GOVERNMENT OF AMERICAN SAMOA
DEPARTMENT OF MARINE AND WILDLIFE RESOURCES

FY96 STUDY/JOB DESCRIPTION

PROJECT: American Samoa Wildlife Investigations
STUDY: Fruit Bat Studies
JOB: Abundance and distribution

STUDY: 1
JOB: 1

OBJECTIVES: Determine the abundance and distribution of the two species of fruit bats in American Samoa.

BACKGROUND: Two species of fruit bats, or flying foxes, occur in American Samoa: the white-necked fruit bat, Pteropus tonganus, and the Samoan fruit bat, P. samoensis. These bats are important seed dispersers in the native rainforest, they are important in the folklore and culture of the Samoan people, and they are traditionally hunted for food.

Data on the status and distribution of fruit bats in Samoa have been collected by the Department of Marine and Wildlife Resources and cooperating agencies over the past seven years. Population declines on the order of 80-90% in the late 1980s and early 1990s have been stopped and populations are slowly increasing. Juvenile bats now seen on a regular basis however young may be two years old before they are able to reproduce.

These very significant and troubling declines and the slow growth of the populations necessitate that thorough monitoring of P. tonganus and P. samoensis populations be continued. Development of a standard methodology for bat surveys by the Department has greatly enhanced the value of these data.

APPROACH: Pteropus samoensis surveys are conducted on a monthly basis at six permanent sites on Tutuila Island. Surveys begin at first light and continue for the next two hours. Data are collected during ten minute sample periods, separated by five minute breaks, for a total of eight samples for each site per census period. Similar surveys are conducted annually at 12 permanent sites on the Manua Islands (four each on Ta'u, Ofu, and Oloataa).

For each of the six sites, DMWR will calculate the average number of observed fruit bats per hectare. A grand mean will then be used to determine the overall average number of bats observed per hectare per ten minute sample. A population estimate will be made by expanding the grand mean estimate to include areas of the island possessing fruit bat habitat that were not sampled. This will provide DMWR with a "Population Index" of fruit bat numbers to determine long-term trends in abundance.

Information on the distribution and status of P. tonganus will be gathered by making quarterly visits to all known communal roost sites on Tutuila. Pteropus tonganus typically roosts in large aggregations whose locations remain relatively consistent for months or even years. Numbers of bats observed at all colonies will be counted over a three day period to minimize double counting.
bats that may have changed roost sites. Counts are made both on land (from roads and other
vantage points) and from the sea (to count the many roosts in inaccessible coastal locations).
Population counts at roosts will be augmented by censuses bats at dusk as they leave the roosts.
Because of dense vegetation in some roosts, these exit counts give us a better estimate of P.tonganus populations than daytime roost counts. Assuming that DMWR does not presently
know the location of all bat roost locations in the territory, this information will provide a
"minimum estimate" of the number of bats found here.

RESULTS: The activity of P. samoensis during the day has led to the assumption that the bat is
and Ebring in 1986, 1989, and 1993, and by DMWR prior to 1992 were done at various times
throughout the day. To determine when P. samoensis is active, we counted the number of bats in
flight during 10 minute periods, at ten minute intervals from dawn until dusk over 5 day periods in
January, March, June, and October at Amalau valley. Counts were also done in March and
October in the Nu‘uuli valley. We also compared the distances traveled and frequency of
movement of bats carrying radio collars during day and night (see job 4).

Figure 1 shows the mean and standard error of all day counts for four months. At all months, bats
are most active during the early morning and late afternoon. Pteropus samoensis is active
throughout the day in January, but during the June and October counts activity dropped
dramatically at mid-day. Radio telemetry data also has shown that bats fly more frequently and
for longer distances at night (see job 4). Bats carrying radio collars returned to their home range
area well before dawn. These two methods of activity assessment indicate that census counts of P.
samoensis that are made throughout the day give inaccurate numbers. P. samoensis can be active
throughout the day, depending on the time of year, but can not be called a "diurnal" bat.

