Recovery Plan

For the Micronesian Megapode (Megapodius laperouse laperouse)

© H Douglas Pratt

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island Territories under U.S. administration.

RECOVERY PLAN

FOR THE

MICRONESIAN MEGAPODE
(*Megapodius laperouse laperouse*)

Published by
Region 1
U.S. Fish and Wildlife Service
Portland, Oregon

Approved: ______________________________
Regional Director, U.S. Fish and Wildlife Service

Date: 4/10/98

DISCLAIMER PAGE

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Costs indicated for task implementation and/or time for achievement of recovery are only **estimates** and subject to change. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service **only** after they have been signed by the Regional Director or Director as **approved**. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature Citation: U.S. Fish and Wildlife Service. 1998. Recovery Plan for the Micronesian Megapode (Megapodius laperouse laperouse). U.S. Fish and Wildlife Service, Portland, OR. 65 + pp.

Additional copies may be purchased from:

Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814
301/492-3421 or 1-800-582-3421

The fee for the Plan varies depending on the number of pages of the Plan.

ACKNOWLEDGEMENTS

Parts I and II of the initial draft of the Recovery Plan for the Micronesian megapode were prepared by Derek W. Stinson, formerly a biologist with the Commonwealth of the Northern Mariana Islands (CNMI) Division of Fish and Wildlife (DFW), Saipan. The manuscript was improved with suggestions by G.J. Wiles, C.G. Rice, R.W.R.J. Dekker, J.D. Reichel, P.O. Glass, and A.P. Marshall. A.P. Marshall kindly provided materials from CNMI-DFW files. Updates to the final plan were done by John Schmerfeld. Modifications have been made by the U.S. Fish and Wildlife Service, Pacific Islands Ecoregion, Honolulu, Hawaii. Cover artwork of the megapode, done by H. Douglas Pratt, was originally published in a poster courtesy of Guam Division of Aquatic and Wildlife Resources (GDAWR) and CNMI-DFW.

EXECUTIVE SUMMARY

Current Species Status: The Micronesian megapode, a pigeon-sized bird, is federally listed as endangered. Small remnant populations are known to exist on the southern Mariana Islands of Aguiguan, Tinian, Saipan, and Farallon de Medinilla while larger populations persist on the northern uninhabited Mariana Islands of Anatahan, Guguan, Sarigan, Alamagan, Pagan, Ascuncion, Maug, and possibly Agrihan. The total number of individuals throughout the Marianas archipelago is estimated to be 1,440 to 1,975 birds.

Habitat Requirements and Limiting Factors: Micronesian megapodes are generally dependent on native limestone forest, but may occasionally use native and non-native secondary forest adjacent to limestone forest. Megapodes primarily select nest sites in sun-warmed cinder fields or areas warmed by geothermal heat, but secondarily will nest in the roots of rotting trees, logs, and in patches of rotting sword grass. Historically, megapodes and their eggs may have been over exploited by native human populations, but this activity has not been documented recently. Current threats to megapodes include habitat degradation by feral ungulates and commercial/residential development, competition with introduced galliformes, and predation by introduced monitor lizards, cats, rats, pigs, and dogs. Megapode populations may also be threatened by stochastic natural phenomenon such as vulcanism, drought, and typhoons. The greatest potential threat to megapode populations is the establishment of brown tree snakes on the islands north of Guam.

Recovery Objectives: The ultimate objective of this plan is to delist the Micronesian megapode, but criteria for downlisting are also established.

Recovery Criteria: The following steps must be accomplished for downlisting: (1) there must be a brown tree snake interdiction and control plan in place, and implementation in effect, for all of the Mariana Islands; (2) current threats to all extant megapode populations must be assessed and controlled; and (3) the comparatively large populations on Anatahan, Sarigan, Guguan, Pagan, and Maug must remain at their current population levels or be increasing for a period of 5 consecutive years. For delisting, the total number of megapodes in the Marianas should be at least 2,650 birds distributed over 10 islands, including at least 2 populations of 600 birds or greater, 3 populations of 300 or greater, 2 populations of 200 or greater, and 3 populations of 50 or greater. All populations must be stable or increasing for 5 consecutive years after achieving these levels.

Actions Needed:

1. Survey for, protect, and manage existing populations.
2. Conduct essential research on the ecology and biology of Micronesian megapodes.
3. Promote expansion of megapodes into suitable habitat.
4. Monitor megapode populations.
5. Establish a brown tree snake interdication and control plan.

Total Estimated Cost of Recovery ($1,000's); some costs yet to be determined:

Year	Need 1	Need 2	Need 3	Need 4	Total
1998	192	19	11	14	236
1999	264	19	11	28	322
2000	232	19	24	0	275
2001	227	19	40	10	296
2002	227	19	40	18	304
2003	198	0	30	10	238
2004	198	0	30	0	228
2005	198	0	30	28	256
2006	198	0	30	0	228
2007	198	0	30	10	238
2008	163	0	45	18	226
2009	163	0	35	10	208
2010	163	0	35	0	198
2011	163	0	35	28	226
2012	163	0	35	0	198
Total	2947	95	461	174	3677

Date of Recovery: Downlisting to threatened should be initiated in 2007 if the downlisting criteria have been met, and delisting should occur in 2012 if all delisting criteria have been met.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

1. Brief Overview

The Mariana Islands lay between 13 degrees and 21 degrees North latitude and between 144 degrees and 146 degrees East longitude in the western Pacific Ocean (Figure 1). These islands, plus many small banks, seamounts and pinnacles extend approximately 800 kilometers (500 miles) in a north-south direction and comprise the Mariana Archipelago. Politically, the Mariana Islands consist of the U.S. Territory of Guam and the Commonwealth of the Northern Mariana Islands (CNMI). Only the islands of Guam, Rota, Tinian, and Saipan have permanent human populations. All islands are small, and each can be considered a single coastal ecosystem, with no point in the archipelago being more than 6 kilometers (4 miles) from the ocean.

The Mariana Islands host an avifauna of Melanesian, Moluccan/ Celebesian, Philippine, and Palearctic origins (Baker 1951). This avifauna is in the midst of at least the second of two human-caused bird extinction events. These pulses of extinction have resulted from a combination of factors, including a history and ecology typical of oceanic islands as well as a somewhat unusual land-use history. Birds of oceanic islands are much more vulnerable to extinction than continental species due to small population sizes and factors such as a lack of both predator avoidance behaviors and resistance to diseases and parasites (Temple 1985). The first wave of extinctions occurred after the arrival of aboriginal humans to Micronesia 2,000 to 4,000 years ago. Archaeological excavations indicate aboriginal human populations were high and may have reached 20,000 on Tinian alone (Farrell 1989). These populations must have profoundly altered the character of the vegetation. These changes, along with human exploitation and the introduction of Polynesian rats (*Rattus exulans*), seem to have caused the extinction of more than half the original avifauna of the Mariana Islands (Steadman 1992). This pattern is typical of many Pacific Islands.

The second wave of extinctions began with the arrival of Europeans in the 16th century, who brought domestic livestock that did widespread damage to the forests of the larger islands (Fosberg 1960, Barratt 1988). Black rats (*Rattus rattus*) and/or Norway rats (*Rattus norvegicus*) spread to some islands during this

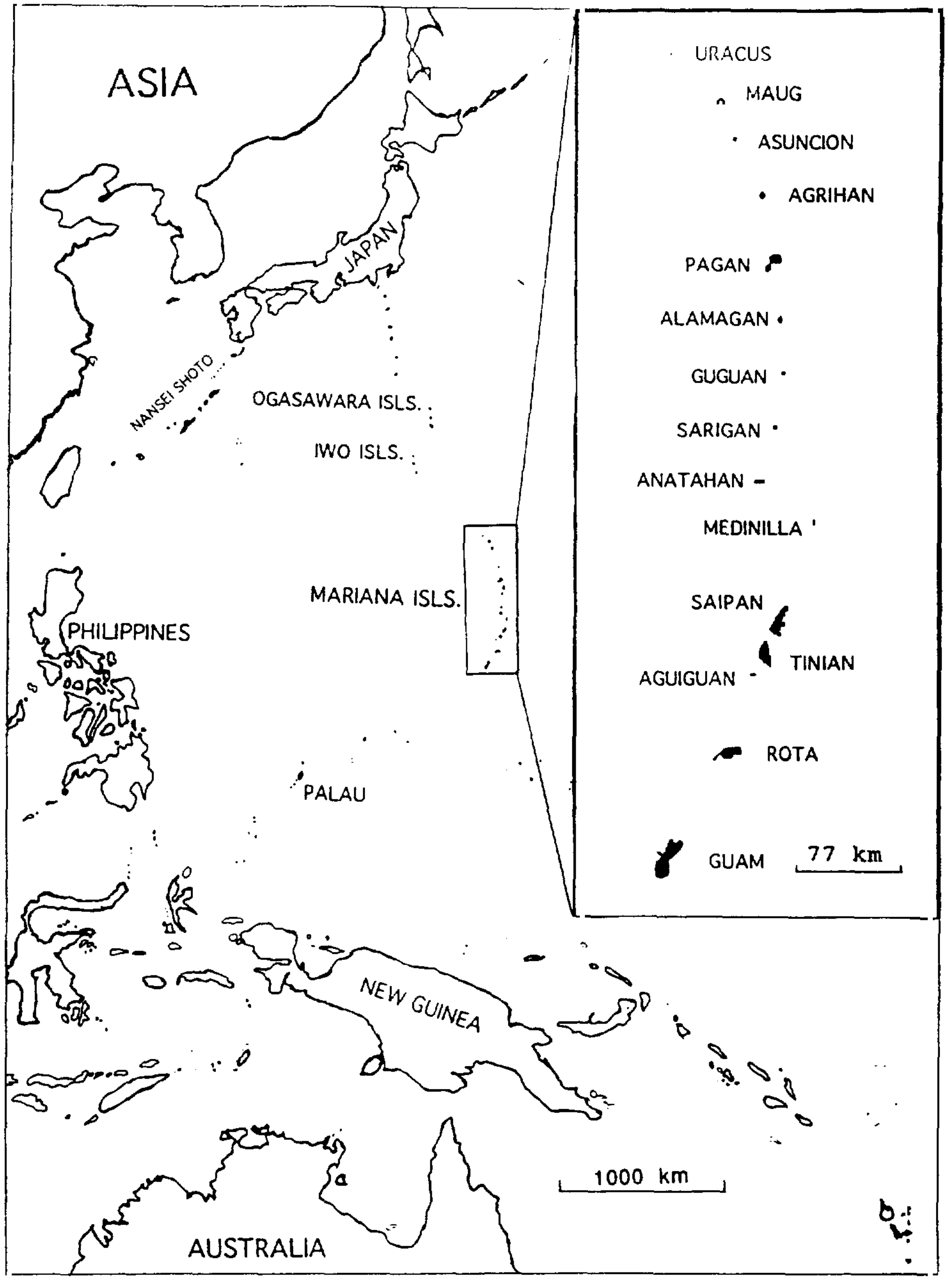

Figure 1. Historic range of the Micronesian megapode in the Marianas: records include all the islands.

period. In the CNMI, native forest was converted to copra (*Cocos nucifera*) production during the German occupation (1899 to 1917) and later to sugarcane (*Saccharum* spp.) during the Japanese period (1917 to 1944). These changes in forest composition continued and considerable destruction occurred during World War II battles. Later, widespread introductions of exotic plants and animals, including the arrival of the brown tree snake (*Boiga irregularis*) on Guam, further increased the extinction rates of birds. These impacts, along with clearing and construction, have resulted in extensive alteration and loss of habitat and increased predation on native species. Historic extirpations from individual islands have occurred in 5 of 15 native land bird species in the CNMI (Reichel and Glass 1991). In addition, nine bird species are believed to be extinct on Guam as a result of predation by the brown tree snake (Savidge 1987). The Marianas were recently identified as an "Endemic Bird Area" of critical importance due to the high endemism and severity of threats to resident birds (ICBP 1992).

The Micronesian megapode (*Megapodius laperouse laperouse*), called "*sasangat*" in Chamorro and "*sasangal*" in Carolinian, is a pigeon-sized bird of the forest floor. The species was extirpated on all of the large southern Mariana Islands (Guam, Rota, and Saipan) except Tinian in the 19th and early 20th centuries. Small remnant populations persist on Aguiguan (alternate spelling: Aguijan), Tinian, and Farallon de Medinilla, along with a very small reintroduced population on Saipan. The megapode remains in relatively large numbers only on the small uninhabited northern islands of Anatahan, Sarigan, Guguan, Pagan, Maug, Almagan, Ascuncion and possibly Agrihan. Population estimates of the megapode total about 1,440 to 1,975 birds in the archipelago.

The Micronesian megapode was federally listed as endangered on June 2, 1970 (35 FR 8491-8498). The species is listed as endangered in the International Union for the Conservation of Nature (IUCN) Megapode Action Plan (Dekker *et al.* 1995) and as threatened by Birdlife International (Collar *et al.* 1994).

Recovery Priority Number

Because the Micronesian megapode has populations dispersed over several islands, many of which are uninhabited, and population trends tend to be stable or slowly declining, the U.S. Fish and Wildlife Service (Service) believes the level of threat to this subspecies is moderate and that there is a high potential for recovery. Therefore, the megapode has been as assigned a Recovery Priority Number of 9 on a scale of 1 to 18 (USFWS 1983).

