	5.00
1995	4	3	4	20.00	1996	6	2	4	30.00
1995	6	3	4	30.00	1996	0	2	4	0.00
1995	5	3	4	25.00	1996	5	3	4	25.00
1995	3	3	4	15.00	1996	6	3	4	30.00
1995	5	3	4	25.00	1996	5	3	4	25.00
1995	1	3	4	5.00	1996	5	3	4	25.00
1995	0	3	4	0.00	1996	1	3	4	5.00
1995	4	3	4	20.00	1996	2	3	4	10.00
1995	1	4	4	5.00	1996	3	3	4	15.00
1995	0	4	4	0.00	1996	5	4	4	25.00
1995	2	4	4	10.00	1996	1	4	4	5.00
1995	1	4	4	5.00	1996	4	4	4	20.00
1995	0	4	4	0.00	1996	6	4	4	30.00
1995	1	4	4	5.00	1996	4	4	4	20.00
1995	1	4	4	5.00	1996	0	4	4	0.00
1995	0	4	4	0.00	1996	1	4	4	5.00
1995	1	5	4	5.00	1996	1	4	4	5.00
1995	1	5	4	5.00	1996	1	5	4	5.00
1995	2	5	4	10.00	1996	2	5	4	10.00
1995	2	5	4	10.00	1996	2	5	4	10.00
1995	0	5	4	0.00	1996	1	5	4	5.00
1995	2	5	4	10.00	1996	1	5	4	5.00
1995	1	5	4	5.00	1996	3	5	4	15.00
1995	1	5	4	5.00	1996	3	5	4	15.00
1995	0	6	4	0.00	1996	1	5	4	5.00
1995	2	6	4	10.00	1996	0	6	4	0.00
1995	0	6	4	0.00	1996	0	6	4	0.00
1995	3	6	4	15.00	1996	0	6	4	0.00
1995	0	6	4	0.00	1996	2	6	4	10.00
1995	1	6	4	5.00	1996	2	6	4	10.00
1995	0	6	4	0.00	1996	3	6	4	15.00
1995	1	6	4	5.00	1996	3	6	4	15.00
1995	0	7	4	0.00	1996	6	6	4	30.00
1995	3	7	4	15.00	1996	2	7	4	10.00
1995	3	7	4	15.00	1996	2	7	4	10.00
1995	0	7	4	0.00	1996	4	7	4	20.00
1995	1	7	4	5.00	1996	2	7	4	10.00
1995	2	7	4	10.00	1996	3	7	4	15.00
1995	2	7	4	10.00	1996	1	7	4	5.00