The results of two years, 1995-1996, of morning surveys for P. samoensis is given in Fig. 2. For
the 1992-1994 counts, 20 minute periods were used to count bats. Data from the 1992-1994
counts has not included. Starting in 1995, counts were reduced to 10 minute periods which
enabled us to distinguish individuals at the more populated sites. Prior to 1995 up to 8 different
people were observers and starting times were not standardized. The extreme difficulty in
distinguishing between the two species makes the accuracy of the pre-1995 counts questionable,

There are a number of problems with the surveys. During any 10 minute period, bats are seen 1)
moving through the survey area, 2) moving within the area, roosting for short times then flying to
a different roost, 3) entering the area, 4) leaving the area. During different counts, some of the
same individuals are seen again. 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 active bats are and one
individual can account for many sightings.

The Aea valley has a decreasing trend, however there is a large P. tonganus roost within the
observation area. Very difficult to distinguish between the species when P. tonganus flies low in
the vegetation. The apparent decline may be a reflection of inaccuracies in identifying the two
species.
Fig. 1. *Pteropus samoensis* all day observations, Amalau valley. Mean and standard error of ten minute periods, five days each month.

- **January**
  - Bats/km²/10 minute period
  - Dawn to Dark

- **March**
  - Bats/km²/10 minute period
  - Dawn to Dark

- **June**
  - Bats/km²/10 minute period
  - Dawn to Dark

- **October**
  - Bats/km²/10 minute period
  - Dawn to Dark
Fig. 2. *Pteropus samoensis* monthly counts. Mean and standard error for 8 ten minute periods monthly.
Fig. 3 *Pteropus tonganus* population estimate from roost counts, Tutuila Island.
GOVERNMENT OF AMERICAN SAMOA
DEPARTMENT OF MARINE AND WILDLIFE RESOURCES

FY96 STUDY/JOB DESCRIPTION

PROJECT: American Samoa Wildlife Investigations
STUDY: Fruit Bat Studies
JOB: Population analysis
STUDY: 1
JOB: 2

OBJECTIVES: Determine the amount of genetic divergence and movement among fruit bat populations on Tutuila, Manu‘a, Western Samoa, and Fiji.

BACKGROUND: Two species of flying fox fruit bats are found on American Samoa, the Samoan fruit bat, Pteropus samoensis, and the white-necked fruit bat, P. tonganus. The Samoan fruit bat is found only in the Samoan archipelago and Fiji.

We believe the population of the Samoan fruit bat, P. samoensis, on Tutuila to be around 1,000 individuals although the population has increased slowly after the all-time low after hurricane Val in 1991. We do not know whether the increase in population is a result of individuals breeding on Tutuila or whether there has been emigration from other islands. The small population of Samoan fruit bats is vulnerable to poaching and loss of habitat from expansion of agricultural land and future hurricanes.

Tutuila supports larger populations of the white-necked fruit bat, P. tonganus. During the 1980’s and early 1990’s the population declined from 14,000 to less than 2,000 individuals. At present, this species is showing a good recovery with approximately 4,500 individuals on Tutuila.

Populations of P. samoensis and F. tonganus on Tutuila, Manu‘a islands and Western Samoa are considered one continuous population. It is unknown whether bats on Fiji are also within this same population. There is no information whether the populations on each island are distinct and non-interbreeding population or if, in fact, there is movement among the islands.

APPROACH: The amount of inter-island movement by fruit bats can be measured by following the movements of marked individuals or by examining differences in the mitochondrial DNA of individuals. Given the difficulties of following marked bats, the likelihood of observing a long-distance movement is very small. The most effective method to measure movement is to compare the DNA of a number of individuals.

A small blood sample will be collected from all bats that are caught for radio telemetry study of home range and foraging areas on Tutuila. Bats on the Manu‘a islands and Western Samoa will netted specifically for this project. Genetic analysis will be undertaken by Dr. G.F. McCracken, University of Tennessee. Preliminary laboratory analysis of samples has yielded high quality DNA.
Low genetic divergence will indicate that there has been recent gene flow among the islands. If necessary, reintroduction would be possible. If genetic divergence high, then island populations are distinct and gene flow between island has not occurred not recently or is very limited. Reintroduction would not be a possible solution if one population were to go extinct.

RESULTS: We have genetic data for 14 P. tonganus and 3 P. samoensis. To date, we have examined these bats at two highly variable microsatellite DNA loci that we have developed for the genus Pteropus. At this writing we have 2 more loci that work for these species.

