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The Status and Distribution of Endangered Animals and Plants in Northern Guam

GARY J. WILES, CELESTINO F. AGUON, GERALD W. DAVIS

Division of Aquatic and Wildlife Resources, P.O. Box 2950, Agana, Guam 96910

and

DANIEL J. GROUT

U.S. Fish and Wildlife Service, Pacific Islands Ecoregion, P.O. Box 1251, Rota, MP 96951

Abstract—A variety of indigenous animals and plants have become endangered or extirpated this century on Guam in the Mariana Islands. Taxa experiencing losses include nearly all resident birds, all mammals, sea turtles, many lizards, four tree snails, and several plants. This paper reviews the status of endangered species in the northern portion of the island. A large segment of this area is included in the newly established Guam National Wildlife Refuge. Northern Guam still holds the island's largest populations of Mariana crows (*Corvus kubaryi*), Micronesian starlings (*Aplonis opaca*), Mariana fruit bats (*Pteropus mariannus*), two tree snails (*Partula radiolata* and *P. gibba*), and the trees *Serianthes nelsonii* and *Heritiera longipetiolata,* as well as several important turtle nesting beaches. The demise of these species is primarily related to the introduction of the brown tree snake (*Boiga irregularis*) and other exotic animals, overhunting, and the destruction or modification of natural habitats.

Introduction

Native fauna and flora of oceanic islands are highly vulnerable to a number of ecological problems related to human settlement. Declines and losses of species have been especially serious on Guam, Mariana Islands of the tropical western Pacific Ocean. Fifteen resident species of animals and plants are currently listed as endangered or threatened on the U.S. Endangered Species List, while another eight species are recognized by the Government of Guam as endangered. At least 12 species of birds, two bats, a lizard, and a tree snail have become extinct in the wild on the island and its offshore islets since 1900. Nine of these were taxa endemic to the island. Breeding populations of white-tailed tropicbirds (*Phaethon lepturus*) and possibly the wedge-tailed shearwater (*Puffinus pacificus*) were also lost during this period, although both species are still present as visitors.

Historic extirpations of Guam's indigenous wildlife began in the 1800s or early 1900s, with the loss of the Micronesian megapode (*Megapodius laperouse*)

and perhaps the wedge-tailed shearwater (Coultas 1931, Baker 1951). Coultas (1931) commented that fruit bats (*Pteropus* spp.) were uncommon and declining by 1931. Species losses continued from World War II to the early 1970s, when the Mariana mallard (*Anas platyrhyncos oustaleti*), white-browed crake (*Poliolimnas cinereus*), nightingale reed-warbler (*Acrocephalus luscinia*), and little Mariana fruit bat (*P. tokudae*) disappeared (Jenkins 1983, Wiles 1987a, Reichel et al. 1992, Reichel & Lemke 1994). The precipitous decline of the island's 11 species of forest birds was first noticed in the 1960s, when portions of southern Guam became devoid of birds (Savidge 1987). Native forest bird ranges receded northward through the 1970s, until nearly all species remained only at the far northern end of the island by the early 1980s (Savidge 1987, Engbring & Fritts 1988). Other taxa have also experienced tremendous declines since the war, including the Mariana fruit bat (Perez 1972, Wiles 1987a), several geckos and skinks (Rodda & Fritts 1992), and four species of tree snails (Hopper & Smith 1992). Little historic information is available to document decreases among sea turtles and rare plants on the island.

A variety of causes are responsible for the declines. The introduction of the brown tree snake after the war has impacted the most native species, including all of the forest birds, Mariana fruit bats, and several lizards (Savidge 1987, Wiles 1987b, Engbring & Fritts 1988, Rodda & Fritts 1992). Other introduced fauna have played important roles in the demise of tree snails (Hopper & Smith 1992) and various plants (G. J. Wiles, pers. obs.). Overhunting has been implicated in the declines or losses of fruit bats, megapodes, and several wetland birds (Coultas 1931, Baker 1951, Engbring & Ramsey 1984, Wiles 1987a). A few species, especially wetland birds, green sea turtles (*Chelonia mydas*), tree snails, and the tree *Serianthes nelsonii,* have been affected by habitat loss and alteration (Jenkins 1983, Davis 1992, Hopper & Smith 1992, U.S. Fish & Wildlife Service 1994).

Our paper summarizes the status of endangered wildlife and plants in northern Guam through 1994. This part of the island holds the only significant populations of several species. A large portion of the area has recently been protected by the U.S. Fish & Wildlife Service through the creation of the Guam National Wildlife Refuge. Justification for the refuge centers largely around the urgent need to preserve endangered species. Current information on these species is needed for proper management of the refuge and nearby areas. This report consolidates information from published and unpublished sources. Detailed survey results will be reported elsewhere.

Study Area

Guam (13°27'N, 144°47'E) is the largest and southernmost of the Mariana Islands, with a total land area of 540 km^2. The northern half of the island is characterized by a large uplifted limestone plateau with elevations of 90–185 m. It is fringed near the ocean by tall cliffs and steep hillsides, and by narrow coastal benches that are 30–1,000 m wide. Fringing coral reefs occur along all shorelines. Guam's climate is tropical and temperatures remain warm and fairly uniform

during the year, ranging from mean daily lows of 22°C to mean daily highs of 30°C (Karolle 1988). Annual rainfall averages about 2,180 mm, most of which falls from July to November. A dry season occurs from January to May.

The northern third of Guam is divided into the municipalities of Dededo and Yigo. These communities are among the fastest growing areas on the island and had a combined population of 46,000 people in 1990. Two military bases, Andersen Air Force Base (AAFB) and Naval Computer and Telecommunications Area Master Station (NCTAMS; formerly known as NAVCAMS), occupy 7,295 ha of land at the far northern end of the island.

