

Observations of Mariana Fruit Bats (*Pteropus mariannus*) in the upper Talofofu watershed on southern Guam

JOHN M. MORTON¹

*Pacific Islands EcoRegion, U.S. Fish and Wildlife Service,
P.O. Box 8134, MOU-3, Dededo, GU 96912*

GARY J. WILES²

*Division of Aquatic and Wildlife Resources, 192 Dairy Road,
Mangilao, GU 96923*

Abstract—Mariana fruit bat populations (*Pteropus mariannus*) on Guam have declined dramatically since the 1950s. The last island-wide survey in 1984 estimated 450–525 animals on northern Guam; no bats were counted on southern Guam. During June–July 1996, we conducted early morning surveys for Mariana fruit bats from eight stations in the upper Talofofu River watershed on southern Guam. We recorded three sightings of solitary bats in flight. We also compiled 35 incidental observations of mostly solitary bats from 1985–1999. Our data suggest that small numbers of fruit bats reside in the watershed, primarily on lands protected by a U.S. Navy base. Disturbance associated with poaching may preclude larger roosts.

Introduction

The Mariana fruit bat is one of six subspecies of *P. mariannus* found in Micronesia and the Ryukyu Islands (Kuroda 1938, Koopman 1993). In the Marianas, this subspecies occurs from Guam (13°28'N, 144°45'E) north to at least Saipan. The Guam population of this subspecies was listed as endangered by the Territory of Guam in 1981 and by the U.S. Fish and Wildlife Service in 1984 (USFWS 1984). As recently as 1958, Woodside (1958) estimated that a maximum of 3,000 bats occurred on Guam but by the time the first islandwide survey was conducted in 1978, the population had declined to fewer than 50 individuals (Wheeler & Aguon 1978). Numbers increased to about 1,000 bats in 1982, apparently due to immigration from Rota, an island 60 km north of Guam (Wiles 1987a, Wiles & Glass 1990). During a second islandwide survey in 1984, the population was estimated to be 475 - 550, most of which roosted in a single colony at

¹Chesapeake Marshlands National Wildlife Refuge Complex, U.S. Fish and Wildlife Service, 2145 Key Wallace Drive, Cambridge, MD 21613. E-mail: john_m_morton@fws.gov.