Appendix 2. Pteropus samoensis survey data 1995-1996

	1995	0	7	4	0.00		1996	0	7	4	0.00
	1995	3	8	4	15.00		1996	1	7	4	5.00
	1995	1	8	4	5.00		1996	2	8	4	10.00
	1995	2	8	4	10.00		1996	1	8	4	5.00
	1995	0	8	4	0.00		1996	4	8	4	20.00
	1995	3	8	4	15.00		1996	5	8	4	25.00
	1995	1	8	4	5.00		1996	6	8	4	30.00
	1995	2	8	4	10.00		1996	2	8	4	10.00
	1995	2	8	4	10.00		1996	3	8	4	15.00
	1995	0	9	4	0.00		1996	2	8	4	10.00
	1995	3	9	4	15.00		1996	3	9	4	15.00
	1995	3	9	4	15.00		1996	2	9	4	10.00
	1995	5	9	4	25.00		1996	4	9	4	20.00
	1995	4	9	4	20.00		1996	2	9	4	10.00
	1995	1	9	4	5.00		1996	5	9	4	25.00
	1995	2	9	4	10.00		1996	5	9	4	25.00
	1995	1	9	4	5.00		1996	2	9	4	10.00
	1995	1	10	4	5.00		1996	4	9	4	20.00
	1995	3	10	4	15.00		1996	3	10	4	15.00
	1995	1	10	4	5.00		1996	2	10	4	10.00
	1995	1	10	4	5.00		1996	4	10	4	20.00
	1995	3	10	4	15.00		1996	1	10	4	5.00
	1995	1	10	4	5.00		1996	1	10	4	5.00
	1995	1	10	4	5.00		1996	3	10	4	15.00
	1995	0	10	4	0.00		1996	1	10	4	5.00
	1995	4	11	4	20.00		1996	2	10	4	10.00
	1995	4	11	4	20.00		1996	2	11	4	10.00
	1995	5	11	4	25.00		1996	2	11	4	10.00
	1995	2	11	4	10.00		1996	0	11	4	0.00
	1995	1	11	4	5.00		1996	1	11	4	5.00
	1995	2	11	4	10.00		1996	4	11	4	20.00
	1995	2	11	4	10.00		1996	4	11	4	20.00
	1995	4	11	4	20.00		1996	5	11	4	25.00
	1995	4	12	4	20.00		1996	6	11	4	30.00
	1995	4	12	4	20.00		1996	2	11	4	10.00
	1995	3	12	4	15.00		1996	1	12	4	5.00
	1995	0	12	4	0.00		1996	0	12	4	0.00
	1995	3	12	4	15.00		1996	4	12	4	20.00
	1995	0	12	4	0.00		1996	8	12	4	40.00
	1995	3	12	4	15.00		1996	2	12	4	10.00
	1995	0	12	4	0.00		1996	2	12	4	10.00
Malaeimi	1995	2	1	5	2.15		1996	1	12	4	5.00
=.93	1995	6	1	5	6.45		1996	2	12	4	10.00
	1995	2	1	5	2.15	Malaeimi	1996	0	1	5	0.00
	1995	3	1	5	3.23	=.93	1996	1	1	5	1.08
	1995	1	1	5	1.08		1996	2	1	5	2.15
	1995	1	1	5	1.08		1996	0	1	5	0.00
	1995	3	1	5	3.23		1996	2	1	5	2.15
	1995	0	1	5	0.00		1996	1	1	5	1.08

Appendix 2. Pteropus samoensis survey data 1995-1996

1995	0	2	5	0.00	1996	2	1	5	2.15
1995	1	2	5	1.08	1996	2	1	5	2.15
1995	3	2	5	3.23	1996	0	2	5	0.00
1995	2	2	5	2.15	1996	0	2	5	0.00
1995	0	2	5	0.00	1996	1	2	5	1.08
1995	3	2	5	3.23	1996	0	2	5	0.00
1995	1	2	5	1.08	1996	0	2	5	0.00
1995	4	2	5	4.30	1996	2	2	5	2.15
1995	4	3	5	4.30	1996	0	2	5	0.00
1995	5	3	5	5.38	1996	2	2	5	2.15
1995	3	3	5	3.23	1996	5	3	5	5.38
1995	2	3	5	2.15	1996	0	3	5	0.00
1995	3	3	5	3.23	1996	3	3	5	3.23
1995	2	3	5	2.15	1996	0	3	5	0.00
1995	3	3	5	3.23	1996	1	3	5	1.08
1995	0	3	5	0.00	1996	0	3	5	0.00
1995	1	4	5	1.08	1996	2	3	5	2.15
1995	0	4	5	0.00	1996	1	3	5	1.08
1995	0	4	5	0.00	1996	3	4	5	3.23
1995	0	4	5	0.00	1996	0	4	5	0.00
1995	0	4	5	0.00	1996	3	4	5	3.23
1995	1	4	5	1.08	1996	3	4	5	3.23
1995	0	4	5	0.00	1996	2	4	5	2.15
1995	0	4	5	0.00	1996	1	4	5	1.08
1995	0	5	5	0.00	1996	2	4	5	2.15
1995	0	5	5	0.00	1996	0	4	5	0.00
1995	0	5	5	0.00	1996	1	5	5	1.08
1995	0	5	5	0.00	1996	2	5	5	2.15
1995	0	5	5	0.00	1996	4	5	5	4.30
1995	1	5	5	1.08	1996	1	5	5	1.08
1995	0	5	5	0.00	1996	1	5	5	1.08
1995	0	5	5	0.00	1996	3	5	5	3.23
1995	4	6	5	4.30	1996	1	5	5	1.08
1995	2	6	5	2.15	1996	2	5	5	2.15
1995	2	6	5	2.15	1996	1	6	5	1.08
1995	1	6	5	1.08	1996	0	6	5	0.00
1995	2	6	5	2.15	1996	1	6	5	1.08
1995	0	6	5	0.00	1996	3	6	5	3.23
1995	0	6	5	0.00	1996	1	6	5	1.08
1995	0	6	5	0.00	1996	3	6	5	3.23
1995	1	7	5	1.08	1996	1	6	5	1.08
1995	1	7	5	1.08	1996	3	6	5	3.23
1995	4	7	5	4.30	1996	0	7	5	0.00
1995	5	7	5	5.38	1996	1	7	5	1.08
1995	1	7	5	1.08	1996	1	7	5	1.08
1995	1	7	5	1.08	1996	2	7	5	2.15
1995	3	7	5	3.23	1996	3	7	5	3.23
1995	2	7	5	2.15	1996	5	7	5	5.38
1995	4	8	5	4.30	1996	3	7	5	3.23