2. Taxonomy

The Megapodiidae are a family within the order Galliformes (chicken-like birds) found only in the Australasian region. The family comprises seven genera found in Australia, New Guinea and surrounding islands, eastern Indonesia, the Nicobar Islands, the Philippines, Micronesia, Vanuatu, and Niuafo'ou of the Tonga Islands. Recent archaeological evidence indicates that megapodes were once found throughout the region of New Caledonia, Vanuatu, Fiji, Tonga, and Samoa (Steadman 1989). Presently 22 extant species are recognized and, of these, 13 are in the genus Megapodius, often called "scrub fowl" (Jones *et al.* 1995).

The Micronesian megapode was first described by Quoy and Gaimard (1824 to 1826) from a single specimen obtained on Tinian by Berard during the Uranie expedition in December 1820. Megapodes collected in the Palau Islands were originally described as a separate species, *Megapodius senex*, by Hartlaub (Baker 1951), but were considered to be a race of *M. laperouse* by later researchers (Momiyama 1922, Baker 1951), with the Marianas' birds belonging to the nominal race *M. l. laperouse*. Baker (1951) and Mayr (1942) both regarded *M. laperouse* and *M. pritchardii* of Niuafo'ou, Tonga as very distinct from their apparent ancestors in New Guinea and Australia.

3. Description and Life History

The Micronesian megapode is a pigeon-sized bird with an average weight of about 350 grams (12.25 ounces) (Glass and Aldan 1988). It has dark gray-brown to black body plumage and an ash gray head with a slightly darker, short, rough crest. The flight feathers and short tail are grayish-black, and the wings are short and rounded. The feathers around the eye, ear, and throat are very sparse or absent, revealing red skin, and a red gular skin patch when the neck is extended. The posture is often rather hunched. The bill is yellow with the upper mandible clove-brown to black at the base. The heavily built legs and feet are yellow with the joints of toes and/or all the upper surface dark gray-black. The iris is orange-brown to dark brown (Baker 1951, Jones *et al.* 1995).

Megapodius laperouse senex, the Palauan subspecies, differs in having a paler head without the slightly darker cap, being darker gray and less brown, and having longer tarsus, toes, and claws.

Vocalizations

Micronesian megapodes are known to give at least three types of calls, including two sexually dimorphic calls that may be given in a duet. The following descriptions are taken from Glass and Aldan (1988).

The curiosity/alarm call is given by both sexes and consists of a series of relatively low "kek" notes at regular intervals of the same pitch and volume, sometimes preceded by a louder "keek" of higher pitch. The same call is given in greater volume and intensity as an alarm call when a bird is frightened. The curiosity call may be given frequently, but is not as loud and not heard over as great a distance as the male alarm call.

The male or territorial call consists of a loud "keek" note followed by a pause and two "keek" notes of lower volume and slightly descending pitch. This call is the first call usually given in response to tape recorded calls and is the most frequently heard call throughout the year.

The female call consists of a loud introductory "kek" note, followed by a rapid series of five to nine short "kek" notes in ascending pitch, followed by a short pause and a loud "keek". It is rarely given alone, and is most often given in duet with the male's call.

The duet is initiated by the female's loud introductory "kek" which stimulates the male to give its call while the female gives the remainder of the female call simultaneously.

Territoriality

The phenomenon of duetting in birds is correlated with year-round territoriality and prolonged monogamous pair bonds (Farabaugh 1982). Duets may function as joint, territory-claiming communication between mates and between neighboring pairs. Duets may also advertise the existence of a pair bond and discourage single birds from entering the territory in search of mates

(Farabaugh 1982). The existence of duetting in the Micronesian megapode supports the report of Glass and Aldan (1988) that on Saipan megapodes seem to remain together throughout the year in territories that are advertised and defended at least part of the year. It is not known how, or if, territoriality functions at or near heavily used communal nesting areas like the one on Guguan. Micronesian megapodes may defend year-round territories to secure adequate foraging areas for the female to produce eggs, and perhaps to secure limited nest burrow sites where large communal sites are not available. Based on repeated sightings and call detections, Glass and Aldan (1988) derived a preliminary estimate of a minimum territory size on Saipan of about 1 hectare (2.47 acres).

Breeding Seasonality

The seasonal change in amount of vocalizations, particularly duetting, is believed to be indicative of seasonal changes in breeding activity, but no clear pattern has yet emerged. Duetting has been reported in August, November, and December on Saipan (Glass and Aldan 1988, D. Stinson, formerly of Commonwealth of the Northern Mariana Islands-Division of Fish and Wildlife (CNMI-DFW), unpublished field notes 1993), and in May on Anatahan and Sarigan, and May and June on Aguiguan (Rice and Stinson 1992, D. Stinson, unpublished field notes 1989). Craig (1996) recorded a peak in all vocalizations on Saipan in July. D. Stinson (unpublished field notes 1989) noted more vocalization in May than in August or October on Aguiguan. During a July trip to Aguiguan there was a very high level of vocalization including calling after dark and some calling past midnight (CNMI 1983). Baker (1951) stated that the breeding season for both *Megapodius laperouse senex* and *M. l. laperouse* appeared to be January to August. However, Glass and Aldan (1988) observed a high level of vocalization and nesting activity on Guguan in September and a reduced level the following May.

Oustalet (1896) reported that chicks emerged from nests from January or February to June. In recent years, chicks of all sizes have been seen in May and August on Guguan (Glass and Aldan 1988, Rice and Stinson 1992, Clapp 1983) and in September on Sarigan (Rice *et al.* 1990). Nesting on some islands may occur year-round. Megapodes have been seen digging nest burrows on Maug in late March and early June and on Guguan in May, August, and September (Glass and Villagomez 1986, Reichel *et al.* 1988, Rice and Stinson 1992). Seasonality may differ between islands depending on the source of heat for incubation. Where only decompositional heat is used, it may be too wet at the peak of the rainy season, and too dry during severe dry seasons.

Nesting

Megapodes are sometimes called "incubator birds" because they rely on solar energy, volcanic activity, or microbial decomposition as a heat source for incubation (Clark 1964). They are also characterized by large eggs without an air chamber and chicks that lack an egg tooth at hatching and kick their way out of the egg (Clark 1964, Dekker and Brom 1992).

Dekker (1990) described four megapode incubation strategies:

1. burrow nesting at sun-exposed beaches (or in this case, cinder fields);
2. burrow nesting at geothermal sites;
3. mound-building, which uses the heat of decomposition (forming a mound of soil and vegetative matter into which a burrow is dug and the egg is laid); and,
4. burrow nesting between the roots of trees (decompositional heat).

Whereas most megapode species use only one of these incubation strategies, the Micronesian megapode seems to use all of these strategies, as do the Melanesian megapode (*Megapodius eremita*) and the orange-footed megapode (*M. reinwardt*) (Crome and Brown 1979, Dekker 1990). On Guguan, Micronesian megapodes lay eggs in dark solar-heated cinders at a communal nesting area. There they excavate burrows about 20 centimeters (7.9 inches) in diameter in moist soil, or an irregular crater in dry soil, to a depth of 48 to 94 centimeters (mean = 73 centimeters) (18.9 to 37 inches; mean = 28.7 inches) (Glass and Aldan 1988). Micronesian megapodes also nested at a geothermal site on Pagan until the site was deeply buried by cinders during the 1981 volcanic eruption (David T. Aldan, CNMI-DFW, personal communication 1989). In Palau, *M. laperouse senex* builds large mounds of sand with a small amount of grass and leaves in strand forest (a thin strip between the ocean and the limestone substrate) adjacent to beaches (Engbring 1988, Wiles and Conry 1990). These large mounds may be built up and used by several birds. *M. l. senex* also builds smaller mounds of leaf litter and detritus in forest (Wiles and Conry 1990). Large mounds in Palau may be used for a number of years (Engbring 1988). Takatsukasa (1932-1938) reported descriptions by Yamashina and Dr. P. Schnee of large mounds of sand and grass in strand forest on Saipan. However, no large mounds have been seen in recent years. Perhaps the disturbance of traditional mound sites by historical development as well as over-exploitation ended the use of large mounds in the southern Marianas (D. Stinson, personal communication 1995). Ludwig (1979) described megapode mounds of volcanic soil with an unknown heat source on Agrihan. Small mounds of soil and leaf litter or rotting wood about 0.5 meters high (1.6 feet) and 2 meters (6.6 feet) across that were believed to be megapode mounds were observed on Aguiguan in 1955 (Owen 1974, in Glass and Aldan 1988) and 1989 (Stinson 1992), and on Saipan in 1991 (Craig 1996). Rice and Stinson (1992) report a megapode seen excavating a burrow among the roots of a coconut (*Cocos nucifera*) snag on Pagan.

Glass and Aldan (1988) believed that *Megapodius laperouse laperouse* required solar or geothermal heat for nesting because megapodes are only abundant on the volcanic islands. However, Stinson (1992) concluded based on the reports of mounds in the Marianas and Palau, and the past and present distribution and abundance of Micronesian megapodes in the Marianas, that all four incubation strategies are used. *M. l. laperouse* may be able to adapt its behavior to reproduce opportunistically wherever warm, friable (easily crumbled) soil is found. The rarity of immature megapode sightings on coral islands and other islands without dark cinders or geothermal sites suggests that hatching success on such islands is low. The mean temperature on Saipan is about 25 degrees Celsius (77 degrees Fahrenheit) (Stanley 1989), while the typical incubation temperature for megapode eggs is 32 to 35 degrees Celsius (89.6 to 94 degrees Fahrenheit) (Dekker 1988, 1990, 1992, Glass and Aldan 1988). Perhaps sites and conditions where decomposition will sustain the needed incubation temperature are rare or ephemeral (D. Stinson, personal communication 1995).

As is typical in burrow nesting *Megapodius*, female *M. l. laperouse* dig the burrow and are not, or only rarely, accompanied by the male (Glass and Aldan 1988). Wiles and Conry (1990) reported that single *M. l. senex* were observed digging at mounds in Palau. Glass and Aldan (1988) observed females digging on Guguan at all times during daylight, but not at night. Females were generally wary and silent on the nesting ground, and defended the burrow from other birds that attempted to take over the hole (Glass and Aldan 1988; Derek Stinson, personal observation 1992) The entire process of digging, laying, and covering the egg takes from 1.5 to 3.0 hours (Glass and Aldan 1988). When a large mound is built, both sexes may be involved in amassing it (Takatsukasa 1932-1938, Ludwig 1979).

Micronesian megapodes lay a very large egg, measuring 67.3 to 73.3 millimeters (2.6 to 2.9 inches) in length and 42.3 to 45.3 millimeters (1.7 to 1.8 inches) wide (based on a sample size of 15 eggs), and weighing 74.3 to 79.7 grams (2.6 to 2.8 ounces) (based on a sample size of three eggs), or about 18 percent of the female body weight (Glass and Aldan 1988, Takatsukasa 1932 to 1938). The eggs also have a high proportion of yolk. Females caught and marked on the nesting ground did not return to lay additional eggs during a 5 to 6 day period (Glass and Aldan 1988). The laying interval may be similar to the 9 days observed in the Nicobar megapode (*Megapodius nicobariensis abbotti*) (Dekker 1992), or the 9 to 20 days (average 13$\pm$ 4 days) in the orange-footed megapode (Crome and Brown 1979). There is no information on the number of eggs laid in a season by *M. laperouse laperouse*. One orange-footed megapode laid 12 or 13 eggs over a 4.5 month breeding season (Crome and Brown 1979), and the Polynesian megapode (*M. pritchardii*) may lay 10 to 12 eggs per year (Todd 1983). There is also no information on incubation period for *M. l. laperouse*, which lasts 62 to 85 days in the related maleo megapode (*Macrocephalon maleo*) (Dekker and Brom 1992).

The chicks of megapodes typically kick their way out of the egg when hatching and take one to two days to dig their way up to the surface (Jones *et al.* 1995). The chicks are super-precocial (fully active), being completely independent and able to fly upon emergence.

Movements

On Guguan, a bird banded in September 1986 was resighted six times within 70 meters (76 yards) of the capture site in September and May 1987. Two birds marked at Marpi, Saipan, in May 1984 were sighted three or four times within 150 meters (164 yards) of the capture site (Glass and Aldan 1988). Presumably, on Guguan, birds with foraging territories from all over the island move up to 2.5 kilometers (1.6 miles) to the nesting ground to deposit eggs. Other megapodes are known to move at least 10 kilometers (6.2 miles) to nesting beaches (MacKinnon 1981).

Based on the distribution of the Megapodiidae, Olson (1980) stated that megapodes are quite capable of dispersing by flying over water for considerable distances. In Palau, *Megapodius laperouse senex* have been observed to fly several kilometers between islands (Pratt *et al.* 1980). *M. l. laperouse* may be able to fly the 4.6 kilometers (2.9 miles) between Saipan and Tinian, and the 8.9 kilometers (5.5 miles) between Tinian and Aguiguan, but they probably would not normally fly the 30 to 60 kilometers (18 to 37 miles) between adjacent northern islands. However, flights between northern islands seem to occur at least rarely, because Falanruw (1975) observed a bird on Uracus, an active volcano with no forest habitat. Although no observations of flights over open ocean have been reported in the Marianas, if birds from adjacent islands flew to Guguan to nest, this would explain the apparent fluctuation of numbers there (Stinson 1993).