Descriptions of the plant communities in northern Guam are given by Fosberg (1960) and Engbring & Ramsey (1984). The most important habitats for most endangered species are mature and secondary growth limestone forests, which remain primarily along coastal cliffs and on military bases. Common tree species in primary forest include *Ficus prolixa, Aglaia mariannensis, Guamia mariannae, Cycas circinalis, Neisosperma oppositifolia, Mammea odorata, Premna obtusifolia, Ochrosia mariannensis, Macaranga thompsonii, Pisonia grandis, Artocarpus mariannensis,* and *Elaeocarpus joga.* In secondary forest, many of the same trees are present in lower abundance along with *Pandanus tectorius, P. dubius, Hibiscus tiliaceus, Morinda citrifolia, Carica papaya,* and *Cestrum diurnum.*

Other habitat types include stands of tangantangan (*Leuceana leucocephala*) forest, groves of coconut palms (*Cocos nucifera*) mixed with some native trees, and calcium carbonate sand beaches ranging from 5–30 m in width with transitional strand vegetation consisting of several species of *Ipomea, Scaevola taccada,* and *Tournefortia argentea.* The largest areas of coconut and beach occur from Tarague Point to Uruno Point. The interior of northern Guam consists of residential and urban areas, military facilities and runways, grassy and weedy fields, scrubby thickets of highly disturbed vegetation, and increasingly fragmented stands of secondary limestone forest.

Methods

Trends in bird abundance and distribution were determined by several methods. Crow numbers were assessed each July from 1990–1994 using tape playback surveys. Twelve transects, each with 8–10 stations, were made in forest and along lightly traveled secondary roads or jeep trails (Aguon 1990). Spacing of stations was 300 m in forest and 500–600 m along roadsides. Surveys were conducted from sunrise to 1100 hr, when birds were most active. Tape-recorded vocalizations of adult crows were played for 2.5 min at each station followed by a 2-min period of silent observation to listen for responses. Observers recorded the number of birds seen and heard, their distance, and their plumage condition. Population estimates were determined from the total number of birds recorded each year plus the number of other individuals known to be present that went undetected.

Personnel from the Guam Division of Aquatic & Wildlife Resources conducted two series of annual bird surveys in which all species of birds seen and heard were recorded. Survey routes followed roads and jeep trails through a variety of habitats. One of the surveys was made islandwide each May and included nine routes in northern Guam (Conry 1986). Each survey route consisted of 5-min point counts at 8–10 stations spaced 600 m apart. The second series of surveys was conducted bi-weekly along three routes in northern Guam by conservation officers (Beck & Wiles 1987). Routes were 17–37 km in length and were driven at 6–9 km/hour beginning at sunrise. Much additional data on bird occurrence in the northern part of the island was gathered from site specific observations, which included a crow monitoring project in the vicinity of Tagua and Tarague Points from late 1992 to 1994 (Grout 1993; J. Morton, pers. comm.), and incidental sightings.

Fruit bats were surveyed by making monthly counts at known colonies following the techniques of Wiles (1987a). Colonies were viewed with 15-60X spotting scope from 0800 to 0930 hr, the period that roosting bats were most visible. Because some bats were concealed by thick foliage and not visible to the observer, the total number of animals counted at roosts was increased by 10–20% to account for hidden individuals. Opportunistic sightings of bats away from colonies were also recorded. These provided data on the locations and numbers of solitary animals during the daytime and animals foraging at night.

Offshore sea turtle counts were made twice a month during low altitude (90–150 m) flights in fixed wing aircraft from 1975–1979 and 1989–1991 (M. Molina in Pritchard 1981, Davis 1992). Flights consisted of a single clockwise pass around the island. Nesting crawls on beaches were also noted during flights. These data were collected incidentally during fisheries participation surveys on randomly selected days with starting times increasing at 1-hr intervals. Aerial sightings of turtles and nesting crawls were probably underestimated by this method because of variation in weather conditions, water clarity, and frequency of flights. However, aerial data did provide trend information. Nesting activity was also monitored by foot patrols on known turtle beaches during the nesting season from March to August. Inspection of crawl marks allowed an observer to determine species identification and whether eggs had been laid.

Information on other endangered taxa comes from a variety of sources, including recent literature and unpublished field observations by the authors and other biologists.

Results

MARIANA CROW

An estimated 40–50 Mariana crows remain on Guam, all of which occur at the northern end of the island (Fig. 1). This number is based on 18 birds detected in the 1994 survey, plus an additional 20 or more known individuals that were not recorded. Currently, about 12–15 crows remain in the vicinity of the Conventional Weapons Storage Area (CWSA), with an additional 12–15 birds present

