

**The Role of Flying Foxes in Maintaining Biodiversity
in Pacific Island Ecosystems**

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**Sandra Banack
Museum of Vertebrate Zoology
University of California
Berkeley, CA 94720**

Executive Summary:

Flying foxes are believed to be important pollinators and seed dispersers in island ecosystems (Cox et al. 1991, 1992; Elmqvist et al. 1992). Because flying foxes are the only indigenous mammal, they are potentially keystone species and therefore crucially important in maintaining the biodiversity of forest communities. Our potential to conserve the diversity of flying fox species will be highly correlated with our understanding of their resource use and basic ecology. I conducted research on the Samoan islands on two species of flying foxes *Pteropus tonganus* and *Pteropus samoensis*. I collected information on resource use and behavioral biology using the following methods: a) focal animal observations; b) radio-tracking; and c) indirect observations under feeding trees. Results detail differences in basic life history traits for the two species and contribute to a more complete understanding of the dynamics of forest regeneration and the role of flying foxes as potential keystone species in these ecosystems. This research provides a baseline to compare seasonal variation in the observed patterns and is directly relevant to conservation and management decisions in the area. Further research is scheduled to examine seasonal variation and thus contribute to long range management plans for flying foxes and the forest communities with which they interact.

Introduction:

Much attention has been focused in recent years on establishing preserves to protect biological diversity. Understanding the processes which maintain that diversity is crucial for their success. In some communities certain species are thought to play disproportionately larger roles than others in interactions that structure communities (Paine 1980, Leigh et al. 1993, Terborgh 1986, Brown and Heske 1990). **These strong interactors deserve attention if we are to make general statements about the kinds of interactions which are important in structuring and maintaining communities, and be in a position to design reserves and manage forests.**

Cox et al. (1991) have hypothesized that flying foxes (fruit bats of the genus *Pteropus*), play important roles as pollinators

and seed dispersers and therefore are strong interactors in oceanic island communities. If flying foxes are strong interactors, then their removal will inevitably lead to changes in community structure and possibly to a cascade of linked extinctions of many species of plants, and the animals that depend upon them. If this hypothesis is correct, then the biodiversity of Pacific islands is at significant risk because populations of flying foxes are declining due to both stochastic natural and anthropogenic causes (Wiles 1987, Wilson and Engbring 1993).

This research focuses on two species of flying fox, *Pteropus tonganus* and *Pteropus samoensis*. It is my aim to detail the overall significance of flying foxes in maintaining island forest diversity and to provide specific recommendations for the conservation of both flying foxes and the forest.

Methods:

I report here the results of an investigation conducted on the islands of Samoa in Western Polynesia from September to December 1992. This work will continue in July 1993 for a minimum of one year in order to establish temporal and spatial variation within the observed patterns.

Thus far, I have located research sites and initiated focal animal observations. Both *Pteropus samoensis* and *Pteropus tonganus* were observed using binoculars, a 20-60X spotting scope, and a night vision device. In addition, *Pteropus tonganus* was studied with the aid of radio-telemetry equipment. Where possible, I conducted searches under feeding trees to verify feeding observations. Fruit bats feed by squeezing fruit pulp between their tongue and the roof of their mouth and subsequently spitting out an "ejecta pellet" of dry pulp. These ejecta pellets and fallen fruits bearing recognizable triangular shaped tooth marks confirm bat use of fruit-bearing trees. I have begun experiments to examine the long term survival of seedlings and have taken measurements to analyze seed shadows both in areas where flying foxes exist and in areas where they have been extirpated.

Most of the information reported here was collected within Amalau Valley on the East Side of Tutuila island, American Samoa. This area has been chosen for inclusion in the National Park of American Samoa which is in the process of being established. Additional data is included from Maloata on Tutuila, and Tafua Tai on Savaii, Western Samoa.

RESULTS:

The results presented here are preliminary and are applicable only for September through December when the data were collected. I will be continuing these studies in July 1993 in order to identify seasonal variation in these patterns.