Diet and Foraging

The Micronesian megapode seems to be an omnivore taking a variety of plant and animal foods available on the forest floor, including seeds, beetles, ants, other insects, and plant matter (Stinson 1993). Feeding observations reported include ants and ant larvae (Glass and Aldan 1988), and a centipede (D. Stinson, 1990 field notes). Baker (1951) reports that foods of *M. l. senex* include seeds, crabs, and wood roaches (Blattidae). Glass and Aldan (1988) reported that foraging usually consists of vigorous digging under ferns, branches, and leaf litter. They also saw birds foraging in trees, usually in bird's nest ferns (*Asplenium nidus*).

4. Habitat

The Micronesian megapode is generally a bird of the forest. Takatsukasa (1932-1938) stated that it inhabited forest along the seacoast. On Saipan, megapodes are largely restricted to native limestone forest remnants around the

Marpi cliffs. Glass and Aldan (1988) reported that 28 percent of sightings at Marpi were in introduced tangantangan forest (*Leucaena leucocephala*) near the limestone forest, but that megapodes did not use tangantangan habitat after it was reduced to dense, impenetrable, viny tangles by Typhoon Kim in 1986. Tangantangan, a small leguminous tree, was probably broadcast seeded to stem erosion after the military invasions of 1944. It now forms extensive stands on Saipan and Tinian (Fosberg 1960). Megapodes are also seen in secondary forest dominated by introduced East Indian walnut (*Albizia lebbeck*) adjacent to limestone forest (D. Stinson, personal observation 1993). Engbring *et al.* (1986) state that Micronesian megapodes are partial to uneven ground along and below cliffs. On Saipan and Tinian, these are also generally the only sites where limestone forest has survived.

Limestone forest, which probably typifies the vegetation of the southern Marianas before widespread historical destruction, is described in Fosberg (1960), Stone (1970), Falanruw *et al.* (1989) and Craig (1992a). Common species include: *Cynometra ramiflora*, *Guamia marriannae*, *Pisonia grandis*, *Ficus tinctoria*, *Ficus prolixa*, *Intsia bijuga*, *Premna obtusifolia*, and numerous other tree species. Only a small fraction of the original limestone forest remains on Saipan (4.2 percent) and Tinian (6.7 percent) (Falanruw *et al.* 1989), with a larger amount remaining on Aguiguan (about 47 percent) (Engbring *et al.* 1986). Megapodes on Aguiguan are also primarily restricted to limestone forest and are not seen in open areas of weeds and scrub. The most recent records of megapodes on Tinian (Wiles *et al.* 1987, Donna O'Daniel, formerly of U.S. Fish and Wildlife Service (Service), personal communication 1995) and recent second-hand reports are all from limestone forest.

Farallon de Medinilla is a small coral island that has no forest habitat except for a few stunted trees. During a recent survey, Lusk and Kessler (1996) found four megapodes using the scrubby interior habitat of the island. On the volcanic islands north of Farallon de Medinilla, megapodes are also usually seen in forest. Low elevation forest is often dominated by coconuts where Micronesian, German, and Japanese settlers cleared native trees, including *Barringtonia asiatica*, *Terminalia catappa*, *Hibiscus tiliaceus*, and *Pandanus tectorius* (Ohba 1994). Ohba (1994) indicated that the major native forest communities included associations dominated by *Elaeocarpus joga* and *Pisonia* *grandis*. Dense swordgrass (*Miscanthus floridulus*) now dominates extensive areas of deep rich soils where the *Elaeocarpus* forest has been degraded due to overgrazing by goats (Ohba 1994). Native pago (*Hibiscus tiliaceus*) often dominates ravines. Other native tree species often present on the islands include *Casuarina equisetifolia*, *Terminalia catappa*, *Aglaia mariannensis*, *Erythrina variegata*, *Ficus* spp., *Morinda citrifolia*, *Artocarpus altilis* and *Pandanus tectorius*.

On Sarigan, megapodes are often seen in coconut forest as well as native vegetation, but have not been seen on the open barren or fern-covered eastern and southern slopes. On Guguan and Maug, megapodes also seem to prefer forest, but are also seen in scrubby vegetation and even on barren areas. Glass and Aldan (1988) believed most of the birds seen in the barren areas were engaged in nesting activities. Megapodes encountered in fields of grass and vines (*Ipomoea pes-caprae*) are mostly juveniles rather than territorial pairs, suggesting that this is a less preferred habitat (Glass and Aldan 1988, Rice and Stinson 1992).

In regards to nesting habitat, sites that provide sun-warmed cinder fields or geothermal heat seem to provide the best nesting grounds. Where these are not available, megapodes may opportunistically use sites that are warm and friable, such as the roots of rotting trees, at logs, and in patches of dead sword grass (Stinson 1992, Rice and Stinson 1992).

5. Associated Rare Species

The endangered nightingale reed-warbler (*Acrocephalus luscinia*) presently shares forest habitat with megapodes on Alamagan and Aguiguan and, rarely, limestone forest on Saipan (Craig 1992b). Other associated rare species include the threatened Tinian monarch (*Monarcha takatsukasae*), the Rota bridled white-eye (*Zosterops conspicillatus rotensis*), and certain plants and lizards on Rota and the northern islands (Table 1).

6. Historic Range and Population Status

The Micronesian megapode was historically widespread in the Mariana

Table 1. Associated rare species within current and historic ranges of the Micronesian megapode.

Species	Legal status[1]	Location
Animals		
Slevin's skink (*Emoia slevini*)	r	Guam, Rota, Tinian, Alamagan, Asuncion
Micronesian gecko (*Perochirus ateles*)	e	Saipan
Tinian monarch (*Monarcha takatsukasae*)	T,e	Tinian
Nightingale reed-warbler (*Acrocephalus luscinia*)	E,e	Guam, Aguiguan, Tinian, Saipan, Alamagan
Mariana crow (*Corvus kubaryi*)	E,e	Guam, Rota
Guam rail (*Rallus owstoni*)	E	Guam (extinct in wild)
Guam Micronesian kingfisher (*Halcyon cinnamomina cinnamomina*)	E	Guam (extinct in wild)
Guam flycatcher (*Myiagra freycineti*)	E,B	Guam, Rota[2]
Guam bridled white-eye (*Zosterops conspicillatus conspicillatus*)	E,B	Guam

Rota bridled white-eye (*Zosterops conspicillatus rotensis*)	C,e	Rota
Mariana fruit bat (*Pteropus mariannus*)	E,e	Guam, Rota, Aguiguan, Tinian?, Saipan
Little Mariana fruit bat (*Pteropus tokudae*)	E,B	Guam
Sheath-tailed bat (*Emballonura semicaudata*)	C,e	Guam, Rota, Aguiguan

Plants

Coelogyne guamensis	r	Guam, Rota
Cyrtandra agrihanensis[3]	r	Agrihan
Nervilia jacksoniae	r	Guam, Rota
Nesogenes rotensis	C	Rota
Lycopodium phlegmaria var. *longifolium*	e	Rota
Malaxis alamaganensis[4]	r	Alamagan
Osmoxylon mariannense	C	Rota
Serianthes nelsonii	E	Guam, Rota
Tabernaemontana rotensis	C	Guam, Rota

[1] Abbreviations: E = Federally endangered; T = Federally threatened; C = Federal candidate for listing as endangered or threatened; e = CNMI endangered species; r = rare species, potential candidate; B = believed extinct.
[2] see Steadman (1992)
[3] see Ohba (1994)
[4] see Kobayashi (1994)

Islands and has been recorded on all of the islands (Figure 1). Philip O. Glass (Service, personal communication 1994) suggests that human transport may have been involved historically in maintaining the megapode's widespread distribution.

Guam

The megapode was very rare on Guam at the time of the first European naturalists. It was not found by Berard (Quoy and Gaimard 1824-1826), Kittlitz (1836), or Marche (Oustalet 1896), but one or two were collected near the turn of the century (Hartert 1898, Baker 1951). The megapode may have survived on Guam into the 1930's (Linsley 1935). Baker (1951) stated that it was "probably extinct", and none have been reported in recent years, despite intensive bird surveys (Engbring and Ramsey 1984, Jenkins 1983, Wiles *et al.* 1995).

Rota

Quoy and Gaimard (1824-1826) believed the megapode to be extinct on Rota. However, either it was only rare or was later reintroduced, because it was collected by Marche in 1888 (Oustalet 1896). Megapodes are at least seasonally conspicuous, but despite extensive bird and bat surveys on Rota in recent years, no reliable sightings have occurred. Although there have been periodic reports of juvenile birds, it is now believed to be extirpated on Rota (Baker 1951, Glass and Aldan 1988, Engbring *et al.* 1986, Wiles *et al.* 1987).

Aguiguan

Megapodes have consistently been found in small numbers on Aguiguan this century, with reports from the 1930's, 1950's, 1980's and 1990's (Takatsukasa 1932-1938, Owen 1974, Engbring *et al.* 1986). Takatsukasa (1932-1938) reported that five birds were collected alive on Aguiguan and brought to Japan.

Tinian

Berard collected the megapode on Tinian, but reported it was rare there in 1820 (Quoy and Gaimard 1824-1826). It was not found in 1945 (Marshall 1949). Owen (1974) cited second-hand reports of megapodes on Tinian, but none were detected by Pratt and Bruner (1978), Engbring *et al.* (1986), by a resurvey of Engbring's transects in 1994 (Scott Johnston, Service, personal communication

1995) or in 1996 (Michael Lusk, Service, personal communication 1997). Wiles *et al.* (1987) reported a single bird observed in 1985, but Glass was unable to relocate any in the area or in other areas of native forest on Tinian (Glass and Aldan 1988). However, reports by local residents of megapodes persist, including one from June 1992 (Tim Sutterfield, U.S. Naval Facilities Engineering Command- Environmental Division, personal communication 1993). A megapode-like bird was reported from Tinian in April 1995 by archaeologists, and the presence of megapodes on Tinian was confirmed in May 1995 (D. O'Daniel, Service, personal communication 1995, USFWS 1996).

Saipan

The megapode was apparently once common on Saipan, as 23 were collected by Marche in 1887, though he thought that they would go extinct because they were hunted incessantly (Oustalet 1896). Later, Takatsukasa (1932-1938) wrote that collectors "lately procured many specimens in Saipan and Pagan," but megapodes may have been declining rapidly by that time due to widespread conversion of forest to agriculture during the Japanese administration of the island (D. Stinson, personal communication 1995). Marshall (1949) did not find megapodes in 1945, and Baker (1951) listed the Saipan population as "probably extinct." However, Pratt and Bruner (1978) reported the presence of a small megapode population on the northern part of the island. These birds were probably the result of the transport of eggs from northern islands by local residents (Glass and Aldan 1988).

Alamagan

Megapodes were first collected on Alamagan in the 1930's (Takatsukasa and Yamashina 1932). There is little other information, though local residents report there were nesting grounds on the northeastern and southeastern parts of the island in the 1950's (Reichel *et al.* 1988).

Pagan

Megapodes were first collected on Pagan by Marche in 1887 (Oustalet 1896). Later specimens include five eggs collected by Yamashina (Takatsukasa 1932-1938). Megapodes were common in the 1950's and 1960's and local residents knew of four nesting areas (Glass and Aldan 1988, D. Aldan, personal communication 1989). One nesting area at a hot spring near the upper lake was deeply buried by cinders during the 1981 volcanic eruption. The eruption also buried much of the vegetation in fine cinders, and no megapodes have been seen on the northern part of the island near the volcano in recent years. Megapodes were relatively common on the southern peninsula during the 1960's and 1970's (D. Aldan, personal communication 1989).

Agrihan

Megapodes were first collected on Agrihan by Marche in 1889 (Oustalet 1896) and Yamashina later collected eggs there (Yamashina 1932). Ludwig (1979) described a nesting area on the east side of the island where local residents collected eggs. Ludwig relayed an account given by Juan Matao of another nesting area where buckets of eggs were once collected, but it was destroyed by village construction during the Japanese period. Egg collecting was still occurring at the existing nesting area in 1978. Local residents said that nests were also preyed upon by monitor lizards (*Varanus indicus*), cats (*Felis catus*) and dogs (*Canis familiaris*) (Ludwig 1979).

Asuncion

Megapodes were first reported on Asuncion by Yamashina (1940), but no further information was obtained on this population until recent years.

Other Islands

Megapodes were not reported on Anatahan, Sarigan, Guguan, Maug, and Uracus until the early 1970's (Falanruw 1975), and only recently on Farallon de Medinilla (Lusk and Kessler 1996). The degree to which these six islands were surveyed by naturalists prior to the 1970's is unknown.

7. Current Range and Population Status

The Micronesian megapode is currently found on 12 islands in the Mariana Islands; this assumes the megapode is still found on Agrihan, and is not present on Uracus (Figures 2 through 14). Most of the megapodes are now found on eight islands, all north of Saipan (Table 2). Recent island estimates yield a total of about 1,440 to 1,975 megapodes in the Mariana Islands. This should be considered a "best guess," as several islands have not been thoroughly surveyed. The basis of estimates and other recent data are summarized below.

Aguiguan

Surveys in 1982 resulted in an estimate of 11 megapodes (Engbring *et al.* 1986). More recent reports indicate that little has changed, with this very small population continuing to survive (Craig *et al.* 1992, Lusk 1993, Stinson 1993) (Figure 2).

Tinian

Engbring *et al.* (1986) found no birds on Tinian in 1982. Similarly, a resurvey of Engbring's transects in 1994 detected no birds (S. Johnston, personal communication 1995). However, incidental reports over the years (USFWS 1996, Wiles *et al.* 1987, D. O'Daniel, personal communication 1995) indicate that there is a persisting remnant population (Figure 3).