Appendix 2. Pteropus samoensis survey data 1995-1996

	1995	2	8	5	2.15		1996	3	7	5	3.23
	1995	2	8	5	2.15		1996	1	8	5	1.08
	1995	4	8	5	4.30		1996	2	8	5	2.15
	1995	2	8	5	2.15		1996	2	8	5	2.15
	1995	1	8	5	1.08		1996	2	8	5	2.15
	1995	0	8	5	0.00		1996	1	8	5	1.08
	1995	1	8	5	1.08		1996	7	8	5	7.53
	1995	2	9	5	2.15		1996	3	8	5	3.23
	1995	2	9	5	2.15		1996	3	8	5	3.23
	1995	4	9	5	4.30		1996	4	9	5	4.30
	1995	4	9	5	4.30		1996	2	9	5	2.15
	1995	0	9	5	0.00		1996	2	9	5	2.15
	1995	1	9	5	1.08		1996	2	9	5	2.15
	1995	0	9	5	0.00		1996	1	9	5	1.08
	1995	0	9	5	0.00		1996	2	9	5	2.15
	1995	4	10	5	4.30		1996	3	9	5	3.23
	1995	5	10	5	5.38		1996	2	9	5	2.15
	1995	5	10	5	5.38		1996	1	9	5	1.08
	1995	2	10	5	2.15		1996	5	10	5	5.38
	1995	5	10	5	5.38		1996	4	10	5	4.30
	1995	3	10	5	3.23		1996	3	10	5	3.23
	1995	3	10	5	3.23		1996	3	10	5	3.23
	1995	2	10	5	2.15		1996	1	10	5	1.08
	1995	5	11	5	5.38		1996	5	10	5	5.38
	1995	6	11	5	6.45		1996	1	10	5	1.08
	1995	1	11	5	1.08		1996	2	10	5	2.15
	1995	1	11	5	1.08		1996	5	11	5	5.38
	1995	4	11	5	4.30		1996	5	11	5	5.38
	1995	1	11	5	1.08		1996	2	11	5	2.15
	1995	1	11	5	1.08		1996	3	11	5	3.23
	1995	1	11	5	1.08		1996	5	11	5	5.38
	1995	2	12	5	2.15		1996	4	11	5	4.30
	1995	2	12	5	2.15		1996	1	12	5	1.08
	1995	2	12	5	2.15		1996	2	12	5	2.15
	1995	1	12	5	1.08		1996	2	12	5	2.15
	1995	2	12	5	2.15		1996	4	12	5	4.30
	1995	2	12	5	2.15		1996	1	12	5	1.08
	1995	3	12	5	3.23	Nu'uuli	1996	2	1	6	3.51
	1995	1	12	5	1.08	=.57	1996	3	1	6	5.26
Nu'uuli	1995	3	1	6	5.26		1996	1	1	6	1.75
=.57	1995	6	1	6	10.53		1996	2	1	6	3.51
	1995	4	1	6	7.02		1996	2	1	6	3.51
	1995	3	1	6	5.26		1996	0	1	6	0.00
	1995	2	1	6	3.51		1996	1	1	6	1.75
	1995	7	1	6	12.28		1996	2	2	6	3.51
	1995	2	1	6	3.51		1996	0	2	6	0.00
	1995	1	1	6	1.75		1996	1	2	6	1.75
	1995	2	2	6	3.51		1996	4	2	6	7.02
	1995	3	2	6	5.26		1996	3	2	6	5.26