Pteropus samoensis is diurnal, territorial, and is commonly found in pairs. I found *P. samoensis* to feed predominantly in the early morning and early evening with the greatest number of observations occurring before 8:00am and after 15:00 (See figure 1). **Radio-tracking is needed for this species in order to follow late evening activity.** During 40+ hours of observation from 19:00- 4:00 I found only one *P. samoensis* active. In this incident the bat was vocalizing and may have been defending a roosting site from *P. tonganus* which were abundant in the area. The bats were often observed resting at 8:00 am followed by a second period of foraging at 9:00am and a period of rest in the hottest part of the day. *P. samoensis* generally became active again during the early evening and spent considerable time soaring on afternoon thermal air currents. The peak time for soaring behavior is also the peak time for evening foraging and territorial behavior including scent marking, and vocalizations. The soaring also occurs one hour before most aerial pursuits which appear to be agnostic territorial confrontations. I propose that soaring activity may be associated with surveying feeding areas, digesting food, or displaying territorial boundaries. The activity requires low energetic output and is consistent with all of these hypothesis. Territory size in Amalau averaged 0.5 km² during the period, however further investigation will identify changes in territory size related to resources or population densities.

P. samoensis foraged almost exclusively in the primary forest (See fig.2). Flying foxes remained at a feeding tree for an average of 15 min and handled large seeded fruits for 10 min. I have identified 22 plant species used by flying foxes during this period 6 of which have not been previously recorded in the literature. I observed *P. samoensis* eating fruit, nectar, pollen, and leaves.

Pteropus tonganus is nocturnal, forms harems and actively defends roosting and feeding branches. I found *P. tonganus* to feed between the hours of 18:50 - 5:30 (See fig. 3). The bats were observed actively feeding during the early evening (upon arrival at a feeding site) and during the early morning (before returning to the roost site). In general, *P. tonganus* females leave the roost in the early evening to forage before the males and return after the males in the morning. There appears to be no coordinated exodus or arrival within social groups suggesting limited exchange of feeding information within this group.

P. tonganus fed in both primary forest and agroforested areas on an equal number of tree species in each area. *Pteropus tonganus* is site faithful at feeding sites and returns to the same feeding area night after night. Bats that wore radio collars fed almost exclusively in agroforested areas, however other animals of this species were seen feeding on primary forest trees. Fruit, nectar, and pollen were eaten by this species, however leaves were not observed to be part of there diet. **Additional research is necessary to understand the dynamics of food choice for these animals.**