Saipan

Engbring *et al.* (1986) estimated the megapode population at 40 in 1982. Glass and Aldan (1988) similarly estimated that there were 25 to 40 birds. A recent estimate of 14 suggests this reintroduced population may be declining (Craig 1996). Glass and Aldan (1988) reported sightings in the Naftan and Talufofo areas in the early 1980's, and Craig (1996) heard a megapode at Laderan Papao south of San Roque in 1989. However, all but one of the most recent sightings have been in the Marpi area on the northern tip of the island (Figure 4). The exception was a sighting in the Naftan area in the general vicinity where they had been seen historically (Steve Mosher, Biological Resources Division (BDR), personal communication 1997). Sightings of immature birds on Saipan are limited to very rare second-hand reports, suggesting that reproductive success is very low. A survey of forest birds on Saipan was completed in May 1997. However, there were too few detections of megapodes to permit an accurate population estimate. Nevertheless, the population is thought to be quite small,

Table 2. Current status of Micronesian megapode populations.

Island	Approximate Insular Area (kilometers^2)	Population Size Estimate	Recent Population Trend
Guam	541	0	n/a
Rota	85	0	n/a
Aguiguan	7	10-15	stable
Tinian	100	<10[1,4]	stable
Saipan	122	10-25	decline[2]
Farallon de Medinilla	2	<10	decline[3]
Anatahan	32	200-300[4]	-
Sarigan	5	545-810[5]	increase[5]
Guguan	3.7	500[4]	decline[6]
Alamagan	11	<30[4]	increase[7]
Pagan	48	50-100[4]	decline[8]
Agrihan	47	?	decline[9]
Asuncion	7	<25[4]	-
Maug	2.5	50-150	-
Uracus	2.5	0	-

[1] (D. O'Daniel, personal communication 1997).
[2] May have declined since 1982 (Engbring *et al.* 1986, Craig 1996).
[3] Probable population decline due to military activities (USFWS 1997).
[4] These figures are rough estimates based on surveys of a small portion of potential habitat on the island.
[5] Data from recent surveys indicates a general population increase (Fancy, in press)
[6] Apparent decline after Glass's 1986 visit (Glass and Villagomez 1986).
[7] May be recovering after severe decline; several were detected in 1992, but not detected on previous trips (Rice and Stinson 1992).
[8] A productive nesting area was buried by cinders in 1981 (D. Aldan, personal communication, 1990).
[9] The fact that a nesting area near the village was destroyed early in this century, and a nesting area described by Ludwig (1979) has never been relocated indicate that megapodes may be extirpated from Agrihan.

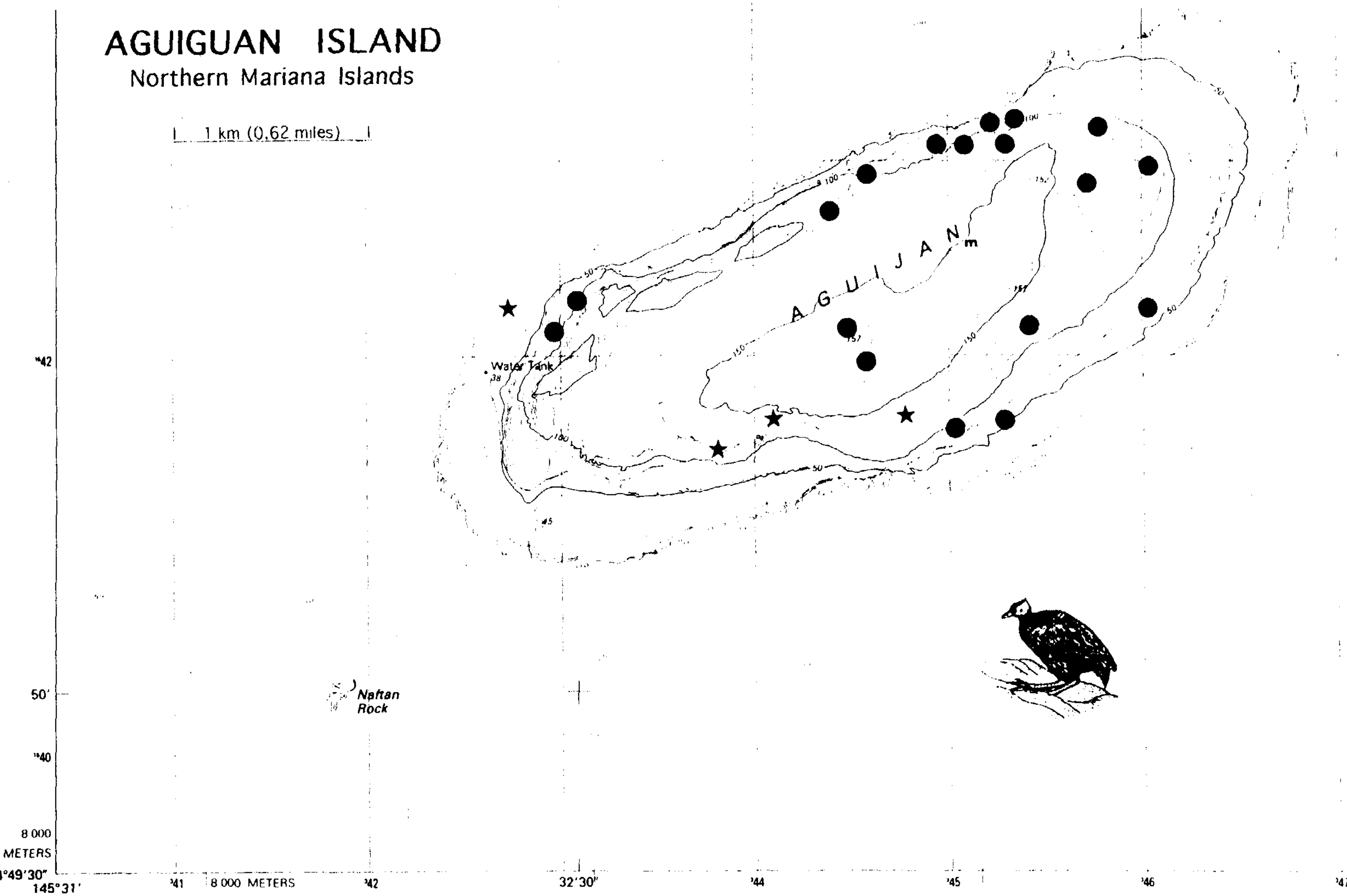

Figure 2. Locations of megapode sightings on Aguiguan in September 1989 (●) and August 1993 (★).

probably less than 30 birds (S. Fancy, personal communication 1997).

Farallon de Medinilla

A total of four megapodes were observed during a site visit in November 1996 (Lusk and Kessler 1996) (Figure 5). No nesting has been recorded on the island, but the possibility of nesting does exist. The total island population is estimated to be less than 10 birds (M. Lusk, personal communication 1997). Practice gunnery and bombardment activities by the U.S. Navy will continue to limit this population (USFWS 1997).

Anatahan

The megapode may have been rare or absent from Anatahan historically because it was not recorded there until 1971 (Falanruw 1975). Lemke (1983) heard five calling in a ravine on the north side, and it was said to be "uncommon" by residents (Glass and Aldan 1988). In September 1988, Reichel and Glass (1988) made a rough population estimate of 300 based on detections on the southern shore and west end of the island (Figure 6). Megapodes seemed relatively common during May 1992, when additional areas of the south slope were explored, though they were not as abundant as on Sarigan (Rice and Stinson 1992). Several megapodes were detected incidentally during a July 1995 expedition, the primary purpose of which was to survey bats (Dan Grout and Tanya Rubenstein, formerly of the Service, personal communications 1995). Megapodes have been detected regularly in the remaining forest areas in various locations on Anatahan during trips made by CNMI-DFW in 1994 to 1996 (Annie Marshall, formerly of CNMI-DFW, personal communication 1996). The 1990 evacuation of human occupants may have benefitted the megapode; however, this benefit may only be temporary because Anatahan will probably be resettled.

Sarigan

Megapodes were first reported on Sarigan by Falanruw (1975) and have consistently been reported as common since then (Ludwig 1979, Clapp 1983, Reichel *et al.* 1989, Rice and Stinson 1992). Pratt (1983) estimated a population of 100 to 200 megapodes. An extensive reconnaissance in 1990 resulted in an estimate of 1 to 1.5 birds/hectare of forest habitat (0.4 to 0.6 birds/acre), or a total of about 180 to 270 birds distributed throughout the forested habitat (Figure 7) (Rice *et al.* 1990). Concurrent variable circular plot counts produced an estimate of 423 to 522 birds. Stinson (1993) listed an estimate of 200 to 300 birds for Sarigan (Figure 7). A recent forest bird survey estimates the current megapode population on Sarigan to be between 545 and 810 birds (Fancy *et al.* 1998).

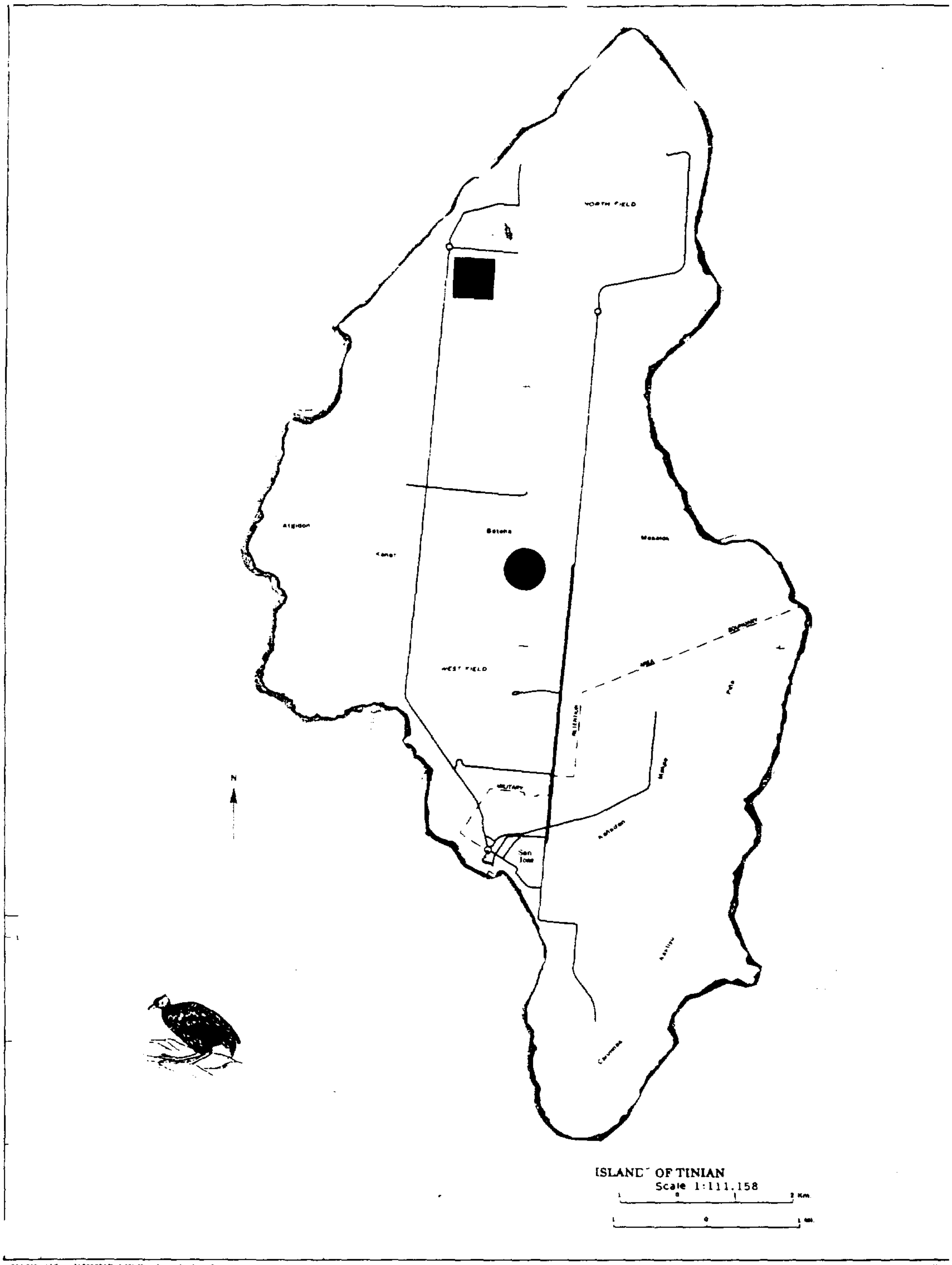

Figure 3. Approximate locations of megapode sightings on Tinian in 1985 (■) and 1995 (●).