²1692 Sunflower Lane, Apt. 19-202, Tumwater, WA 98512

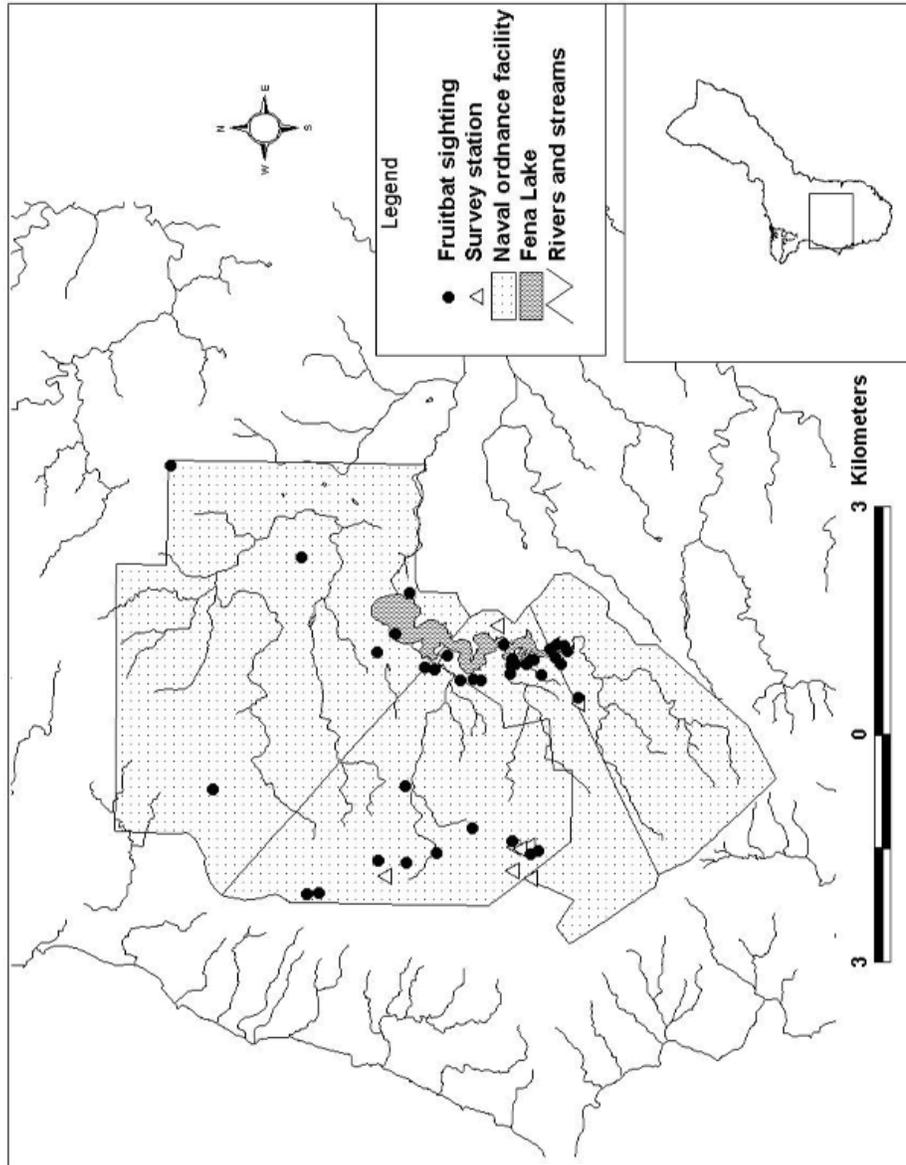


Figure 1. Survey stations used during 1996 and locations of all confirmed Mariana fruit bat sightings (n = 38) in the Upper Talofoto River watershed during 1985-99.

Mergagan Point on northern Guam (Wiles 1987a). By 1996, the population was believed to number fewer than 400 fruit bats, most of which aggregated at Pati Point on northern Guam (Wiles et al. 1995). Scattered fruit bat sightings continue to occur in other parts of Guam and usually involve solitary individuals, most often in flight.

In this paper, we report the results of a fruit bat survey conducted in the upper Talofofo watershed in the southern part of the island. This site contains large tracts of forest appropriate for fruit bats, but has held few animals since the late 1960s (Perez 1972). Our study is the first survey of bats in southern Guam since 1984 (Wiles 1987a). We also summarize the incidental reports of Mariana fruit bat sightings in the Talofofo watershed that have been compiled by the Guam Division of Aquatic and Wildlife Resources (GDAWR) since 1984.

Study Area and Methods

The upper Talofofo River watershed was defined as the 36-km² area above the confluence of the Mahlac and Maagas Rivers. This watershed holds some of the best remaining native forest in southern Guam (Fosberg 1960). Limestone forest, typically dominated by *Elaeocarpus joga*, *Aglaia mariannensis*, and *Guamia mariannae*, covers the high ridges from Mt. Alifan to Mt. Lamlan; the latter is the highest point (406 m) on Guam. Ravine forest covers the numerous tributaries flowing into the upper Talofofo River. *Calophyllum inophyllum* dominates some upper reaches of the ravines associated with the Imong and Sadog Gago Rivers, and stands of *Areca catechu*, *Cananga odorata*, and *Cocos nucifera* are patchily distributed closer to the riparian zone. Extensive lowland swamps of *Hibiscus tileaceus*, *Pandanus tectorius*, *A. catechu*, *Cynometra ramiflora*, and *Barringtonia racemosa* occur in the Mahlac-Maagas floodplain. A unique stand of almost pure *Merrilliodendron megacarpum* occurs in a huge karst depression near Mt. Almagosa.

