

CURRENT RESEARCH AND FUTURE MANAGEMENT OF MARIANAS FRUIT BATS (CHIROPTERA: PTEROPODIDAE) ON GUAM

TWO species of fruit bat, the Marianas Fruit Bat (*Pteropus mariannus*) and the Little Marianas Fruit Bat (*P. tokudae*), are native to Guam (13°28'N, 144°45'E; 540 km² in area) in the southern Mariana Islands of Micronesia. Overhunting of bats for use as a delicacy by Chamorro residents has caused fruit bat numbers on the island to remain low since the 1920s (Coultas 1931, Baker 1948, Wheeler 1979). Fruit bats continue to be hunted illegally today despite being fully protected by local laws since 1973 and federal law since 1984 (Wiles, in press). Predation on young *P. mariannus* by Brown Tree Snakes (*Boiga irregularis*) has emerged as a second, equally serious threat to bats since the early 1980s (Wiles, unpubl. data). *Boiga irregularis* was introduced to the island shortly after World War II and has become exceedingly abundant. Initially confined to southern Guam, snakes slowly spread northward and reached the extreme northern end of the island, where most fruit bats remained, by the early 1980s (Savidge, in press). *Boiga irregularis* is nocturnal and arboreal, habits which make it a potentially efficient predator of fruit bats.

Pteropus mariannus occurs throughout the Mariana Islands. Rota, which lies 60 km north of Guam, has a population of about 2000 fruit bats (P. Glass and G. J. Wiles, unpubl. data) but on the other southern islands of Aguijan, Tinian and Saipan, numbers of bats have plummeted because of overhunting (Payne *et al.*, in prep.). The species is still fairly common on most of the 10 islands north of Saipan (Payne *et al.*, in prep.).

Pteropus tokudae is endemic to Guam and has long been considered rare by hunters, elderly residents and scientific collectors (Baker 1948, Perez 1972). Only three specimens are known to have ever been captured, the last being shot by a hunter in 1968 (Perez 1972). No confirmed sightings of this bat have been made since then and the species is now thought to be extinct (Wiles, in press).

Both species of fruit bats were listed as endangered on Guam in 1984 by the U.S. Fish and Wildlife Service. A recovery plan aimed primarily at restoring numbers of *P. mariannus* has recently been written (U.S. Fish and Wildlife Service, in press). The highlights of that report are summarised here as are the preliminary results of several ongoing

natural history studies that will be published in greater detail elsewhere.

The island's population of *P. mariannus* fell from an estimated several thousand bats in 1958 (Woodside 1958) to approximately 50 fruit bats in 1978 (Wheeler and Aguon 1978). Numbers recovered to about 1000 animals in 1982, probably the result of immigration of bats from Rota and natural recruitment (Wiles, in press). Most of these bats resided in a single, large colony found on Andersen Air Force Base (AAFB) in northern Guam while very low numbers existed in forested areas elsewhere on the island. Illegal hunting of bats increased during 1983 and 1984. At least four and possibly six poaching incidents occurred at colony roosts, resulting in a serious decline in bat numbers. An intensive survey of fruit bats made in early 1984 produced an island-wide estimate of only 425 to 500 animals (Wiles, in press). During 1985 and 1986, most bats resided in a single colony whose size varied from approximately 400 to 575 bats. In September 1986, Guam's population of *P. mariannus* was estimated to contain 540-625 animals.

Within most colonies of 60-800 animals, bats tend to segregate sexually and roost in harems, predominantly male bachelor groups, or singly (males only) on the periphery of the colony. Throughout the year, about 69-80% of the members of the colony roost in harems which contain a male and 2-15 females. Harem males maintain exclusive breeding rights with these females and defend them from intruding males. Females appear to be loosely bound to particular harems. The number of females present in a harem may vary considerably over a span of several days; even during periods of two to three hours, several females may arrive or depart from a harem. Colonies normally contain one or two groups of bachelor males that number from 10-120 animals, or 17-28% of the colony, and roost in nearby trees. Sexual segregation within bachelor groups is often not complete and up to 20% of the individuals present may be females. The remaining 3-8% of bats in a colony consist primarily of solitary males found around the periphery of the roost.

Bachelor fruit bats occasionally form separate smaller colonies of 10-125 animals. Among these

colonies, a few females may roost temporarily in small harems with 3-4 members for several weeks. Additionally, a small portion (about 5-10%) of Guam's population of *P. mariannus* roosts solitarily or in small groups of 2-12 animals during the day.

Copulations and the presence of nursing young have been observed throughout the year for *P. mariannus*. From August 1982 to October 1986, 33 monthly observations were made at colonies using a 15-60x spotting scope. Each month, 50-100 harem females were identified with 7.2% to 22.6% of these animals found to possess small or medium-sized young. No consistent peak in the birth of young was evident.