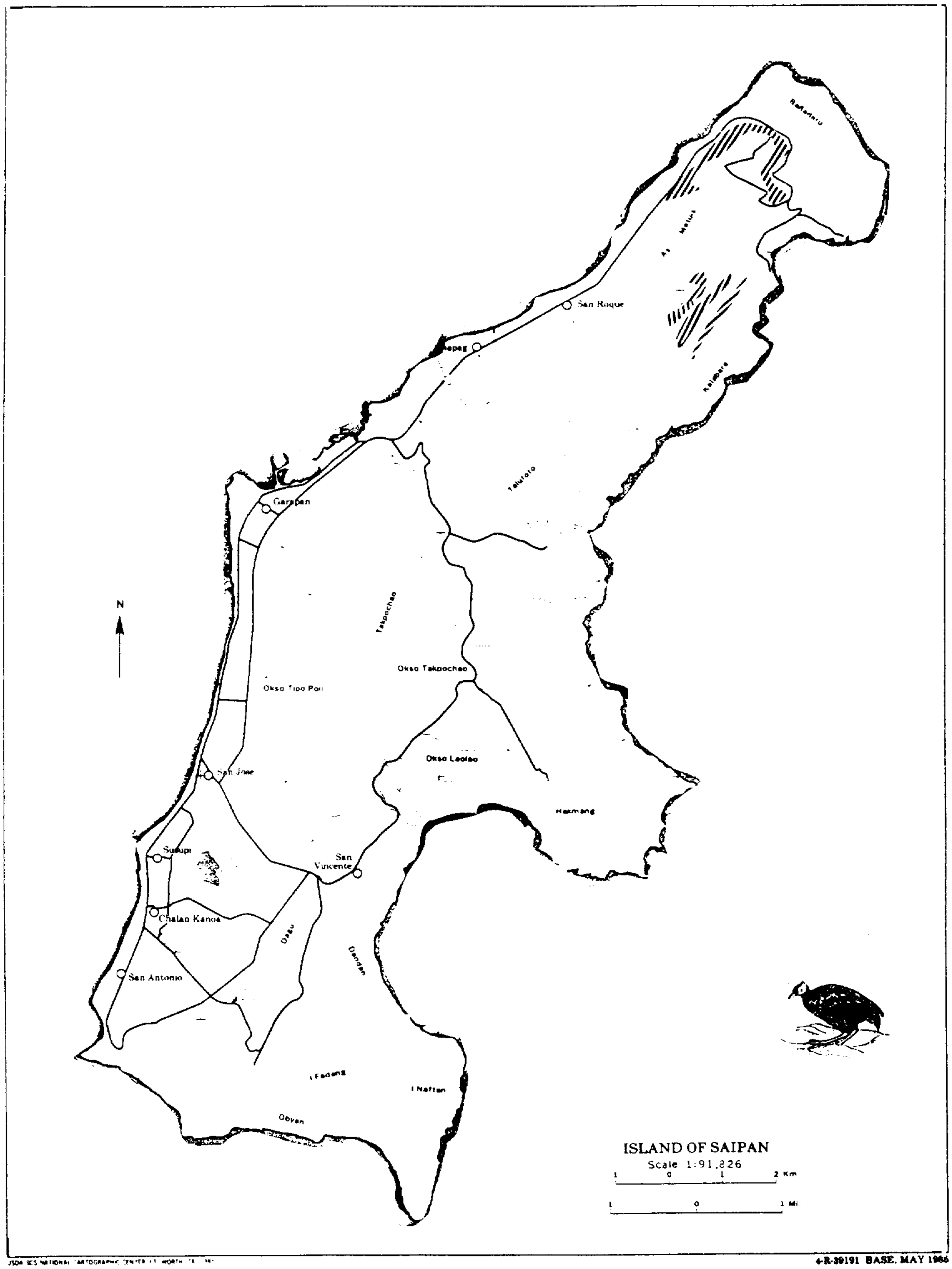

Figure 4. The approximate area of native forest (||||||) on Saipan known to contain megapodes in 1993.

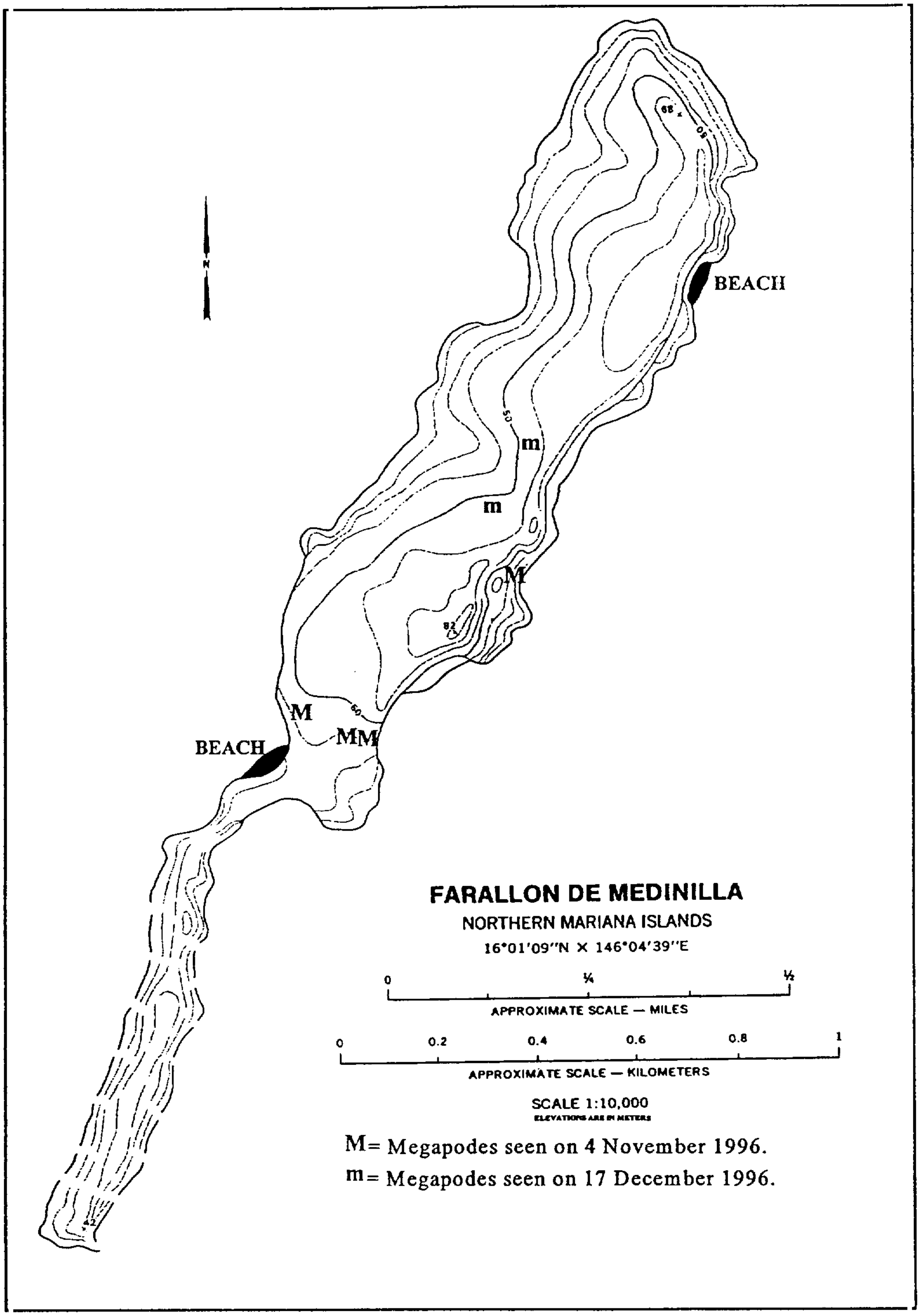

Figure 5. Locations of megapode sightings and beaches on Farallon de Medinilla.

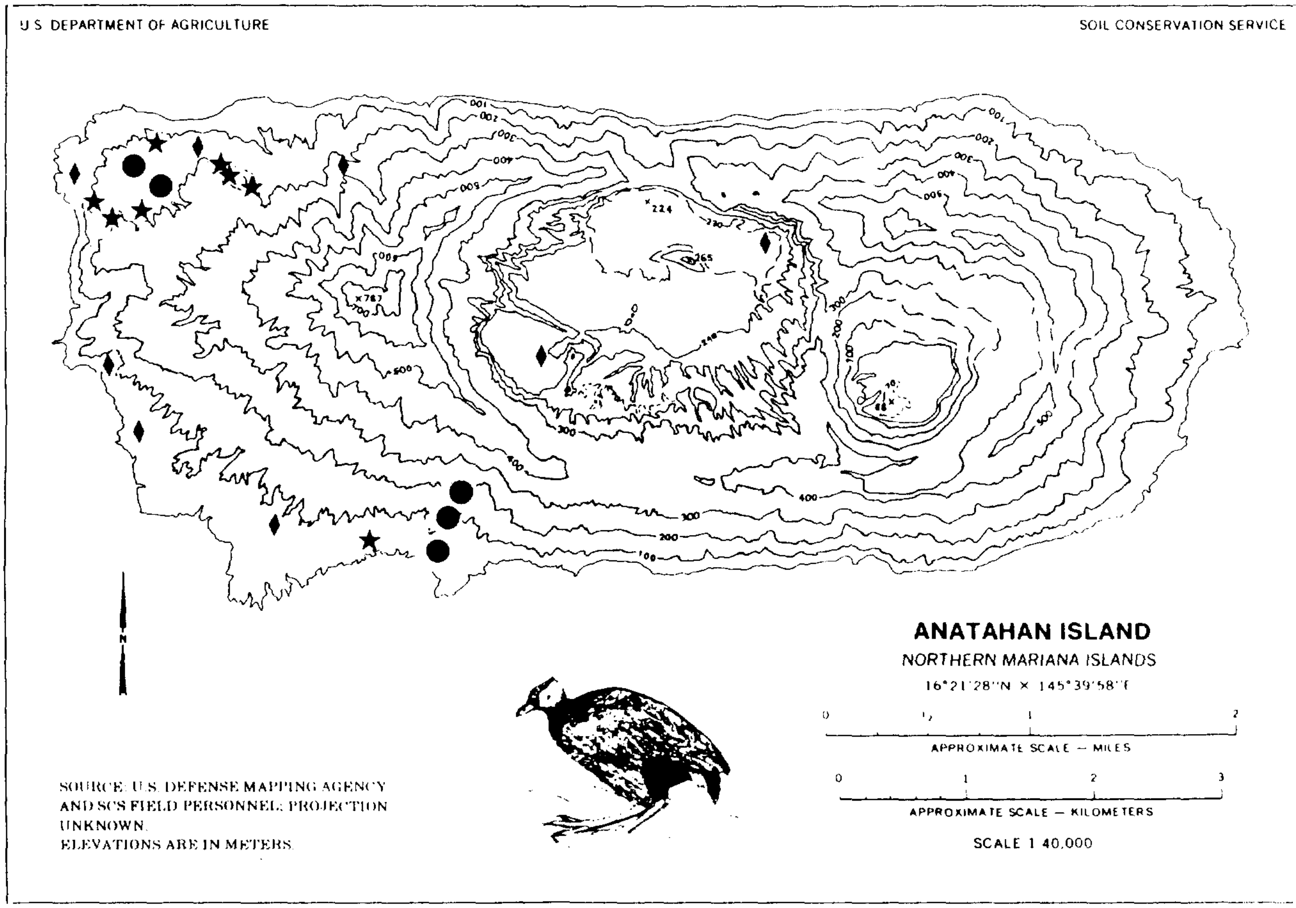

Figure 6. Approximate locations of megapode detections in 1988 (★), 1992 (●), and 1995 (◆) on Anatahan.

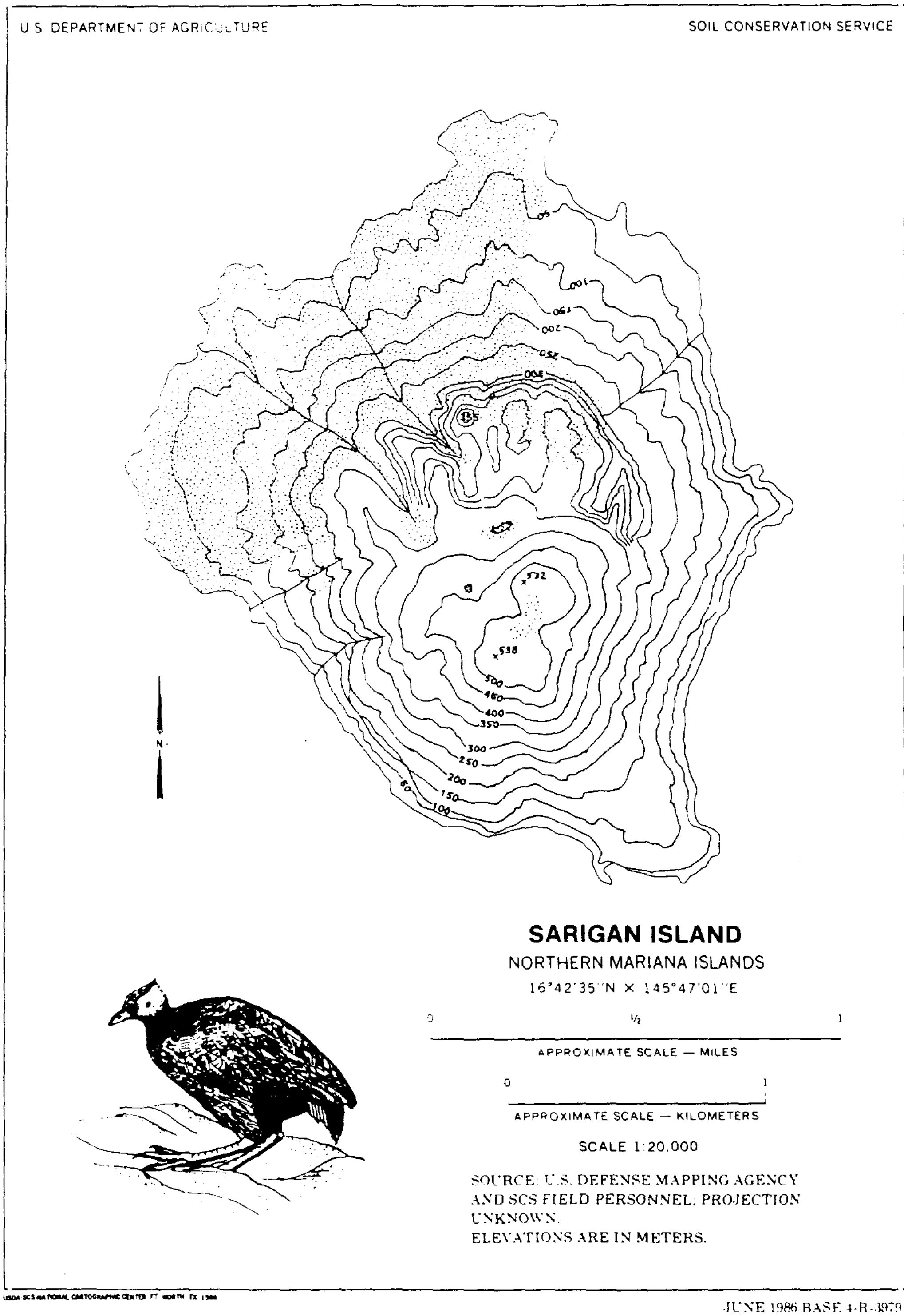

Figure 7. Approximate extent of forest habitats (⁘) on Sarigan (from Rice 1993). Megapodes are distributed throughout this habitat.