Most of the watershed, including the 75-ha Fena Reservoir, is administered by the U.S. Navy as the Ordnance Annex. The military security associated with the munitions bunkers and surrounding explosive arc protects, to a great extent, much of the area from poaching, human disturbance, and destruction of native limestone and ravine forest. Training activities in much of the Ordnance Annex are also restricted to prevent trampling of sensitive flora near Mount Almagosa and disturbance of Mariana swiftlets (*Aerodramus bartschi*) near the Mahlac River (U.S. Navy 1999). Consequently, this area may be an important foraging and roosting area for the remaining Mariana fruit bats on southern Guam.

We surveyed Ordnance Annex for fruit bats on seven days during 24 June - 10 July 1996. Single observers searched for bats from eight sites that gave commanding views of this area (Fig. 1): one overlooking the sinkhole west of the Almagosa-Lamlam ridge, one on Mt. Almagosa, three overlooking the Almagosa Springs area, one at West Tower overlooking the upper reaches of the Maulap and Almagosa Rivers, one overlooking the confluence of the Imong and Sadog Gago

Rivers, and one overlooking Fena Reservoir between the Sadog Gago and Maulap Rivers. All sites were surveyed once except the one at Fena Reservoir which was surveyed twice, on 24 June and 8 July. Sites were actively scanned with binoculars from approximately 30 min before sunrise to 0700 hr (Morton 1996b). Additional records of bat sightings in the upper Talofofu Valley since 1984 were obtained from a file of sightings maintained by GDAWR.

Results

Three solitary Mariana fruit bats were counted during our survey. Two separate bats were observed on 24 June and almost certainly represented different individuals. The first flew southwest over Fena Reservoir towards the Sadog Gago River at 0530 hr, whereas the second flew southwest above Almagosa Springs at 0608 hr. The third bat was seen at 0518 hr on 26 June flying southwest over *Merrilliodendron* forest near Mt. Almagosa.

Eight other sightings of fruit bats were reported in 1996. During our 17-day survey period, Navy security personnel with night-vision goggles reported three nocturnal observations of solitary bats in flight between Mt. Almagosa and West Tower. One bat was observed in February at West Tower (PHRI Consultants, pers. comm.) and another was seen flying over *Merrilliodendron* forest near Mt. Almagosa in March (A. Asquith, USFWS, pers. comm.). GDAWR conservation

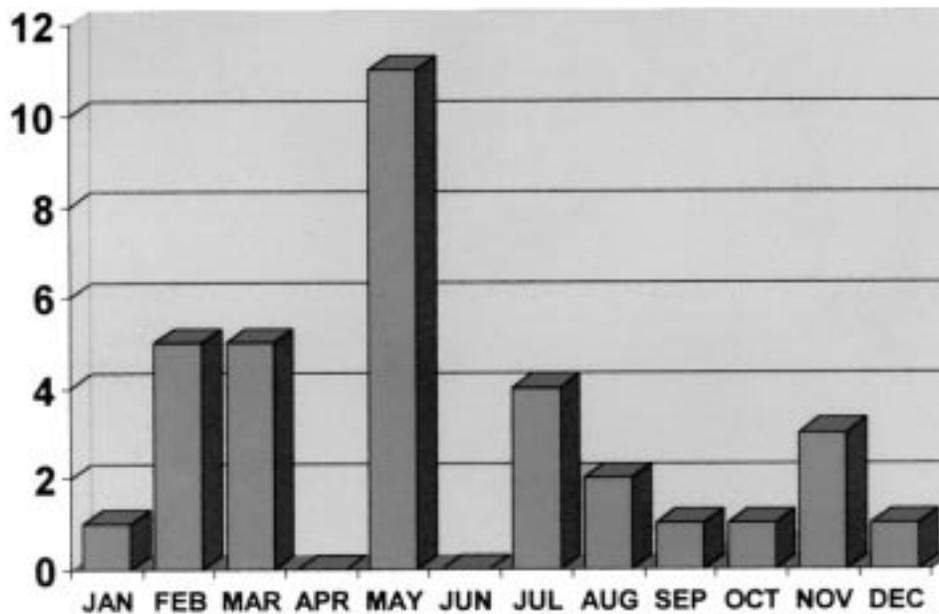


Figure 2. Incidental Mariana fruit bat sightings ($n = 34$) in the Upper Talofofu River watershed by month (excludes 3 bats recorded during survey and 1 incidental sighting for which the month was not definite).

officers observed a single bat on two or more nights in late May and again on 10 August 1996 over a planted stand of exotic *Acacia auriculiformis* near the East Tower.