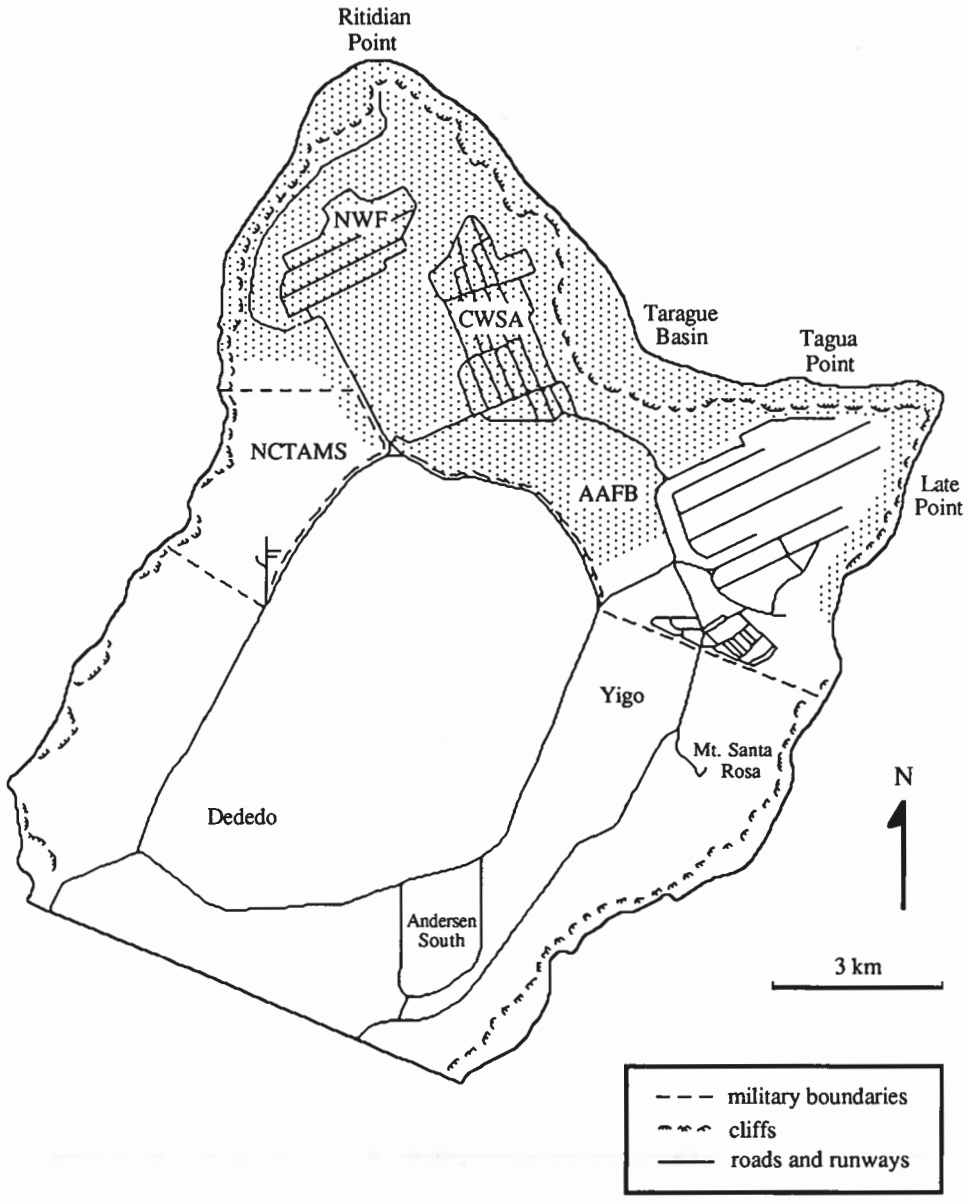

Figure 1. Distribution (stippled area) of Mariana crows in northern Guam in 1994. Site location names are abbreviated as: Andersen Air Force Base, AAFB; Conventional Weapons Storage Area, CWSA; Naval Computer and Telecommunications Area Master Station, NCTAMS; and Northwest Field, NWF.

in an adjoining area extending from the upper rim of the Tarague basin to Pati Point (C. F. Aguon & D. J. Grout, unpubl. data). Smaller numbers inhabit Northwest Field (about eight birds), the cliffline behind Uruno Beach (about four to six birds), and the area between Pati Point and Lafac Point (two birds). A comparison of survey results from 1994 with those of previous years (1991, 41 birds detected; 1992, 57 birds detected; and 1993, 51 birds detected) suggests that the population lost some individuals in late 1993 and 1994.

Our estimate represents a decline from previous population estimates of 350 birds in 1981 (Engbring and Ramsey 1984) and 100 birds in 1985 (Michael 1987). The distribution of crows has contracted slightly since it was last reported in 1981 (Engbring & Ramsey 1984). Birds now occur on just a small portion of NCTAMS and are no longer present between Lafac Point and Mt. Santa Rosa (Fig. 1).

Mariana crows reside primarily in mature and secondary limestone forest with limited human disturbance. Birds sometimes forage in scrub forest and small brushy fields with scattered trees, and occasionally nest and feed along the edges of undisturbed openings. Crows will cross roads used infrequently by vehicles, but avoid highways with more traffic.

Nesting occurs from October to May. Nests are typically placed in emergent trees such as *Elaeocarpus joga, Tristiropsis obtusangula,* and *Ficus prolixa,* and less frequently in *Intsia bijuga, Premna obtusifolia, Guamia mariannae* and *Aglaia marianensis.*

Predation by brown tree snakes is the major factor responsible for the decline of Mariana crows on Guam. Most predation probably occurs on eggs and nestlings rather than on adults. No fledglings other than five produced at protected nest trees in 1992 and 1994 have been seen in the wild since late 1985. The inability of crows to produce young is further compounded by monitor lizards (*Varanus indicus*), which occasionally destroy crow nests and probably prey on eggs and young (C. F. Aguon, unpubl. data). Roof rats (*Rattus rattus*) are another potential predator (Atkinson 1985). These impacts have resulted in little or no recruitment of new birds into the population during the last decade.

MICRONESIAN STARLING

The largest remaining population of starlings on Guam, estimated at 50–100 birds, is centered in the residential and administrative areas of AAFB and in an adjacent area of Yigo (Fig. 2). Its range extends from the northern and western boundaries of the airfield eastward to the forest outside the base's golf course. The distribution continues southward to Mt. Santa Rosa and the Gayinero district of Yigo. The density of birds is low throughout the area, but appears highest in the developed portion of AAFB. The size and distribution of the population have remained relatively unchanged since the mid-1980s.