Guguan

First reported in Falanruw (1975), Guguan probably supports the largest megapode population in the Marianas (Figure 8). Unfortunately, locations of sightings on the island have not been recorded. Less than half of Guguan is forested, with the remainder being covered in grass, vines, scrub, lava flows, and cinder fields. Lemke (1983) estimated the population in the "low thousands" after a trip during September 3 through 6, 1983. In September 1986, Glass recorded an adult:chick ratio of 1:1, and estimated the population at 1,500 to 2,200 (Glass and Villagomez 1986). Reports from May 1988 and May 1992 suggested the population has declined since 1986 (Reichel *et al.* 1988, Rice and Stinson 1992). Rice and Stinson (1992) also reported a fairly high number of immature birds (40 to 70 percent), but a population maximum of 500. The cause of the apparent decline is unknown. Perhaps populations are affected by periodic droughts (Reichel *et al.* 1988, Rice and Stinson 1992).

Alamagan

Residents reported that the megapode still existed on Alamagan in the early 1970's (Falanruw 1975), but none were detected on the southern part of the island in 1988, or on either the northern or southern part in 1990 (Reichel *et al.* 1988, Rice *et al.* 1990). However, a former resident indicated there were two active nesting areas in the 1950's (Reichel and Glass 1988). Rice and Stinson (1992) reported the first confirmed sightings since Takatsukasa and Yamashina (1932) (Figure 9). Megapodes may have recovered somewhat with the lack of permanent residents since 1990 when they were evacuated due to increased seismic activity (Stinson 1993). A rough estimate of less than 30 individuals is based on surveys of a small portion of potential habitat on the island (D. Stinson, personal communication 1995).

Pagan

The megapode has not been observed on the northern part of Pagan since the 1981 volcanic eruption. Megapodes are still found on the southern peninsula where nesting seems to occur in at least seven locations (Figure 10). Digging by feral pigs, monitor lizards, and coconut crabs (*Birgus latro*) made the amount of megapode burrowing activity at these sites difficult to assess (Rice and

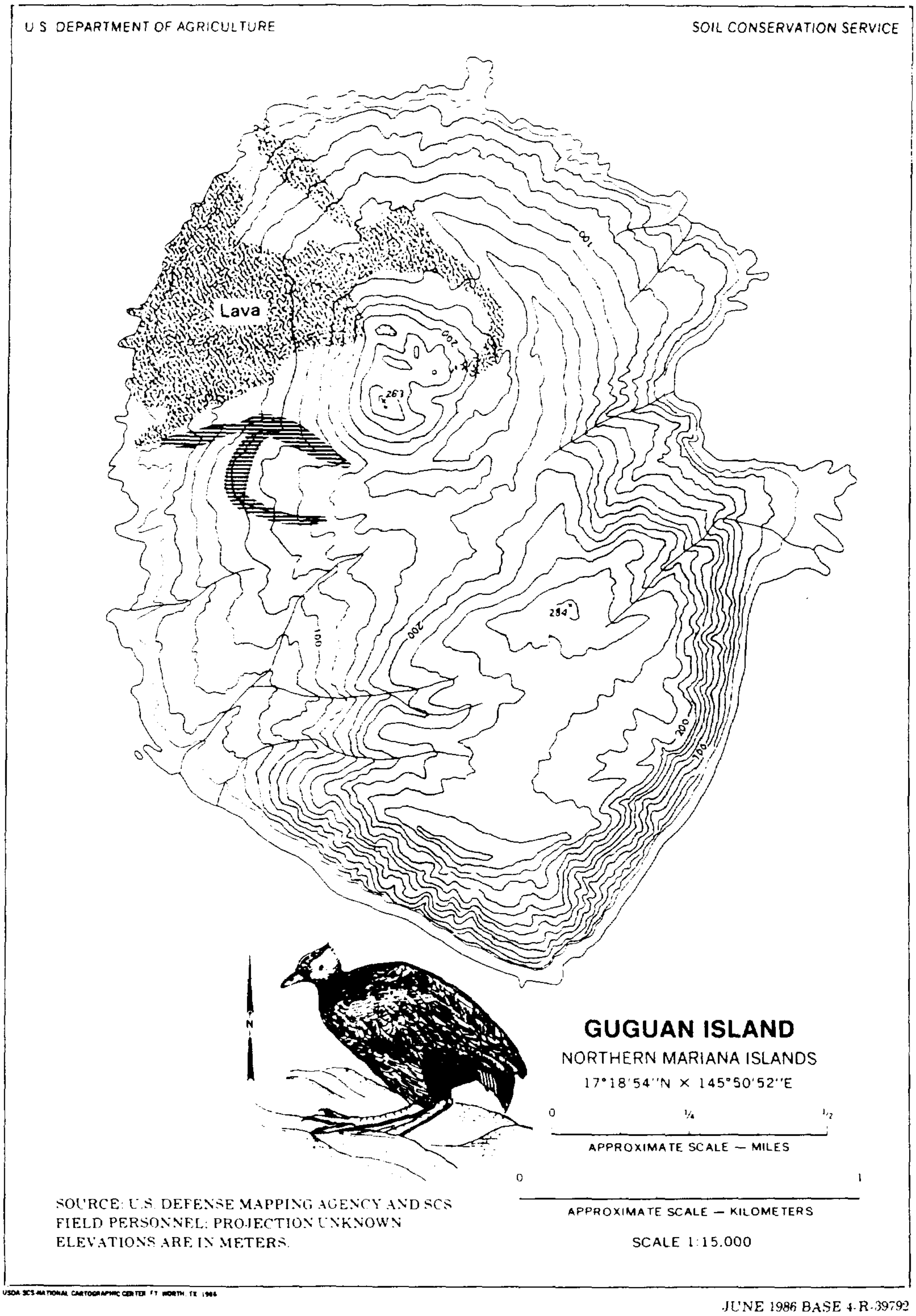

Figure 8. Approximate area of megapode nesting ground (≡) on Guguan in 1992. Exact locations of sightings were not recorded.

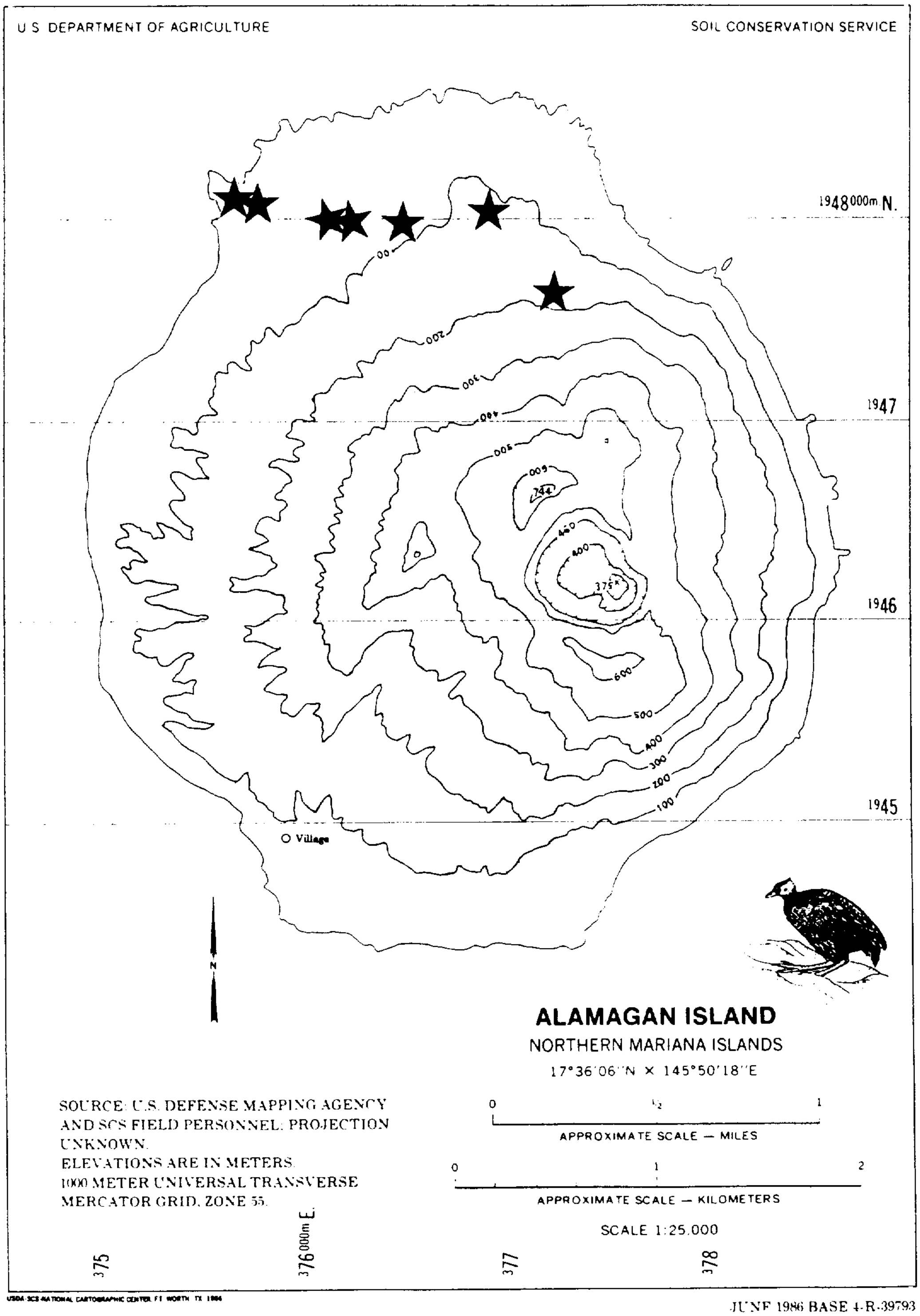

Figure 9. Approximate locations of megapode sightings (★) on Alamagan in 1992.

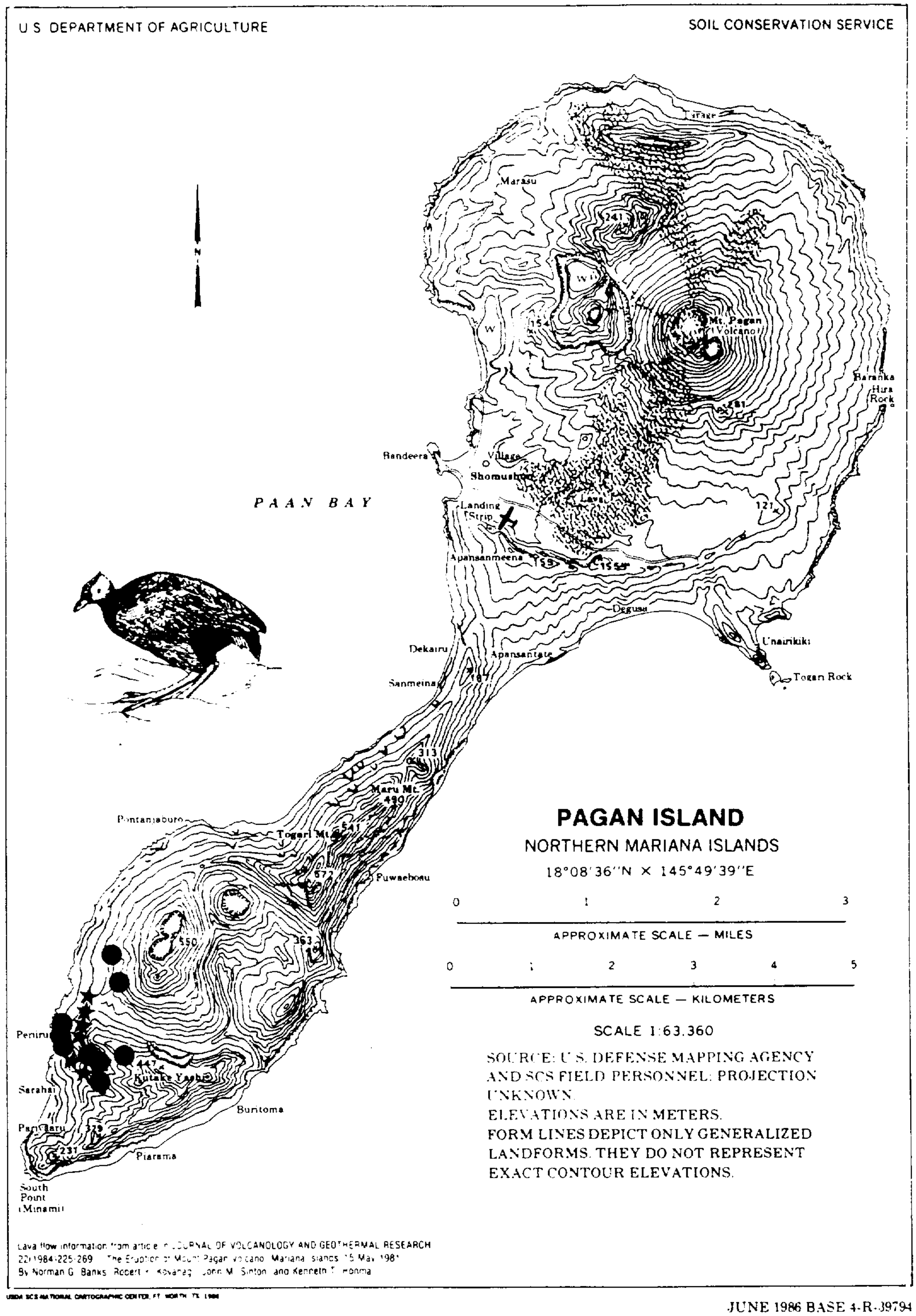

Figure 10. Approximate locations of megapode sightings (●) and nesting areas (★) on Pagan in 1992.