Appendix 2. *Pteropus samoensis* survey data 1995-1996

1995	1	2	6	1.75		1996	1	2	6	1.75
1995	3	2	6	5.26		1996	5	2	6	8.77
1995	2	2	6	3.51		1996	0	2	6	0.00
1995	2	2	6	3.51		1996	1	3	6	1.75
1995	1	2	6	1.75		1996	1	3	6	1.75
1995	0	2	6	0.00		1996	1	3	6	1.75
1995	1	3	6	1.75		1996	2	3	6	3.51
1995	1	3	6	1.75		1996	1	3	6	1.75
1995	0	3	6	0.00		1996	2	3	6	3.51
1995	1	3	6	1.75		1996	3	3	6	5.26
1995	2	3	6	3.51		1996	0	3	6	0.00
1995	2	3	6	3.51		1996	2	4	6	3.51
1995	2	3	6	3.51		1996	2	4	6	3.51
1995	2	3	6	3.51		1996	6	4	6	10.53
1995	1	4	6	1.75		1996	3	4	6	5.26
1995	0	4	6	0.00		1996	4	4	6	7.02
1995	3	4	6	5.26		1996	3	4	6	5.26
1995	1	4	6	1.75		1996	2	4	6	3.51
1995	0	4	6	0.00		1996	3	4	6	5.26
1995	0	4	6	0.00		1996	2	5	6	3.51
1995	1	4	6	1.75		1996	2	5	6	3.51
1995	1	4	6	1.75		1996	1	5	6	1.75
1995	2	5	6	3.51		1996	3	5	6	5.26
1995	1	5	6	1.75		1996	1	5	6	1.75
1995	1	5	6	1.75		1996	4	5	6	7.02
1995	3	5	6	5.26		1996	3	5	6	5.26
1995	1	5	6	1.75		1996	5	5	6	8.77
1995	2	5	6	3.51		1996	0	6	6	0.00
1995	0	5	6	0.00		1996	1	6	6	1.75
1995	1	5	6	1.75		1996	5	6	6	8.77
1995	3	6	6	5.26		1996	2	6	6	3.51
1995	4	6	6	7.02		1996	2	6	6	3.51
1995	7	6	6	12.28		1996	4	6	6	7.02
1995	4	6	6	7.02		1996	2	6	6	3.51
1995	4	6	6	7.02		1996	4	6	6	7.02
1995	2	6	6	3.51		1996	0	7	6	0.00
1995	0	6	6	0.00		1996	0	7	6	0.00
1995	2	6	6	3.51		1996	0	7	6	0.00
1995	1	8	6	1.75		1996	3	7	6	5.26
1995	5	8	6	8.77		1996	1	7	6	1.75
1995	2	8	6	3.51		1996	4	7	6	7.02
1995	3	8	6	5.26		1996	3	7	6	5.26
1995	3	8	6	5.26		1996	1	7	6	1.75
1995	1	8	6	1.75		1996	2	8	6	3.51
1995	2	8	6	3.51		1996	0	8	6	0.00
1995	3	8	6	5.26		1996	4	8	6	7.02
1995	1	7	6	1.75		1996	5	8	6	8.77
1995	3	7	6	5.26		1996	0	8	6	0.00
1995	7	7	6	12.28		1996	0	8	6	0.00