Starlings have probably survived in this part of the island because of their ability to adapt to living in a highly altered landscape, where they are able to avoid excessive predation by brown tree snakes. On AAFB, the birds inhabit areas consisting primarily of large open lawns and low concrete buildings planted

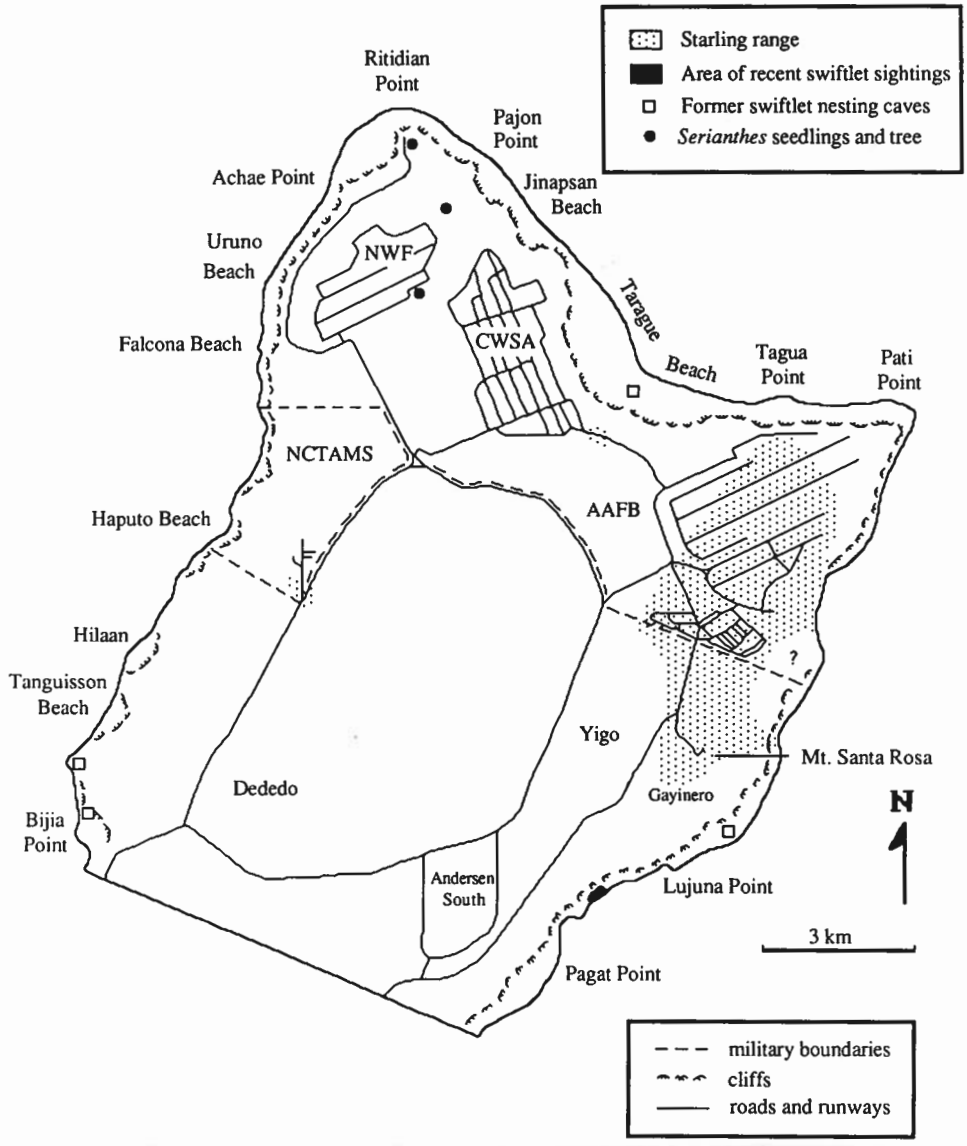

Figure 2. Distribution of Micronesian starlings, island swiftlets, and *Serianthes nelsonii* in northern Guam in 1994. See Figure 1 for an explanation of abbreviated site names.

with scattered trees, mostly *Cocos nucifera, Casuarina equisetifolia,* and some *Delonix regia.* Similar but smaller patches of habitat are used in Yigo, but are intermixed with secondary forest. Nesting occurs in the crowns of coconut trees, the hollow tops of wooden telephone poles, and in cavity-like openings in buildings. Foraging takes place both in developed areas and adjacent forests.

The population's size and distribution are probably kept in check by snake predation, thereby precluding expansion into surrounding areas. Although snakes do occur in the developed sections of the base, their abundance is likely to be lower than in nearby forests because of greatly reduced vegetation, lower prey densities, and greater human persecution. In addition, snakes probably have a difficult time reaching starlings that nest and roost at the types of sites described above. Birds that select such sites probably suffer far less predation than those attempting to reside in adjacent forests.

Two other much smaller populations of starlings persist near the main entrance of the CWSA and in the administrative area of NCTAMS (Fig. 2). Each apparently contains fewer than five birds. Both localities feature mowed lawns, scattered coconut trees, and buildings.

Elsewhere on Guam, an estimated 25–40 Micronesian starlings remain on Cocos Island and a few scattered birds are found in the strip of forest along the southern coast of the island from the Ylig River to Umatac. A small population of fewer than 10 starlings is thought to have recently died out in downtown Agana.

ISLAND SWIFTLET

In November 1992, a colony of swiftlets (*Aerodramus vanikorensis bartschi*) was found in the Lumuna district of Yigo (Fig. 2). Infrequent sightings of one to six birds foraging along the coastal cliffs of this area suggest that the colony is small and possibly contains only 15–30 individuals. The cave used by the swiftlets has not yet been discovered, but may be in a 3-km stretch of little-explored limestone forest between Pagat Point and Lujuna Point. The colony is isolated from other populations on the island. One of these has about 500 birds and is located in the Talofofo River Valley 23 km to the south. Another small colony is believed to persist in the Geus River Valley in Merizo.

A number of empty caves with deposits of guano exist in northern Guam, indicating previous use by swiftlets or Pacific sheath-tailed bats (*Emballonura semicaudata*). Based on the presence of old nests clinging to walls and the reports of long-time residents, at least four of the caves formerly held nesting colonies of swiftlets (Fig. 2).