Pteropus tonganus: This species has very high levels of genetic diversity and high levels of heterozygosity. Given the small sample size, the amount of genetic diversity is impressive, 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) = 0.38, f(D) = 0.08. The average heterozygosity of P. tonganus at these loci is H = 78%. That is 78% of the the loci examined in these bats were in the heterozygous state. The diversity in P. tonganus is impressively large.

There is no strong evidence for any geographic structure, i.e. genetic differences among bats on different islands, but this conclusion is tentative because of the small sample sizes. Most of the same alleles are seen in bats taken from Vatia, Fiji, and Am. Samoa. However, at both loci we see alleles in bats from Vatia, that we do not see in bats from elsewhere: i.e. alleles G & F at locus 1, and allele D at locus 2. The possibility of genetic differences among populations exists but larger sample sizes would be needed to document this possibility.

Pteropus samoensis: The results could not be more different. The three individuals, 2 from Am. Samoa, and one from Fiji are homozygous and identical. That is, we see no variation to date. With the small sample size and limited number of loci examined, I would not conclude that this species is devoid of variation. But, certainly, the variation in this species appears to be lower than the variation that we have seen in any of the other Pteropusids that we have examined with these loci, including P. reticulatus. The examination of more P. samoensis at more loci is critical, and at least the more loci component is underway.

We also have the hair samples of 12 P. samoensis and 17 P. tonganus. We have tried and had trouble getting usable DNA. However, we now have a new protocol that is working quite well for hair from bears, and I'm optimistic that we'll be able to expand the sample size using these hair samples.

LOCATION: Tutuila island, Manu'a islands, Western Samoa, and Fiji
PROJECT SUPERVISOR: Dr. Anne Brooke
GOVERNMENT OF AMERICAN SAMOA
DEPARTMENT OF MARINE AND WILDLIFE RESOURCES

FY96 STUDY/JOB DESCRIPTION

PROJECT: American Samoa Wildlife Investigations
STUDY: Fruit Bat Studies
JOB: Social organization and behavior

STUDY:1
JOB:3

OBJECTIVES: Describe the social organization, demography, and other aspects of the natural history of this species.

BACKGROUND: The Sanoan fruit bat, Pteropus samoensis, does not form large colonies as does the white-necked fruit bat, P. tonganus. Because the bats are difficult to observe, we have little knowledge of the basic biology of this species: timing and rate of reproduction, whether young remain with a parent or disperse, if bats use the same roost repeatedly, how territorial bats are at roost sites and fruiting trees. Pteropus samoensis is apparently a solitary species. As other pteropodid bats are colonial, we are unable to draw from the literature on other species.

APPROACH: We will continue to make detailed field observations of the social and reproductive behaviors. The roosting positions, movements, territorial and mating behaviors of known individuals continue to be observed.

RESULTS: Detailed field observations have been conducted systematically at 6 sites monthly for the past 2 years. A number of individual bats have been identified that are seen repeatedly in the same trees. Individual bats utilize a series of trees as their 'home range' or 'roost'. Territoriality does not extend to roost sites but bats defend fruiting trees aggressively. Aerial chases that terminate when the pursuer bites the interloper are common.

During October in 1995 and 1996, pairs of bats were seen repeatedly in at the same locations and copulations were common. Although it has been suggested that P. samoensis is monogamous (Cox, 1983), we have no evidence to support this. Males have been observed copulating with different females in rapid succession. During other times of the year, we do not see pairs of bats together.

We first see females carrying small young in late March. Most young are born between April and June although some young are born as late as October. Table 1 shows the dates that pups seen carried by females. Pteropodid bats carry young until they are approximately one month old (Pierson and Rainey, 1992). Mothers leave the older young behind when they forage. Juvenile bats were seen in flight beginning in June when 2-3 months old. Young bats were distinguished by clumsy flight. Young bats follow other individuals during June-Sept. Presumably they are following the mother. As in other Pteropodid species (Pierson and Rainey, 1992) P. samoensis do not mate until at least one year old. Adult sized young are frequently seen with the adult female of a mating pair.
Literature

LOCATION: Tutuila island
PROJECT SUPERVISOR: Dr. Anne Brooke
Table 1. Dates, locations and size of *P. samoensis* young carried by females.