Stinson 1992). Clifford G. Rice (U.S. Army Construction Engineering Research Laboratories, personal communication 1994) estimated the population at 50 to 150, but further investigation is needed.

Agrihan

There is no recent record of megapodes on Agrihan, but local residents indicated they are still present (Figure 11) (Reichel *et al.* 1987, Rice *et al.* 1990, Rice and Stinson 1992). The exact location of the nesting area described by Ludwig (1979) is unknown, but Rice hiked along most of the eastern side and saw no evidence of megapodes (Rice and Stinson 1992; C. Rice, personal communication 1994). The megapode seems to have declined since 1978, perhaps due to exploitation (Ludwig 1979). The current status of the megapode on Agrihan is uncertain, but megapodes probably still exist on this relatively large, rugged island.

Asuncion

Megapodes are present on Asuncion, but seem to be rare. Only one or two were detected on recent visits (Reichel *et al.* 1987, Rice and Stinson 1992) (Figure 12), although five were seen in 1979 (Rufo J. Lujan, Aquatic and Wildlife Resources, Guam, personal communication 1995). Asuncion is a steep cone, covered primarily with ferns, grass, and cinder fields, but with a band of forest on the western and southwestern slopes. It is a wildlife sanctuary island, and free of feral animals. It is not clear why megapodes are not more common, but the rock soil may not provide a good nesting substrate (P. Glass, personal communication 1994). A rough estimate of less than 25 individuals is based on surveys of a small portion of potential habitat on the island (D. Stinson, personal communication 1995).

Maug

Most recent trips to Maug have found megapodes common on all of the three islands (Figure 13) (Clapp 1983, Reichel *et al.* 1987, Rice and Stinson 1992). Megapodes were frequently encountered in both forest and scrub habitat, were observed digging nest burrows in areas of loose cinder soil on the north and east islands. Maug is a sanctuary and free of feral animal problems (Rice and

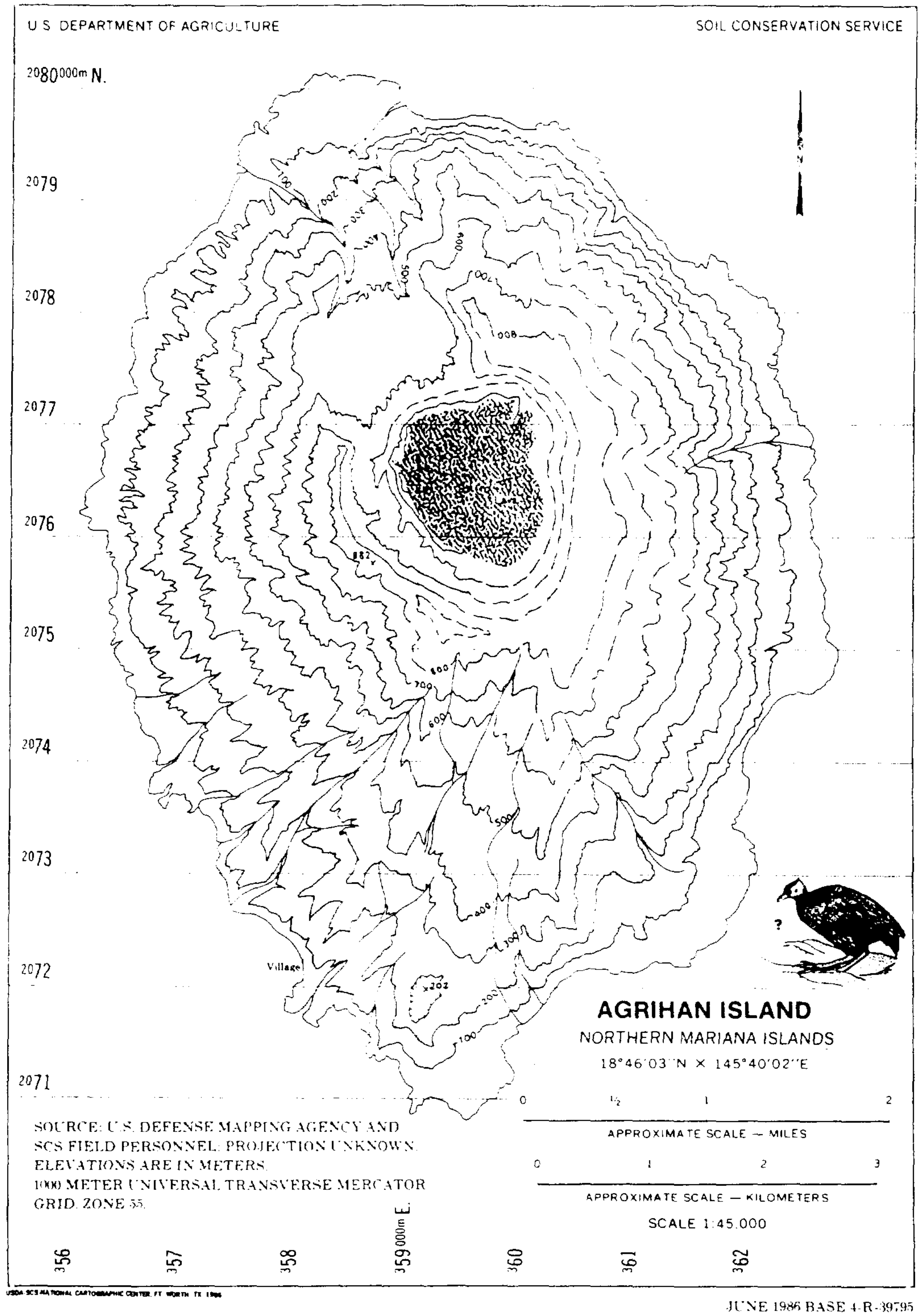

Figure 11. Agrihan: the exact locations of past or present nesting areas are unknown.

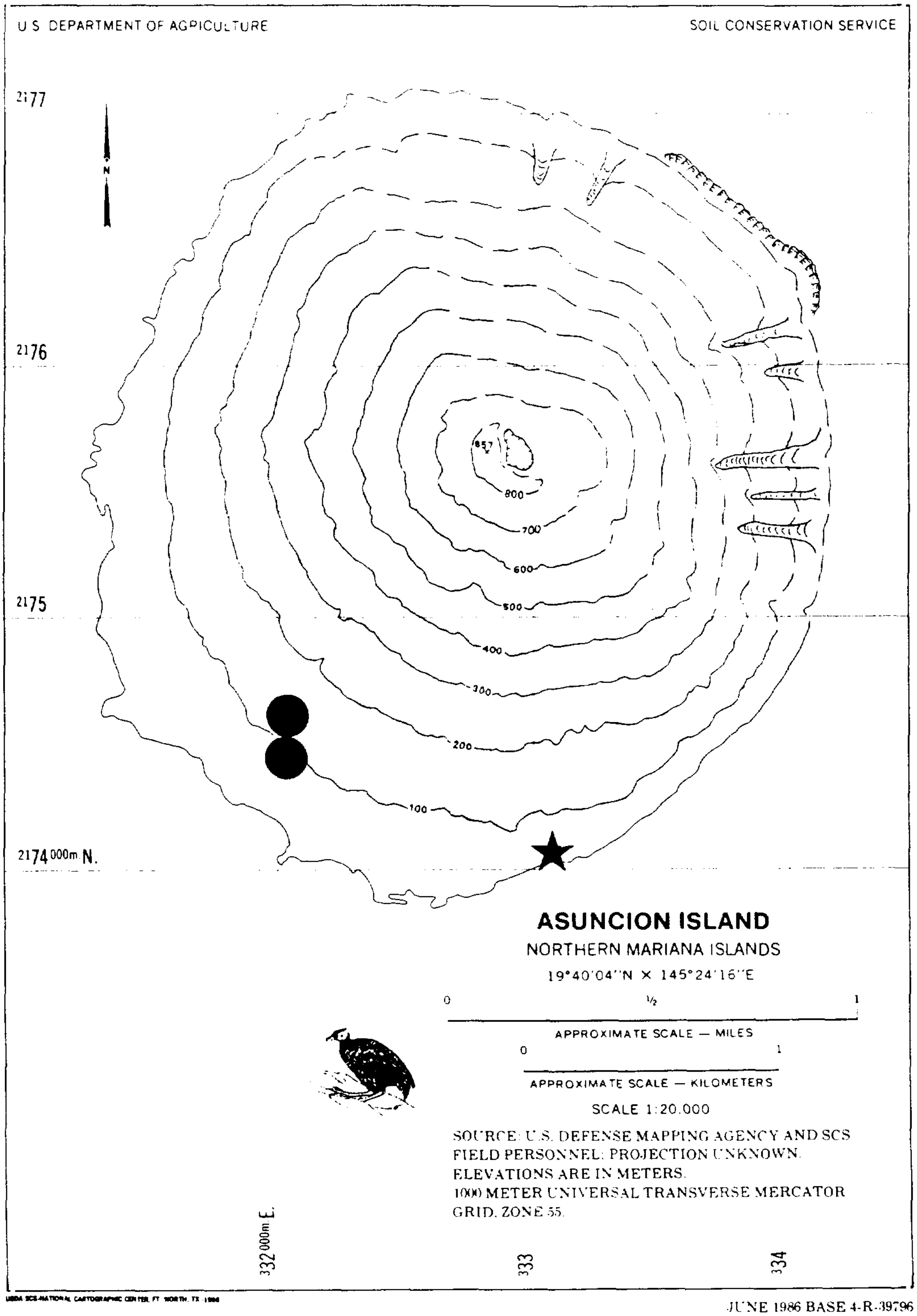

Figure 12. Approximate locations of megapode sightings on Asuncion in 1987 (●) and 1992 (★).

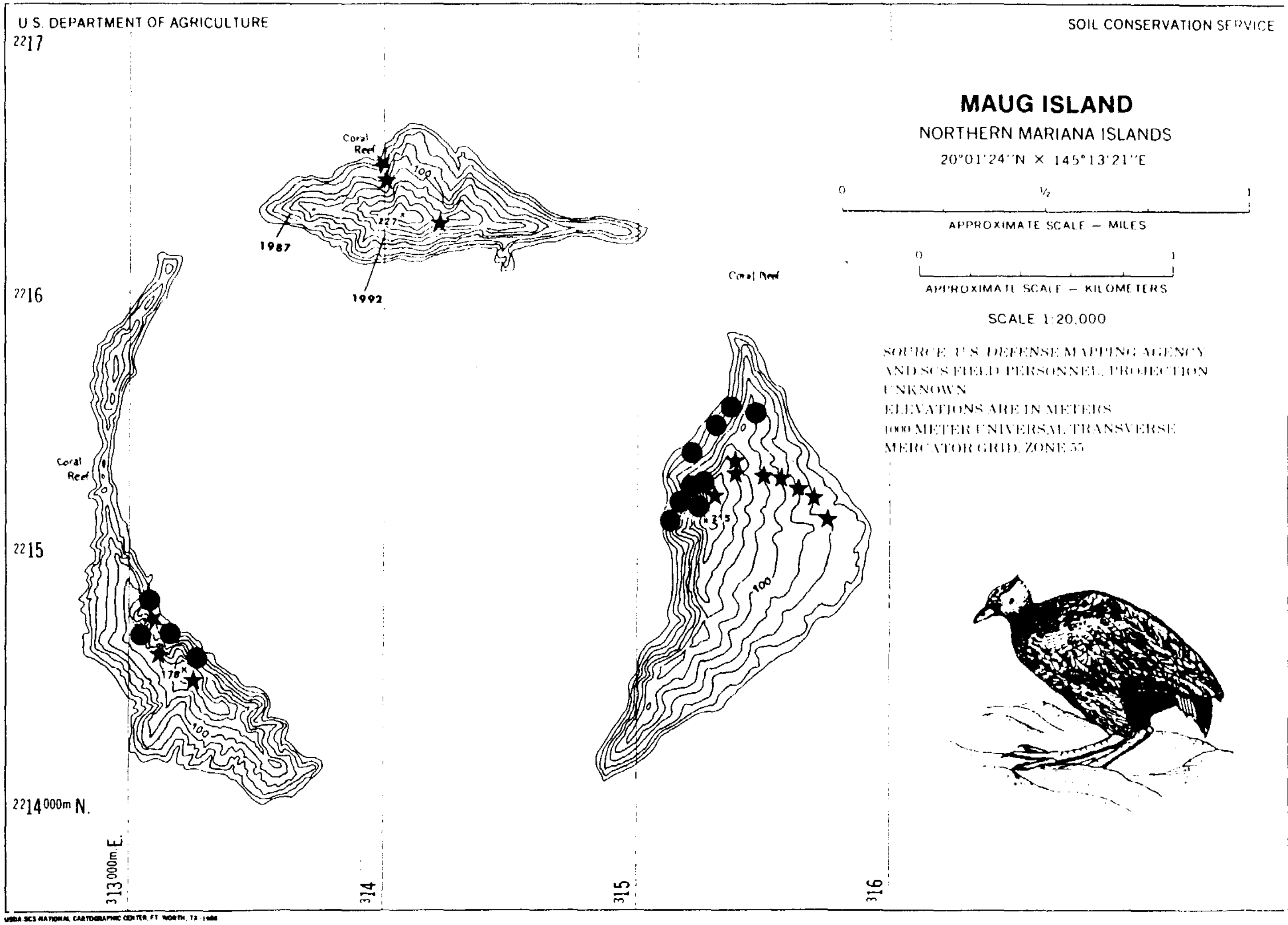

Figure 13. Approximate locations of nesting sites (pointers) and sightings on Maug in 1987 (●) and 1992 (★).