Appendix 2. Pteropus samoensis survey data 1995-1996

	1995	2	7	6	3.51		1996	2	8	6	3.51
	1995	3	7	6	5.26		1996	1	8	6	1.75
	1995	0	7	6	0.00		1996	2	9	6	3.51
	1995	1	7	6	1.75		1996	2	9	6	3.51
	1995	0	7	6	0.00		1996	1	9	6	1.75
	1995	7	9	6	12.28		1996	2	9	6	3.51
	1995	3	9	6	5.26		1996	2	9	6	3.51
	1995	1	9	6	1.75		1996	3	9	6	5.26
	1995	1	9	6	1.75		1996	1	9	6	1.75
	1995	0	9	6	0.00		1996	1	9	6	1.75
	1995	1	9	6	1.75		1996	1	10	6	1.75
	1995	1	9	6	1.75		1996	2	10	6	3.51
	1995	2	9	6	3.51		1996	1	10	6	1.75
	1995	5	10	6	8.77		1996	2	10	6	3.51
	1995	1	10	6	1.75		1996	6	10	6	10.53
	1995	3	10	6	5.26		1996	2	10	6	3.51
	1995	3	10	6	5.26		1996	4	10	6	7.02
	1995	1	10	6	1.75		1996	1	10	6	1.75
	1995	1	10	6	1.75		1996	1	11	6	1.75
	1995	3	10	6	5.26		1996	5	11	6	8.77
	1995	0	10	6	0.00		1996	2	11	6	3.51
	1995	3	11	6	5.26		1996	3	11	6	5.26
	1995	2	11	6	3.51		1996	4	11	6	7.02
	1995	3	11	6	5.26		1996	2	11	6	3.51
	1995	1	11	6	1.75		1996	1	11	6	1.75
	1995	0	11	6	0.00		1996	2	11	6	3.51
	1995	1	11	6	1.75		1996	3	12	6	5.26
	1995	3	11	6	5.26		1996	4	12	6	7.02
	1995	2	11	6	3.51		1996	1	12	6	1.75
	1995	3	12	6	5.26		1996	4	12	6	7.02
	1995	3	12	6	5.26		1996	6	12	6	10.53
	1995	1	12	6	1.75		1996	2	12	6	3.51
	1995	3	12	6	5.26		1996	1	12	6	1.75
	1995	2	12	6	3.51		1996	2	12	6	3.51
	1995	0	12	6	0.00					sum	6991
	1995	0	12	6	0.00					avera	12.22
	1995	2	12	6	3.51			pop est		*69.9	854
				sum	7604			pop est		*76	929
		average bats/			13.20						
		69.9k	forest	923	pop est						
		76km	forest	1003	pop est						

Appendix 3. *Pteropus samoensis* 15 replecate counts, Leone

count	period	day	Surveys done with 8 ten minute counts per day.
5	1	1	period is the number of the ten minute period, first, second, etc
7	2	1	
4	3	1	count is number of bats observed in flight
1	4	1	
3	5	1	
4	6	1	
1	7	1	
1	8	1	
4	1	2	
5	2	2	
3	3	2	
3	4	2	
3	5	2	
2	6	2	
2	7	2	
2	8	2	
5	1	3	
5	2	3	
3	3	3	
3	4	3	
4	5	3	
0	6	3	
2	7	3	
0	8	3	
2	1	4	
5	2	4	
5	3	4	
1	4	4	
3	5	4	
5	6	4	
3	7	4	
1	8	4	
3	1	5	
4	2	5	
4	3	5	
3	4	5	
4	5	5	
3	6	5	
1	7	5	