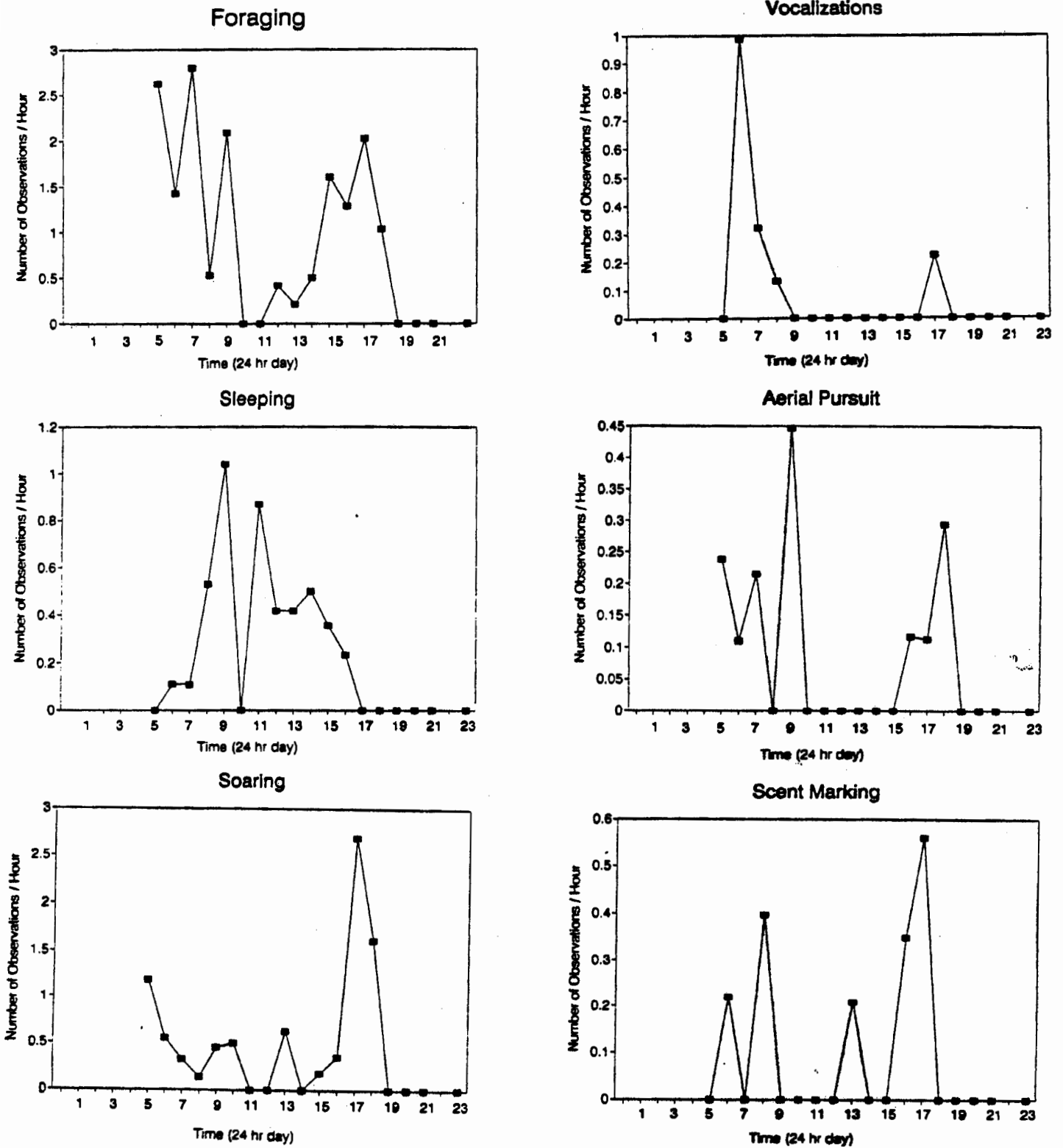
Further Work Planned:

Information concerning seasonal variation in this data is presently lacking. In order to make management decisions which will be successful in preserving flying foxes for long periods of time, we must have information on temporal and spatial variations in behavior and resource use. Currently, I plan to return to Samoa in July to begin a one year (minimum) study of seasonal variation.

The results of my study will provide information on diet and patterns of resource use by *Pteropus tonganus* and *P. samoensis*. In addition to expanding our knowledge of the biology of these important and interesting frugivores, this information is directly applicable to broader management and conservation concerns in the region. This work will provide an essential basis for further investigation of the role of *Pteropus* in structuring communities.

Figure 1.