Including these 11 sightings in 1996, there have been only 38 confirmed sightings of Mariana fruit bats in the upper Talofoto River watershed from 1985-1999 (Fig. 1). Twenty-three of these occurred at or near Fena Reservoir, including 13 sightings during early morning surveys for common moorhens (*Gallinula chloropus guami*). Other sightings of bats were fairly well distributed across the Ordnance Annex (Fig. 1), from Mt. Alifan in the northwest, to the Acacia forest at East Tower in the northeast, to the *Merrilliodendron* forest at Mt. Almagosa in the southwest, to the southeast shore of Fena Reservoir. No sightings were reported outside the Ordnance Annex.

Fruit bat sightings occurred in all but four years from 1985 -1999 and showed no apparent change in frequency during this interval. Except for four sightings of two to three bats from 1985 -1987, all incidental sightings have been of solitary bats. Bats were seen in most months of the year, but were recorded most commonly in May (Fig. 2). Most (80%) observations were made during daylight and all sightings were of bats in flight. None of the observations were of fruit bats roosting or foraging, although there were two observations of bats landing on ridges above the Almagosa and Sadog Gago Rivers. To a certain extent, these observations may simply be an artifact of the time of day when most observers were in the field. Wheeler & Aguon (1978) reported that solitary bats tended to be more mobile during the early morning hours, which coincides with the timing of moorhen surveys at Fena Reservoir.

We noted two incidences of illegal hunting activity during the 1996 survey that were perhaps associated with fruit bats. On 24 June, two camouflaged hunters were observed on the north ridge above the Sadog Gago River, 30 minutes after a fruit bat appeared to have landed there. These same hunters were observed leaving Ordnance Annex on the same ridge near Mt. Jumullong two days later.

Discussion

Historically, Mariana fruit bats were probably common in Guam. In 1920, Crampton (1921) reported bats to be "not an uncommon" sight as they flew over forest during the daytime. However, fruit bat abundance declined greatly on the Ordnance Annex during the mid-1960s. During systematic surveys of Fena Reservoir in 1963-1968, Perez (1972) reported that counts declined from 1.4 to 0.1 bats per ha. As many as 300 bats were recorded at a roost site on Orote Point in 1967 and 1968 (Perez 1972), but only 150 bats were present when the colony was last observed in 1971 (Wiles 1987a). This site is the last known roost in southern Guam.

By the time that Wheeler & Aguon (1978) conducted their islandwide survey in 1978, only one fruit bat was recorded at the Ordnance Annex. During the next extensive survey in 1984, no bats were observed at 15 stations in southern

Guam, including 5 stations in the upper Talofofu watershed (Wiles 1987a). However, based on incidental reports in 1983, Wiles (1987a) concluded that as many as 25 bats may have resided on southern Guam at that time.

Several factors have contributed to the declining population of Mariana fruit bats on Guam. Fruit bats have long been harvested for human consumption by Chamorros, but the impact of hunting was exacerbated during the early 1900s by an expanding human population and the increasing availability of firearms (Wiles 1987a, 1990). Territorial legislation that criminalized bat harvest in 1966, the designation of Pati Point as a protected area by the Air Force in 1973, and the listings as an endangered species by Guam in 1981 and the U.S. in 1984 have helped bats to survive on Guam, although the population is apparently sustained by immigration from Rota (Wiles & Glass 1990). Illegal hunting, however, continues to be a serious threat to Mariana fruit bats on Guam (Wiles et al. 1995).

Predation by brown tree snakes (*Boiga irregularis*) has very likely contributed to declining populations since the 1950s and prevented recovery despite legal protection (Wiles 1987a, Wiles et al. 1995). The age structure of the bat colony on northern Guam is skewed, with little or no recruitment into mature age classes despite successful reproduction. Wiles (1987b) suggested that unattended juveniles older than 1 - 2 months are preyed on by snakes while their mothers are foraging at night; these juveniles are too heavy to be carried but are still incapable of escape by flight. Although data are unavailable, it is likely that predation rates on young bats in southern Guam are as high as those in the north.