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Pups</th>
<th>Size</th>
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<td>March 6</td>
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<td>1</td>
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</tr>
<tr>
<td>March 30</td>
<td>Malaeimi</td>
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<td>Amalau</td>
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<td>May 25</td>
<td>Asili</td>
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<td>Malaeimi</td>
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<td>August 2</td>
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<tr>
<td>October 1</td>
<td>Aoa</td>
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</tr>
<tr>
<td>May 5</td>
<td>Maloata</td>
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<td>small</td>
</tr>
<tr>
<td>May 12</td>
<td>Amalau</td>
<td>3</td>
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<td>Alega</td>
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<td>small</td>
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<tr>
<td>June 2</td>
<td>Aoa</td>
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<td>small</td>
</tr>
<tr>
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<tr>
<td>August 7</td>
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<tr>
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<td>Amalau</td>
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GOVERNMENT OF AMERICAN SAMOA
DEPARTMENT OF MARINE AND WILDLIFE RESOURCES

FY96 STUDY JOB DESCRIPTION

PROJECT: American Samoa Wildlife Investigations
STUDY: Fruit Bat Studies  STUDY: 1
JOB: Home range and movement studies  JOB: 4

OBJECTIVES: Determine home range sizes and activity patterns of the two fruit bat species in American Samoa through the use of radio tracking.

BACKGROUND: Effective conservation and management of the fruit bats of American Samoa require detailed information on their home range sizes, movement patterns, and activity cycles. Visual observation can provide only a limited amount of data on these important parameters, for several reasons. First, P. tonganus, is active primarily at night. Observations at the daytime roosts of this species are obviously inadequate to document ranging and activity patterns. Second, both species of bats are difficult to follow visually as they forage in the forest canopy. They often enter and leave a tree crown at different points, and may fly through the canopy for some distance before re-emerging. Also, the highly dissected topography of American Samoa, with many sharp ridges and narrow ravines, makes visual tracking difficult. Finally, without individually marked bats, it is almost impossible to be certain that the same individual is being followed as it enters and leaves the canopy. The only technique which will address these problems is to capture and radio-tag individuals of both species.

APPROACH: We will continue capturing fruit bats of both species with mist nets rigged near favored feeding sites. Our efforts will concentrate on P. samoensis which has been difficult to capture as they feed in crows of forest trees. Once captured, the bats will be weighed, measured, evaluated for general health and condition, and assessed for reproductive status. Each will then be fitted with a collar containing a radio transmitter, and released. Tracking will begin immediately in order to monitor the location of the bat; however, the first 48 hours of data will probably reveal little about normal ranging or activity patterns. We will continue monitoring the bat’s activity until the daily pattern of activity is determined. Thereafter, we will continue to monitor at less frequent intervals to document ranging patterns. If consistent foraging areas are identified in the telemetry data, we will attempt to reach those sites for visual observation of foraging activity.

Our initial goal will be to obtain extensive telemetry data for five adults of each sex for each of the two fruit bat species. Five P. tonganus were fitted with transmitters in FY93, seven adult males and one adult female were radio tracked in 1994, and two adult male P. samoensis carried radios in 1994. Activity patterns and foraging sites vary tremendously from one bat to another and usage of feeding sites by a bat also varies from night to night. Equipping additional bats with
transmitters and extensive monitoring will be undertaken in FY94 to further document these activities.

RESULTS: Netting efforts have concentrated on capturing *P. samoensis*. Two males were caught in Amalau valley and fitted with radio collars and followed for two months when 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. By recording the bats locations at 10-15 minute intervals, we were able to determine both the home range and foraging area.

Both bats returned before dawn to the same home range, or roost, during the two months they were monitored. The home range covered approximately 7 ha and 10 ha. The bats moved within the home range during the day but did not fly long distances (Fig. 1A). Activity increased in late afternoon as the bats began to forage. During 150 hours of monitoring one individual moved more frequently during the night than during the day (Fig. 2). Bats foraged over large distances at night (Fig. 1B). We were unable to follow the bats foraging on the north coast because of they moved rapidly over ridges where we could not follow.

LOCATION: Tutuila island
PROJECT SUPERVISOR: Dr. Anne Brooke
Fig. 1A. Home range of *P. samoensis* #1. Day time telemetry fixes for Dec. 7 & 8, 1995.

Fig. 1 B. Foraging range of *P. samoensis* #1 for the nights of Dec. 3-4 & Dec. 5-6, 1995.
Fig. 2. Movement of *Pteropus samoensis* during 24 hour period. Data taken during 150 hours of telemetry monitoring during November and December 1995.