OTHER BIRDS

No other species of native forest birds retain breeding populations in northern Guam. Based on last field sightings, the approximate dates of extirpation for eight species, all of which were last found in this part of the island, are as follows: Guam flycatcher (*Myiagra oceanica*), 1984; rufous fantail (*Rhipidura rufifrons uraniae*), 1984; bridled white-eye (*Zosterops conspicillatus conspicillatus*), 1984; Mariana fruit-dove (*Ptilinopus roseicapilla*), 1985; white-throated ground-dove (*Gallicolumba xanthonura*), 1986; Micronesian honeyeater (*Myzomela cardinalis saffordii*), 1986; Guam rail (*Rallus owstoni*) 1987; and Micronesian kingfisher (*Halcyon cinnamomina cinnamomina*), 1988 (R. E. Beck, Jr., unpubl. data). Single fruit-doves and ground-doves have been seen or heard calling very rarely since 1987. These include three fruit-doves in the CWSA, one in Northwest Field, and

one at Andersen South. Ground-doves have been recorded in the CWSA, at Mt. Santa Rosa, and in northern Yigo. We believe these birds are much more likely to be recent immigrants from the neighboring island of Rota, which lies 60 km north of Guam, than individuals that have survived since the mid-1980s.

Northern Guam has only one wetland, a municipal ponding basin in central Yigo, that currently offers suitable habitat for common moorhens (*Gallinula chloropus guami*). In the late 1970s, up to 10 adult moorhens and several broods of chicks were noted there (J. M. Jenkins, unpubl. data), but the site became heavily overgrown with tall grass within a few years and was abandoned by the birds. It was cleared of most vegetation in 1993, but has not yet been recolonized by moorhens. A number of artificial ponds have been constructed at three new golf courses in this part of the island since the late 1980s, however, none contains sufficient natural vegetation to attract moorhens.

MARIANA FRUIT BAT

Nearly all of Guam's remaining fruit bats occur on AAFB, where they are much safer from illegal hunting and other forms of human disturbance than on non-military lands. Seasonal fluctuations in the size of the population have been recorded each year since 1987 (G. J. Wiles & C. G. Rice, unpubl. data). Numbers typically increase to about 400–750 bats for one to several months during November to February, then fall to 200–400 animals during June to September. Movements of animals between Guam and Rota most likely account for this variation. Although occasional interisland flights have been previously reported (Wiles & Glass 1990), the pattern of abundance suggests that some movement occurs annually.

During daytime, most of the population aggregates in a single large colony (Wiles 1987b). From 1981–1994, colonies used 21 locations on AAFB, with 11 sites present on Pati Point and 10 between Ritidian Point and the northern rim of Tarague basin (Fig. 3). All roosts occurred on or within 50 m of the tall coastal cliffline in this part of the island. In addition, very small numbers of fruit bats also roost solitarily or in small groups of several individuals away from the main colony. These animals are scattered throughout mature and secondary forests on AAFB, NCTAMS, and small private landholdings at Uruno and Jinapsan Beaches (Fig. 3).

The nocturnal foraging range of the population is poorly known, but is probably similar to that of day-roosting animals, with most bats feeding in limestone forests on or near both military installations. Some individuals may fly up to 12 km between roosts on Pati Point and foraging sites in Northwest Field and adjacent areas. Some feeding activity also occurs south of the bases, with a few sightings of bats at night in northern Yigo, Agafo Gumas, and at the Hatsuho Golf Course. Foraging is suspected to extend into the Anao Conservation Area and perhaps as far south as Campanaya Point (Fig. 3).

Based on observations at colonies from 1982–1986, Wiles (1987b) reported the failure of virtually all immature fruit bats to survive beyond an estimated age of 1–2 months. He suggested that juveniles were preyed upon by brown tree