Human disturbance of roosts is also problematic and likely contributes to roost dispersal. When undisturbed, Mariana fruit bats may roost at a site for up to several years (Wiles 1990). Military training activities such as aircraft overflights can negatively affect bat behavior. Roosting bats that were exposed to departing aircraft over Pati Point spent significantly less time resting and more time engaged in maintenance, alert, and agonistic behaviors than undisturbed bats (Morton 1996a). More subtle human activities such as pedestrian activity and human odor may be perceived as disturbing by bats because of their association with illegal hunting. Despite restricted public access to the Ordnance Annex and the relative remoteness of this watershed, illegal entry by hunters may be frequent. Introduced Philippine deer (*Cervus mariannus*) and water buffalo (*Bubalus bubalis*) are the main quarry, but hunters presumably also take fruit bats when the opportunity arises.

Our data clearly indicate that Mariana fruit bats continue to use the upper Talofofu watershed albeit in very low numbers and generally alone. We suspect that there may be anywhere from 5 to 20 fruit bats that forage in this area at night, with no large roosts remaining. Although the Navy-owned land has severely restricted access and the southern end of this watershed may be the most remote area on Guam, much of the area is visible from the high mountain ridges. It is virtually impossible that a large roost would go undetected for several years.

Although *Pteropus* are strong fliers and are known to make long nocturnal foraging flights elsewhere in their range (Fujita & Tuttle 1991), it is unlikely that

Mariana fruit bats seen on southern Guam make the 30-km commute between Pati Point and the upper Talofofu River. Several reasons suggest that most of the animals in the upper Talofofu watershed are more or less full-time residents of the area. First, most sightings occur during daylight, when bats should have already returned to the main colony. Secondly, the watershed's extensive limestone and ravine forests contain a number of common plant species eaten by fruit bats including *Artocarpus* spp., *Cocos nucifera*, *Pandanus tectorius*, *Elaeocarpus joga*, *Freycinetia reineckeii*, *Cycas circinalis*, *Merrilliodendron megacarpum*, *Mammea odorata*, *Calophyllum inophyllum*, *Carica papaya*, and *Cananga odorata* (Wiles & Fujita 1992; G. Wiles, unpubl. data). With adequate food resources widely available, it would seem energetically inefficient for fruit bats to make this long flight routinely. However, the relatively large number of sightings in the upper Talofofu watershed during May (Fig. 2) coincides with the annual period when bat numbers in the Pati Point colony decline, presumably due to migration to Rota (Wiles et al. 1995). Our data suggest that a few bats may disperse into southern Guam rather than return to Rota.

Use of Ordnance Annex by larger numbers of Mariana fruit bats may be precluded by poaching activity and the disturbance associated with it. Despite its relative remoteness, we were surprised to observe two illegal hunting incidents in seven mornings. Poaching is a particularly insidious activity because not only does it impact fruit bats through mortality, it reinforces behavioral avoidance of humans. Consequently, roosting or foraging fruit bats that might not otherwise be disturbed by some human activities (such as low-impact military training; Morton 1996a) may become unduly sensitized to them because of illegal hunting.

We recommend that additional fruit bat surveys be conducted at night using night-vision equipment so that a more accurate population assessment on the Ordnance Annex can be made. Additionally, we recommend that illegal hunting activities be pursued more aggressively by Navy security. Not only does aggressive law enforcement reduce illegal take, it is an effective way of minimizing disturbance associated with future military training.

Acknowledgements

Funding for this study was provided by the U.S. Fish and Wildlife Service, including its program of Federal Aid to Wildlife Restoration on Guam (Project W-1-R-7), and the U.S. Navy (COMNAVMARIANAS). Fred A. Amidon provided valuable field assistance.