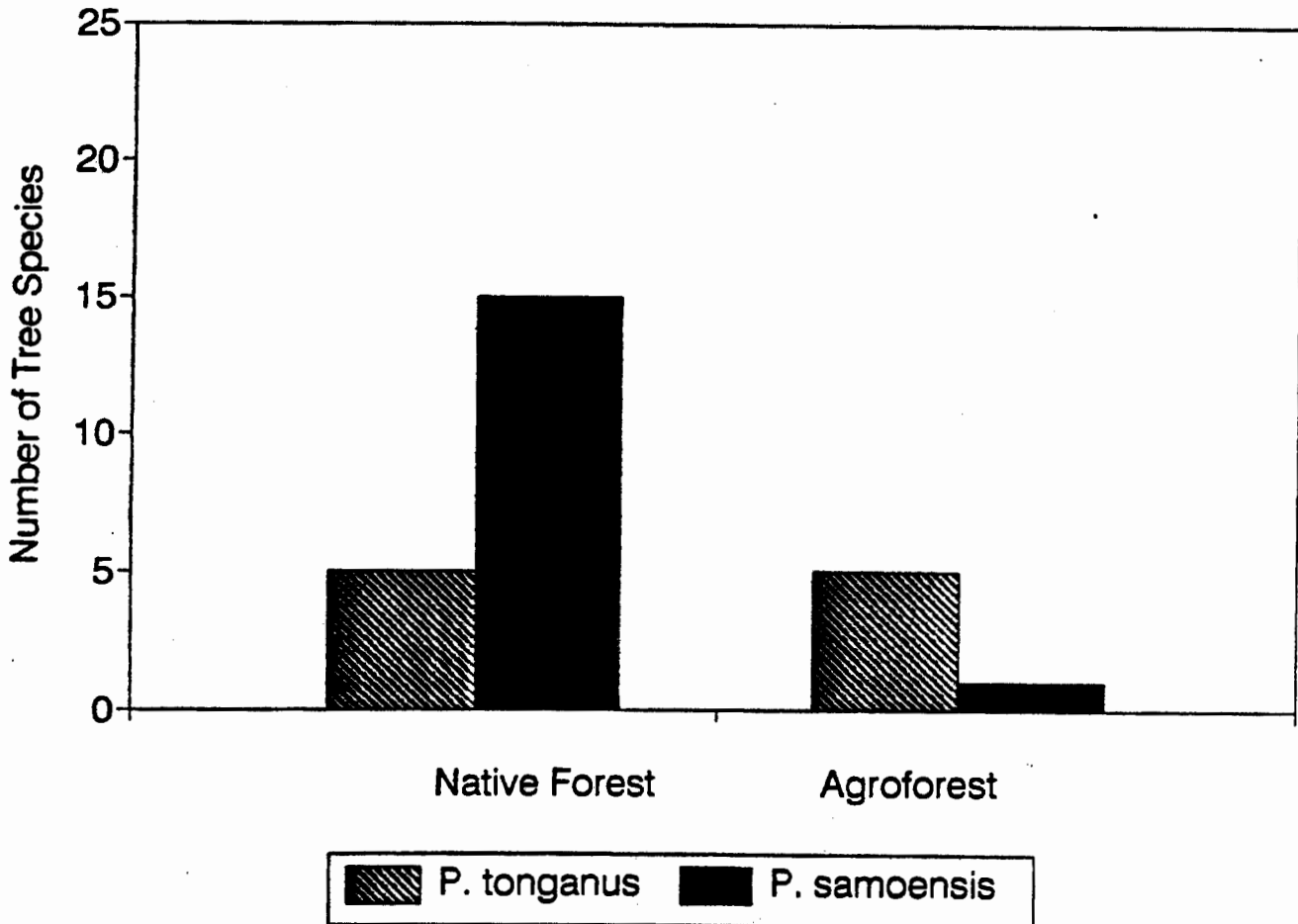
Dial Activity, *P. samoensis*



Activity patterns were collected from Aug-Dec 1992. The principal field site was Amalau, on Tutuila, American Samoa, however additional data was included from Maloata, Tutuila and Tafua, on Savaii, Western Samoa.

Figure 2.