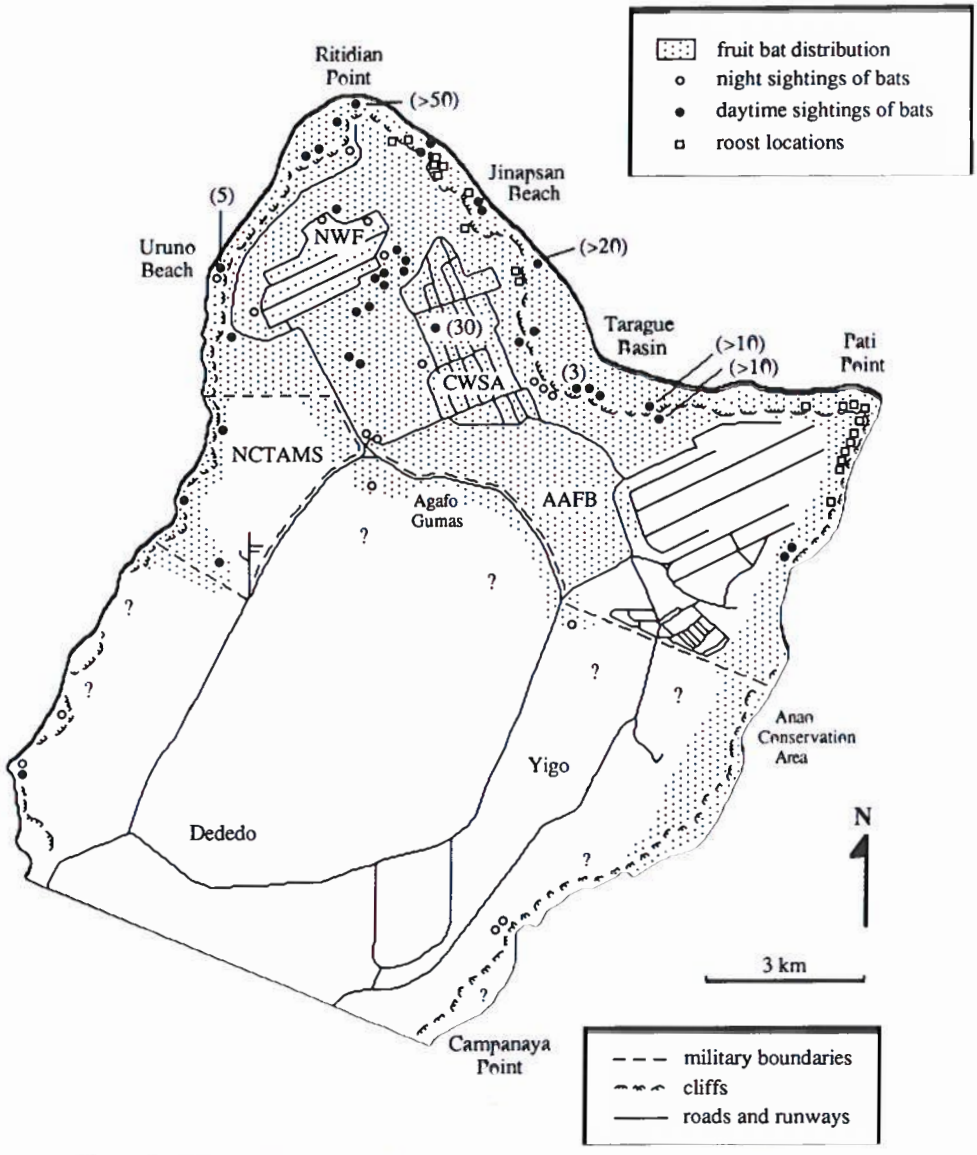

Figure 3. Distribution of Mariana fruit bats in northern Guam in 1994. Colony sites used from 1981–1994 are depicted. Numbers in parentheses indicate the number of bat sightings in a particular area. Question marks depict areas that may be regularly used by bats for which observations are lacking. See Figure 1 for an explanation of abbreviated site names.

snakes when left alone at night by their mothers during feeding. Continued observations from 1987–1994 have shown that the pattern of the loss of young remains unchanged (G. J. Wiles, unpubl. data). Without local recruitment, we believe the island's bat population is probably maintained only through the immigration of animals from Rota.

OTHER BATS

Two other species of bats, the little Marianas fruit bat and the Pacific sheath-tailed bat, once occurred on Guam. Both species were last recorded in the Tarague basin, with the fruit bat last seen in 1968 (Perez 1972, Wiles 1987a) and the sheath-tailed bat in 1972 (Kami et al. 1976). Both are thought to be extinct on the island.

SEA TURTLES

Three species of sea turtles are known from Guam's waters. Green turtles are most common, while hawksbill turtles (*Eretmochelys imbricata*) are much less numerous but not rare. Leatherback turtles (*Dermochelys coriacea*) have been recorded only a few times ever.

The size of the breeding populations of green and hawksbill turtles on Guam is not known. However, the trend in aerial counts suggests that turtle numbers have been reduced islandwide in recent years. Turtle sightings declined from 9.5 animals per flight (n = 82) during 1975–1979 (M. Molina in Pritchard 1981) to 4.0 animals per flight (n = 41) during 1989–1991. Turtle abundance in the north is thought to have dropped accordingly. Aggregations of 40–50 turtles were occasionally observed offshore between Ritidian Pont and Pati Point during flights in the 1970s (Pritchard 1981), but groupings of this type are no longer seen.

During 1989–1991, 57.9% of all aerial sightings of turtles (n = 164) occurred in northern Guam from Tanguisson Beach to Pago Bay. Green turtles are considerably more common in this region than hawksbills. Of 95 aerial sightings, 57 animals were identified as green turtles, two were hawksbills, and 36 were unidentified. Major sea grass beds used by green turtles occur on reef flats along Tarague Beach and Hilaan, and in deeper water south of Falcona Beach. Hawksbills prefer feeding in areas with sponges typically found near river mouths and inside Apra Harbor (G. W. Davis, pers. obs.), but these habitats are lacking in the northern part of the island.

Two large stretches of beach occur in northern Guam. The longest strip runs from Falcona Beach eastward to Tagua Point (15 km), while the second extends from Bijia Point north to Hilaan (4 km). Both were probably used extensively by nesting turtles in the past. Landowners at Jinapsan Beach have reported that it was once a particularly well-used site. However, in recent years, nests and crawls have been limited primarily to three areas: near Falcona Beach, from Ritidian Point to Pajon Point, and along the eastern half of Tarague Beach (Fig. 2). Based on records from 1985–1992, 74% of the known green turtle nesting attempts (n = 131) on Guam occurred at these locations. We estimate that about 1–7 nests and an average of about 10 false crawls are made annually at each of

these beaches. During exceptional years, however, about 35 false crawls at Falcona Beach and 20 false crawls along eastern Tarague Beach have been noted. These key sites receive little disturbance by humans. Long stretches of adjacent beach at Uruno and Jinapsan and from Bijia Point north to Hilaan are heavily disturbed by people and vehicular traffic and are rarely visited by nesting turtles. There are no records of hawksbills nesting in northern Guam.

Illegal harvesting of turtles occurs much less frequently in northern Guam than in the southern part of the island. The robbing of eggs from nests by people has not been observed anywhere on the island in recent years, however, there are several records of nest predation by feral pigs (*Sus scrofa*) in northern Guam (G. W. Davis, unpubl. data).

LIZARDS

A number of lizards have become rare or probably extinct on Guam in recent decades, although none is yet officially designated as endangered. Species documented from northern Guam that have not been recorded in more than 15 years include the Pacific slender-toed gecko (*Nactus pelagicus*), Micronesian gecko (*Perochirus ateles*), and Slevin's skink (*Emoia slevini*). The oceanic gecko (*Gehyra oceanica*) still occurs in very low densities throughout the island, including the north (Rodda & Fritts 1992; M. J. McCoid, pers. comm.). The moth skink (*Lipinia noctua*) is known from just a few sites on the island, including Hilaan, Haputo Beach, and Achae Point along the northwestern coast. It also survives in small numbers (Rodda & Fritts 1992). Predation by tree snakes is implicated in the declines of *G. oceanica* and *P. ateles,* but the introduction of the skink *Carlia fusca* and the musk shrew (*Suncus murinus*) may have harmed some species as well (Rodda & Fritts 1992).