Alarmingly, recent colony observations indicate that juvenile fruit bats are not surviving beyond an estimated age of 1-2 months. In 1982, 46.6% (n = 88) of all young counted were judged as large-sized, however, from 1984-1986, no juveniles of this size class were observed (n = 259). These data suggest that juveniles are being lost by predation and that *B. irregularis*, as the only arboreal predator on Guam, is responsible. Supporting evidence includes one report of a snake discovered with three small fruit bats in its stomach and a baby bat found dead with possible snake saliva on its head. Snakes may be preying on young *P. mariannus* left at the colony at night, when their mothers go to feed. Predation may also occur when the young are carried to feeding sites in the forest and left on their own for short periods while the mother feeds. *Boiga irregularis* is a major nocturnal predator of birds and small mammals on Guam and is already responsible for the nearly total disappearance of the island's forest-dwelling avifauna (Savidge, in press).

Vegetation characteristics of nine roosts used by colonies of *P. mariannus* have been recorded. All sites occurred in limestone forest and were found along or within 100 m of the large 80-180-m-tall cliffline that fringes northern Guam. Bats preferred to roost in mature fig trees (*Ficus prolixa*) at eight colonies and in *Mammea odorata* at a ninth location. Other trees used as roosts included *Macaranga thompsonii*, *Casuarina equisetifolia*, *Guettarda speciosa* and *Neisosperma oppositifolia*.

Information on the foods of *P. mariannus* was gathered by direct observations, finding evidence (discarded fruit, chewed pellets of fruit pulp) of bats feeding, examining faeces collected under roosts and interviewing island residents. Thirty species of plants are known to be used by fruit bats in the Marianas. These include 21 different fruits, 11 flowers and one leaf. Favoured foods include the fruits of *Artocarpus mariannensis*, *A. altii*, *Pandanus tectorius*, *Cycas circinalis*, *Mammea odorata*, *Ficus prolixa* and *Terminalia catappa* as

well as the flowers of *Ceiba pentandra*, *Erythrina variegata* and *Cocos nucifera*. The stems of leaves and tips of small twigs on *A. mariannus* are also frequently eaten.

Planned recovery efforts for *P. mariannus* on Guam will focus on reducing snake predation and illegal hunting with an ultimate goal of reestablishing the population at a high enough level to allow delisting. Prior to removing the species' endangered status, the island's population of *P. mariannus* should increase to at least 2500 bats with a minimum of two permanent colonies in northern Guam and one permanent colony in southern Guam (U.S. Fish and Wildlife Service, in press). The presence of more than one bat roost will reduce the threat of having most of the island's bats killed during a severe typhoon, as has occurred with other species of *Pteropus* in the Indian Ocean (Cheke and Dahl 1981).

Of primary importance, a solution is urgently needed for effectively controlling the numbers of *B. irregularis* on Guam to alleviate predation on *P. mariannus*. Control measures must be applicable to remote, forested habitats without harming non-target wildlife. Methods such as trapping, biological control, and the use of toxicants and attractants should be developed and tested, and if successful, be implemented to reduce snake numbers.

Government of Guam conservation officers, with assistance from military security police, need to increase patrolling efforts to stop illegal fruit bat hunting. Patrols should be centred on AAFB near known bat roosts and foraging areas. An anti-poaching plan should be developed by government and military agencies to better coordinate enforcement activities.

Forest destruction has probably been a minor factor in the decline of this species of *Pteropus* on Guam (Wiles, in press). However, it is important that several large remaining tracts of forest on the island be protected to provide *P. mariannus* with adequate habitat in the future. Of particular importance is a 43-km-long strip of forest around Guam's northern coastline where most bats presently live. Finally, a public awareness campaign for fruit bats is needed on the island, as many residents under the age of 30 years old have a limited knowledge of bats, their ecological value and their conservation problems.

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REFERENCES

- BAYER, R. H., 1948. Comments on conservation problems in Micronesia. Pp. 53-55 in 'Conservation in Micronesia' ed by H. J. Coolidge. National Research Council: Washington, DC.
- CHEKE, A. S. AND DAHL, J. F., 1981. The status of bats on western Indian Ocean islands, with special reference to *Pteropus*. *Mammalia* 45:205-238.
- COULTAS, W. F., 1931. Whitney South Sea Expedition Journals, Vol. W. Journal and letters, Vol. II, of William F. Coultas, November 1930 to December 1931'. American Museum Natural History: New York. Unpublished.
- PAYNE, N. H., LEMKE, T. O. AND WILES, G. J., in prep. Fruit bat populations in the northern Mariana Islands, western Pacific.
- PEREZ, G. S. A., 1972. Observations of Guam bats. *Micronesica* 8: 141-149.
- SAVIDGE, J. A., in press. The extinction of an island forest avifauna by an introduced snake. *Ecology*.

U.S. Fish AND WILDLIFE SERVICE, in press. 'Recovery plan for the Marianas fruit bat and little Marianas fruit bat on Guam'. U.S. Fish and Wildlife Service: Honolulu.

WHEELER, M. E., 1979. The Marianas fruit bat: management history, current status and future plans. *Cal.-Neva. Wildl. Trans.* 1979: 149-165.

WHEELER, M. E. AND AGUON, C. F., 1978. The current status and distribution of the Marianas fruit bat on Guam. *Aquatic Wildl. Resources Div. Tech. Rep.* No. 1: t-29.

WILES, G. J., in press. The status of fruit bats on Guam. *Pacific Science* (in press).

WOODSIDE, D. H., 1958. Fish and wildlife investigations'. Guam Department of Agriculture: Guam. Unpublished.

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