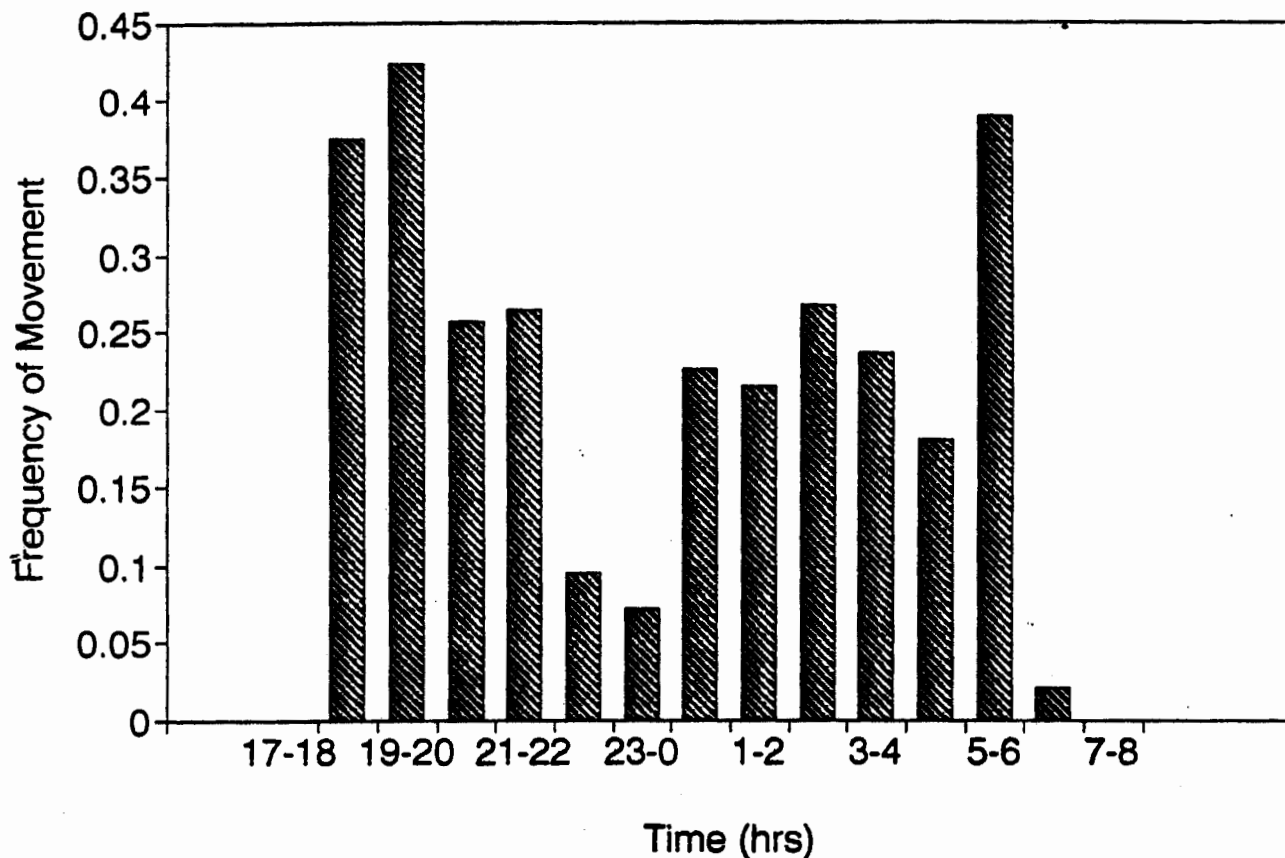
Habitat Differentiation



The number of tree species I saw two species of flying fox, *Pteropus tonganus* and *Pteropus samoensis* visit, between Aug and Dec 1992, is shown. Each tree species has been divided according to whether or not it is normally found in the native forest or the agroforest, a multi-crop agricultural area. *P. samoensis* fed almost exclusively on species found in the native forest. On one occasion I saw *P. samoensis* feed on the inflorescence of a coconut, *Cocos nucifera*, in a littoral habitat. I have included that species here under agroforest because the species is often cultivated regardless of the trees actual location. *P. tonganus* was found feeding in both habitats on an equal number of species within each habitat.

Figure 3.

Movement at a Feeding Site *Pteropus tonganus*



Fine scale movement patterns at a feeding site show periods of higher activity during the early evening and late morning and a lull in activity in the late evening. Three *Pteropus tonganus* were tracked throughout the evening for a two week period in Amalau Valley, Tutuila, American Samoa. The flying foxes arrived at the feeding site between 18:50 and 19:50 and left between 2:40 and 5:30. The distance between the roost and the feeding site was 2.5 km and the distance traveled within the feeding site averaged 0.5 km.