References

- Crampton, H. E. 1921. A journey to the Mariana Islands - Guam and Saipan. *Journal of the American Museum of Natural History* 21: 127-145.
- Fosberg, F. R. 1960. The vegetation of Micronesia. 1. General descriptions, the vegetation of the Marianas Islands, and a detailed consideration of the

- vegetation of Guam. *Bulletin of the American Museum of Natural History* 119: 1–75.
- Fujita, M. S. & M. D. Tuttle. 1991. Flying foxes (Chiroptera: Pteropodidae): threatened animals of key ecological and economic importance. *Conservation Biology* 5: 455–463.
- Kami, H. T., N. Drahos, R. D. Strong & R. J. Lujan. 1976. Job progress report, federal aid to fish and wildlife restoration. Project no. FW-2R-13. Guam Division of Aquatic and Wildlife Resources, Mangilao, Guam. 112 pp.
- Koopman, K.F. 1993. Order Chiroptera. *In* D.E. Wilson and D.M Reeder (eds.), *Mammal Species of the World: a Taxonomic and Geographic Reference*, pp.137-241. Smithsonian Institution Press, Washington, D.C.
- Kuroda, N. 1938. A list of Japanese mammals. Self-published, Tokyo.
- Morton, J. M. 1996a. The effects of aircraft overflights on endangered Mariana crows and Mariana fruit bats at Andersen Air Force Base, Guam. U.S. Fish and Wildlife Service, Pacific Islands Office, Honolulu, HI. 81 pp.
- Morton, J. M. 1996b. Mariana fruit bat on the Ordnance Annex. *In* Faunal Survey for the Ordnance Annex, Naval Activities, Guam, pp. 99–108. Prepared for Naval Activities, Guam. USFWS, Pacific Islands EcoRegion, Honolulu, HI. 148 pp.
- Perez, G. S. A. 1972. Observations of Guam bats. *Micronesica* 8: 141–149.
- Tate, G. H. H. 1934. Bats from the Pacific islands, including a new fruit bat from Guam. *American Museum Novitates*, no. 713. 3 pp.
- U.S. Fish and Wildlife Service. 1984. Endangered and threatened wildlife and plants; determination of endangered status for seven birds and two bats of Guam and the Northern Mariana Islands. Final rule. *Federal Register* 49: 33881–33885.
- U.S. Fish and Wildlife Service. 1996. Faunal Survey for the Ordnance Annex, Naval Activities, Guam. Prepared for Naval Activities, Guam. USFWS, Pacific Islands EcoRegion, Honolulu, HI. 148 pp.
- U.S. Navy. 1999. Final Environmental Impact Statement for Military Training in the Marianas. U.S. Pacific Command, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, HI.
- Wheeler, M. E. & C. F. Aguon. 1978. The current status and distribution of the Mariana fruit bat on Guam. Tech. Report No. 1. Guam Division of Aquatic and Wildlife Resources, Agana, Guam. 29 pp.
- Wiles, G. J. 1987a. The status of fruit bats on Guam. *Pacific Science* 41: 148-157.
- Wiles, G. J. 1987b. Current research and future management of Marianas fruit bats (Chiroptera: Pteropodidae) on Guam. *Australian Mammalogy* 10: 93–95.
- Wiles, G.J. 1990. Guam Mariana fruit bat and little Mariana fruit bat recovery plan. U.S. Fish and Wildlife Service, Portland, OR. 63 pp.
- Wiles, G. J. & M. S. Fujita. 1992. Food plants and economic importance of flying foxes on Pacific Islands. *In* D. E. Wilson & G. L. Graham (eds.), *Pacific Island Flying Foxes: Proceedings of International Conservation Conference*,

- Biological Report. 90(23), pp. 24–35. U.S. Fish and Wildlife Service, Wash., D. C. 176 pp.
- Wiles, G. J. & P. O. Glass. 1990. Inter-island movements of fruit bats (*Pteropus mariannus*) in the Mariana Islands. Atoll Research Bulletin 343: 1–6.
- Wiles, G. J., C. F. Aguon, G. W. Davis & D. J. Grout. 1995. The status and distribution of endangered animals and plants in northern Guam. Micronesica 28: 31–49.
- Woodside, D. H. 1958. Fish and wildlife investigation. Department of Agriculture, Agana, Guam.

Received 30 June 2001, revised 11 Jan. 2002.