Appendix 3. *Pteropus samoensis* 15 replicate counts, Leone

5	8	5							
4	1	6							
3	2	6							
1	3	6							
4	4	6							
4	5	6							
4	6	6							
1	7	6							
2	8	6							
5	1	7							
3	2	7							
4	3	7							
1	4	7							
0	5	7							
4	6	7							
0	7	7							
6	8	7							
6	1	8							
2	2	8							
4	3	8							
7	4	8							
0	5	8							
0	6	8							
0	7	8							
1	8	8							
2	1	9							
3	2	9							
3	3	9							
2	4	9							
4	5	9							
3	6	9							
3	7	9							
3	8	9							
3	1	10							
2	2	10							
5	3	10							
3	4	10							
3	5	10							
2	6	10							
3	7	10							

Appendix 3. *Pteropus samoensis* 15 replicate counts, Leone

1	8	10							
4	1	11							
1	2	11							
2	3	11							
3	4	11							
2	5	11							
3	6	11							
2	7	11							
2	8	11							
5	1	12							
6	2	12							
3	3	12							
3	4	12							
0	5	12							
0	6	12							
0	7	12							
0	8	12							
5	1	13							
7	2	13							
5	3	13							
3	4	13							
4	5	13							
2	6	13							
2	7	13							
1	8	13							
4	1	14							
6	2	14							
5	3	14							
4	4	14							
5	5	14							
3	6	14							
2	7	14							
3	8	14							
5	1	15							
4	2	15							
6	3	15							
4	4	15							
1	5	15							
0	6	15							
2	7	15							

Appendix 3. *Pteropus samoensis* 15 replicate counts, Leone

2	8	15							
5	1	16							
5	2	16							
2	3	16							
3	4	16							
4	5	16							

Appendix 4. Pteropus samoensis survey data, Manu'a Islands

year	count	site	Sites key		
1996	1	6	Ta'u 1	Lepula	
1996	0	6	2	Avatele Cove	
1996	1	6	3	Loto Point	
1996	0	6	4	Saua south	
1996	2	4	5	Saua north	
1996	1	4	6	Luamau	
1996	1	4	7	Letula	
1996	1	4	Ofu 8	hotel	
1996	1	5	9	Toaga east	
1996	2	5	10	Toaga west	
1996	1	5	11	Ofu Harbor	
1996	3	5	12	Ofu village	
1996	1	2	13	Ofu jetty	
1996	3	2	Olosega	14 Sili west	
1996	1	3	15	Sili east	
1996	1	3	16	village	
1996	1	17	17	dump	
1996	3	17			
1996	1	17			
1996	0	17			
1996	1	16			
1996	0	16			
1996	0	16			
1996	0	10			
1996	0	10			
1996	1	10			
1996	0	10			
1996	4	15			
1996	4	15			
1996	4	15			
1996	3	15			
1996	5	14			
1996	3	14			
1996	3	14			
1996	3	14			
1996	1	13			
1996	3	13			
1996	1	13			
1996	0	13			

Appendix 4. Pteropus samoensis survye data, Manu'a Islands

1996	1	8				
1996	1	8				
1996	3	8				
1996	3	8				
1996	1	9				
1996	0	9				
1996	0	9				
1994	0	6				
1994	0	6				
1994	0	6				
1994	0	5				
1994	0	5				
1994	1	5				
1994	0	5				
1994	0	9				
1994	0	9				
1994	0	9				
1994	0	9				
1994	1	10				
1994	2	10				
1994	0	10				
1994	5	10				
1994	1	10				
1994	0	13				
1994	0	13				
1994	1	13				
1994	0	13				
1994	0	11				
1994	0	11				
1994	0	11				
1994	0	11				
1994	1	11				
1994	2	8				
1994	1	8				
1994	2	8				
1994	2	8				
1994	1	8				
1994	2	15				
1994	0	15				
1994	2	15				

Appendix 4. Pteropus samoensis survey data, Manu'a Islands

1994	2	15				
1994	0	14				
1994	4	14				
1994	1	14				
1994	4	14				
1994	0	17				
1994	2	17				
1994	0	17				
1994	0	17				
1994	0	16				
1994	3	16				
1994	3	16				
1994	2	16				
1994	4	3				
1994	4	3				
1994	2	3				
1994	4	2				
1994	2	2				
1994	2	2				
1994	5	1				
1994	7	1				
1994		1				