TREE SNAILS

None of the island's four partulid tree snails is listed as endangered, even though one (*Partula salifana*) has recently become extinct and the others have greatly declined (B. D. Smith, pers. comm.). Three species occur in northern Guam and are now restricted to several small areas (Hopper & Smith 1992; B. D. Smith, pers. comm.). The narrow strip of coastal forest from Bijia Point to Haputo Beach holds several populations of *P. radiolata,* with *P. gibba* and *Samoana fragilis* restricted to the Haputo area. A population of *P. radiolata* also remains at Jinapsan Beach. The introduction of several carnivorous land snails (*Euglandina rosea, Gonaxis kibweziensis,* and *G. quadrilateralis*) in the 1950s and 1960s and a predatory flatworm (*Platydemus manokwari*) in 1978 is largely responsible for the loss of the species (Hopper & Smith 1992). Habitat destruction and modification have also affected some populations.

SERIANTHES NELSONII

The status and conservation problems of this species, which is endemic to Guam and Rota, have been recently summarized (U.S. Fish & Wildlife Service 1994). The last remaining adult tree on Guam occurs at Ritidian Point, with one

seedling also present (Fig. 2). Four seedlings survive at a second location in Northwest Field, where the parent tree was destroyed by Typhoon Omar in 1992. Another seedling occurs at a third site in Northwest Field known as Area 50. It was transplanted there in October 1992 after being raised from seed stock originating from Rota. Major threats to this species on Guam are the browsing of seedlings by Philippine sambar deer (*Cervus mariannus*) and feral pigs and herbivory on trees and seedlings by mealybugs (*Dysmicoccus brevipes, D. neobrevipes, Ferrisia virgata,* and *Planococcus citri*) and a butterfly (*Eurema blanda*).

HERITIERA LONGIPETIOLATA

Surveys are underway to census the population of *H. longipetiolata* on Guam (G. J. Wiles, unpubl. data). Preliminary results indicate that about 250 trees are present in northern Guam, with the largest numbers occurring east of the golf course and main airfield on AAFB. Additional trees are scattered primarily along the eastern and northern coasts from Ritidian Point to Pagat Point. Nearly all *H. longipetiolata* grow on or within several hundred meters of the limestone cliffs fringing the coast. Other populations exist in central and southern Guam. Reasons for the decline of this tree may involve heavy predation on seeds by deer or coconut crabs (*Birgus latro*) and the browsing of seedlings by deer and pigs. As with *S. nelsonii,* this has resulted in almost no regeneration of young trees.

Discussion

A broad range of indigenous wildlife has become endangered or extirpated on Guam this century. Groups experiencing losses include all mammals, nearly all resident birds, sea turtles, many lizards, four tree snails, and some terrestrial snails. Status information for other native invertebrates and native plants is generally lacking, but some of these species have also declined greatly or disappeared. The most important factors involved in the demise of these taxa are the introduction of exotic animals, overhunting, and the destruction or alteration of habitats. Investigations of other possible causes have dismissed diseases (Savidge et al. 1992), pesticides (Grue 1985), and interactions with introduced black drongos (*Dicrurus macrocercus*) (Maben 1982) as factors contributing to the decline of native bird populations. Actions needed to save some of the island's endangered species are outlined in a series of recently published recovery plans (Beck & Savidge 1990; Wiles 1990; U.S. Fish & Wildlife Service 1991a, 1991b, 1994).

The most crucial conservation need on the island is control of the brown tree snake. Recovery of fruit bats and a number of birds and lizards cannot occur until a significant reduction in snake numbers is achieved. Despite the loss of most of their endothermic prey, brown tree snakes remain in high densities at many sites in northern Guam and other parts of the island (Rodda et al. 1992; E. W. Campbell, pers. comm.), being able to survive on several common species of introduced geckos and skinks. Research has begun on methods of excluding snakes from small study plots, but application of techniques to larger areas where

self-sustaining populations of birds can be established may be years away. It is also vital to prevent the colonization of other islands by the brown tree snake.

A method of guarding nest sites of Mariana crows from snakes has been successfully implemented and involves the placement of an electrical barrier on the trunks of active nest trees (Aguon et al., in press). This resulted in the fledging of three crow chicks in 1992 and two in 1994, the only young known to be produced in the wild since 1985.

Control of other exotic organisms, such as feral pigs, deer, flatworms, mealybugs, and perhaps *Carlia,* is similarly needed on the island, but also poses significant logistical problems and monetary expense. Eradication of pigs and deer from areas of up to several square kilometers may be achievable through a combination of hunting, snaring, and fencing. Ungulate control of this type has succeeded on several Hawaiian Islands (Stone & Anderson 1988, Anderson & Stone 1993, Katahira et al. 1993).

Until the last few years, the loss of forested habitat has not been a major conservation concern for most endangered species on Guam, nor an important contributing factor in their declines. However, economic and human population growth during the last decade has spurred development and increased pressure on some of the most important remaining tracts of forest. Construction and land clearing is occurring more quickly in the interior regions of northern Guam than in most other parts of the island. At the present rate of development, most remaining forest in central Dededo and Yigo will be destroyed in the next 10–20 years. It is very likely that the only significant tracts of forest to survive in northern Guam will be along clifflines, on military lands, or in the Anao Conservation Reserve, which is owned by the Government of Guam. However, even many of these lands may be threatened. Increased public support for indigenous land rights issues and the return of unused military land to private landowners is creating additional pressure to open up forested lands for private and commercial use.

Permanent preservation of a large area of forest in northern Guam is necessary to ensure the continued existence of Mariana crows, Mariana fruit bats, and a number of native plants. Protection of this habitat will also provide adequate room for the reestablishment and recovery of a variety of species should control of brown tree snakes ever occur. Probably the best method of protecting and managing this forest is through the creation of a conservation reserve. To meet this goal, the U.S. Fish & Wildlife Service established the Guam National Wildlife Refuge in late 1993. The refuge encompasses about 5,200 ha of land in northern Guam and an additional 4,000 ha in the southwestern corner of the island.

Disruption of nesting habitat has become a primary concern in sea turtle conservation on Guam. Economic growth and a rapidly expanding tourism industry has stimulated considerable development of coastlines during the last few decades, resulting in greater human activity at many beaches. Records reveal that a number of turtle nesting beaches used in the past, including several long stretches of beach in northern Guam, are no longer active. The driving of four-

wheel-drive vehicles on beaches has become especially problematic in northern Guam. The vehicles create deep ruts in the sand, which may change the physical character of beaches enough to reduce or deter nesting. Vehicle use may cause sand compaction, alter beach slope, kill important fringe vegetation, and contaminate the sand with petroleum. Additionally, tire ruts may trap hatchlings and prevent them from reaching the ocean. Heavy vehicle use currently occurs at Uruno and Jinapsan Beaches and on parts of Tanguisson Beach. Little or no turtle nesting has been noted at these locations since observations began in the mid-1970s. Instead, nesting now occurs mainly at smaller beaches that are blocked off from vehicles by rock outcroppings or on military beaches where vehicle access is prohibited. It is feared that increasing human use of beaches may eventually eliminate turtle nesting on the island. The establishment of the wildlife refuge and the Andersen Air Force Base Marine Resources Preserve, which runs from Tarague Beach to Anao Point, should help to protect some beaches in northern Guam from disturbance.

Prevention of illegal hunting is needed for sea turtles and fruit bats. Although turtles were formally protected in the 1970s under the U.S. Endangered Species Act, poaching continues to be a problem, especially in southern Guam. Green turtles are targeted more commonly than hawksbills because of their greater abundance and larger size. Because green turtles are long-lived and females may not become reproductive for 10–50 years (Balazs 1981), illegal taking of adults has an immediate impact on the population. The removal of adult females is of particular concern because of the small number of nesting females remaining on Guam.

Poaching of Mariana fruit bats was the major source of mortality in the population on Guam until the mid-1980s, but has become much less of a problem since then (Wiles 1987a, unpubl. data). However, illegal hunting remains a serious threat and must be guarded against. Fruit bats are still regularly taken illegally on Rota and other islands in the Commonwealth of the Northern Mariana Islands (Wiles et al. 1989, Stinson et al. 1992). This threatens the species' survival on Guam because bats throughout the southern Marianas form a single population linked by flights between islands (Wiles et al. 1989, Wiles & Glass 1990).

Over time, the small populations described in this report will become increasingly vulnerable to an assortment of other problems that may preclude recovery, including loss of genetic diversity, chance demographic events, environmental variation, and catastrophic events (Shaffer 1981, Gilpin & Soule 1986, Pimm 1991). Several examples illustrate that these problems already affect some species on Guam. Low rates of egg hatching have been recently noted in Mariana crows, suggesting the possibility of inbreeding (C. F. Aguon, unpubl. data). Changes in the plant composition of limestone forest are gradually occurring as a number of introduced weeds and trees invade the forest and populations of native trees suffer low recruitment rates because of overbrowsing by ungulates and the loss of pollinators and seed dispersers. Guam lies in Micronesia's typhoon belt and is struck by severe storms on an average of about once every 10–20 years. Endangered animal and plant populations may be especially susceptible

to such storms through direct mortality of significant numbers of individuals or subsequent habitat disruption and temporary reductions in food sources. For example, two major typhoons in 1990 and 1991 reduced the population of Micronesian starlings on Cocos Island from about 100 birds to 20 birds (C. F. Aguon & G. J. Wiles, unpubl. data). Another storm in 1992 killed one of only two known adult *Serianthes nelsonii* on Guam (U.S. Fish & Wildlife Service 1994).

Another recent concern has been an increase in military aircraft activity at AAFB and the effects it may have on crows and fruit bats. Frequent loud overflights by helicopters and jets may alter behavior, impair reproduction, and change habitat use of animals living in forests next to the airfield and could hinder efforts to recover both species. Several interactions between aircraft and these species have been seen on the base, including a helicopter that distracted a male crow away from its nest, which allowed an unmated crow to enter the nesting territory and attack the incubating female (Grout 1993). On two known occasions, jet aircraft have flushed roosting bats from colonial sites on Pati Point, once causing the abandonment of a roost (Grout 1993). A study is currently underway to evaluate the extent of aircraft disturbance (J. Morton, pers. comm.).

Fortunately, many of Guam's endangered animals and plants retain populations on the neighboring Mariana Islands. Additionally, the Guam rail and Micronesian kingfisher occur in captive breeding programs and it is likely that several of the partulid tree snails can be bred in captivity. These sources of individuals can be used to reintroduce species back to Guam, once the problems causing their declines are controlled. Supplementation of existing populations is also a management option for a few species, such as Mariana crows and *Serianthes nelsonii.* A program to establish a wild population of rails on Rota through the translocation of captive birds is planned to resume in the near future (Witteman & Beck 1991).

Comprehensive surveys of the status and distribution of native plants and other invertebrates are needed for the island. These will identify species of concern and possible management needs. Some species probably already qualify for listing as endangered or threatened by the federal and territorial governments. Among the plants, the trees *Drypetes dolichocarpa* and *Tabernaemontana rotensis,* a shrub (*Solanum guamense*), a vine (*Canavalia sericea*), three ferns (*Lycopodium phlegmaria, Cyathea lunulata,* and *Thelypteris warburgii*), seven orchids (*Coelogyne guamensis, Dendrobium philippinense, Eria rostiflora, Geodorum densiflorum, Liparis guamensis, Nervilia jacksoniae,* and *N. platychila*), and an undescribed species of mint (Labiatae) have been identified as deserving of additional survey work (L. Raulerson, pers. comm.; S. Perlman & K. Wood, unpubl. data).

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