and Stinson 1992). In May 1987, Reichel estimated the population at roughly 150 to 300 (Reichel *et al.* 1987). C. Rice (personal communication 1994) believed that estimate to be high. He made a more conservative estimate of 50 to 150 megapodes based on his 1992 visit, and the available land area [10 to 15 percent forested; approximately 200 hectares (494 acres)].

Uracus

Falanruw (1975) saw a megapode and tunnels in cinder sand filled with humus that she believed were nesting burrows on Uracus. However, megapodes have not been recorded in recent trips, and the burrows observed may have been those of seabirds (Procellariiformes) (Clapp 1983, Lemke 1984, Reichel *et al.* 1987, Rice and Stinson 1992). Uracus is a sporadically active volcano of about 2 square kilometers (494 acres), and has little vegetation and no forest habitat (Figure 14).

8. Reasons for Decline and Current Threats

The Micronesian megapode was listed as endangered due to historical extinctions on Guam, Rota, Tinian and Saipan (USFWS 1970). Those extinctions probably resulted from a combination of exploitation and habitat losses.

High prehistoric human populations, and later, large numbers of cattle and pigs, particularly on Tinian, had a profound effect on the vegetation in the southern islands. Tinian was described in 1742 as having broad open savannahs with thousands of cattle (Barratt 1988). Early in this century, much of the native forest in the Marianas, particularly on Saipan, Tinian, and Aguiguan, was cleared for agriculture. During the Second World War, forests in Micronesia were further damaged by clearing for military operations, bombing and other fighting (Baker 1946). In addition to historical losses, forest habitat on the southern islands is now being converted to golf courses and urban development.

On the northern islands, native forest has been degraded to swordgrass due to centuries of overgrazing by feral goats (Ohba 1994). Forest habitat on many islands continues to be damaged by feral goats, pigs, and cattle, particularly on the topsoil. This damage has probably affected megapode populations by reducing the amount and diversity of foods available, as well as reducing the

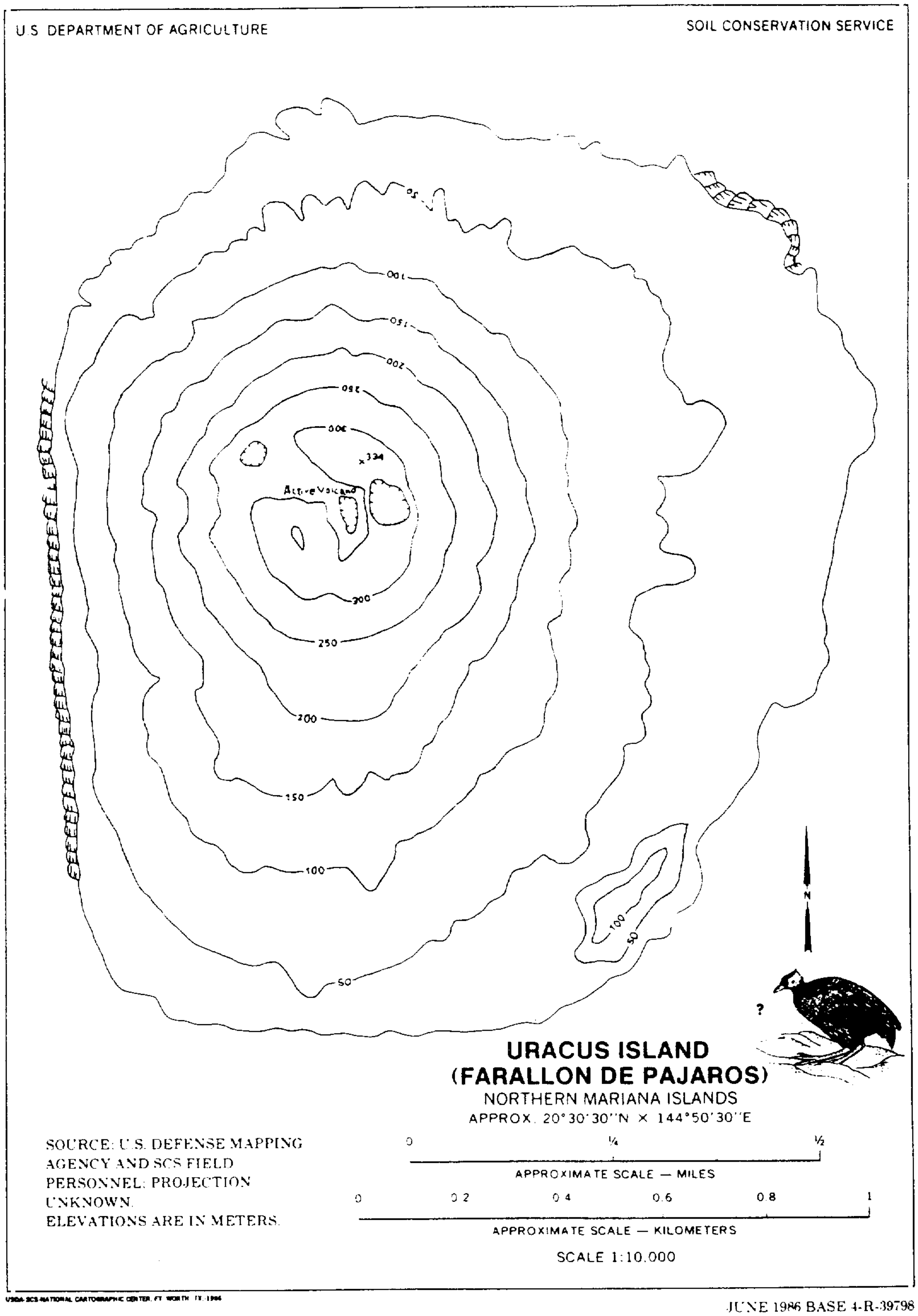

Figure 14. Uracus Island.

Anatahan, Alamagan, Pagan, and Sarigan (Rice 1993). Loss of vegetation at some sites on these steep and highly erodible islands has resulted in the complete loss of availability of sites suitable for building decompositional nest mounds. A nesting area on Agrihan was destroyed by village construction during the Japanese period, and similar destruction has probably occurred elsewhere as well.

Marche predicted that megapodes would not last long on Rota and Saipan because islanders hunted them intensely (Oustalet 1896). Megapodes were overexploited on the southern islands, and possibly on all inhabited islands. Human exploitation of nests was still a problem when Ludwig visited Agrihan in 1978. Megapodes are now protected by both Federal and local laws, and there have been no recent reports of exploitation. However, megapodes are fairly conspicuous and relatively tame, making them vulnerable to hunting with firearms or pellet guns. Also, concentrated nesting areas in the northern islands are vulnerable to the collection of eggs. The only indication that poaching may be a problem is the apparent increase in birds on Alamagan after the human residents were evacuated in 1990. Pagan, Alamagan, and Anatahan had small villages that were abandoned during recent episodes of increased volcanic or seismic activity. These islands are likely to be re-occupied. Agrihan has had permanent human residents in recent years. Megapode recovery may not succeed on these islands without the cooperation of residents. Guguan and Maug, which are uninhabited wildlife sanctuaries, have healthy but small megapode populations and the birds are vulnerable to poaching by passing fishing boats (Reichel *et al.* 1988).

In addition to possible direct human predation, megapodes are known to be preyed on by introduced monitor lizards (Ludwig 1979) and may also be preyed on by feral dogs, cats, and pigs (Dekker 1989). The number of cats has increased dramatically on Saipan in recent years, and they have been seen in limestone forest near megapodes (D. Stinson, personal observation 1994). *Rattus* species may prey on young chicks.

A serious potential threat to megapode populations is the establishment of populations of the brown tree snake (*Boiga irregularis*) from Guam to other islands in the Marianas archipelago. The brown tree snake was introduced to Guam shortly after World War II (before 1952) and has systematically spread throughout the island, extirpating nearly all of the avifauna and other native vertebrate species of Guam (USFWS 1996). Although the megapode was extirpated from Guam before the establishment of the brown tree snake (USFWS 1990), had it been present during the time of the spread of the tree snake, it would have probably been affected in a similar manner as the rest of Guam's avifauna. The threat of brown tree snakes being spread to other islands is particularly acute for Rota, Tinian and Saipan, which receive large amounts of cargo shipped through Guam. It is not certain that a brown tree snake population has been established on Saipan, but there have been several sightings of snakes in recent years (McCoid and Stinson 1991). In 1986, an unidentified snake that may have been *Boiga irregularis* was seen at the commercial port facility. In 1987, a brown tree snake was seen crawling out of a container at the same port facility. In 1990, a dead brown tree snake was found inside a container arriving from Guam. In 1994, a live brown tree snake was captured at Saipan International Airport (Eva Beyer, CNMI-DFW, personal communication 1994). There were two more sightings in 1994, and two sightings in 1995 (Fritts *et al.* 1995). In 1996, two snakes were caught when they left cargo ships that arrived from Guam and swam to shore near Charlie Dock, Saipan, and in August 1997, a female snake was captured at Saipan Airport (Scott Vogt, CNMI-DFW, personal communication 1997). In all, 31 snake sightings have been reported on Saipan since 1986 and sightings have increased in recent years indicating an incipient population on the island (Vogt 1997).

There has been at least one report of an unidentified snake seen on a vessel off-loading cargo at the Tinian port (McCoid and Stinson 1991). As with Saipan, the establishment of a brown tree snake population on Tinian would probably lead to the extirpation of the megapode, as well as other avifauna, from that island.

Dekker (1989) presented evidence that the distribution of the Megapodiidae was determined by the absence of predators. Alternatively, Olson (1980) believed that the Phasianidae (pheasants, quails, and francolins) had competitively excluded the Megapodiidae from Southeast Asia, Borneo, Sumatra, and Java. Thus, another potential threat to the full recovery of megapode populations may be competition with exotic galliformes. Though a past pheasant introduction on Saipan failed (U.S. Navy 1949), private individuals continue to import game birds. Any that could become established in forest are a potential threat to megapodes. Feral chickens may compete with megapodes, and could expose megapodes to diseases for which they have no resistance. Populations of feral chickens exist on Rota, Tinian, Saipan, Anatahan, Alamagan, and Pagan (Reichel and Glass 1991).

Vulcanism constitutes a long-term threat to megapode populations in the northern islands. The Pagan population probably has declined due to the impacts of the 1981 volcanic eruption that buried vegetation and a nesting area in fine cinders. There were numerous previous eruptions on Pagan in the 19th and 20th centuries. Guguan experienced eruptions in 1819, 1901, and an explosive eruption in the 1880's (Asakura *et al.* 1994). Steam was being emitted from the volcano on Guguan in 1975, and it appears cinders have been emitted in recent years. Eruptions were also recorded on Alamagan in 1885 and on Agrihan in 1917 (Asakura *et al.* 1994). Vulcanism cannot be prevented, but it increases the need for a large number of megapode populations in order to assure the long-term survival of the subspecies.

Megapodes may be affected by a few other natural phenomena. Drought may affect the ability of birds to dig burrows in cinder soil, and affect food availability (Reichel *et al.* 1988). Also, typhoons periodically degrade forest habitat (on Saipan, Glass and Aldan 1988; on Maug, Wiles *et al.* 1989; and on Rota, Stinson *et al.* 1992).

9. Conservation Efforts

Federal Actions

In 1970, the Service listed the Micronesian megapode as endangered because of the extirpation of several populations, and past human exploitation (USFWS 1970). In 1982, the Service conducted the Micronesian Forest Bird Surveys in the Marianas to determine the status of populations in the southern Marianas (Engbring *et al.* 1986). More recent surveys have been completed for the islands of Rota, Tinian, Saipan, and Sarigan.

A Habitat Conservation Plan (HCP) for the island of Rota is under development by the CNMI Government, local Rota residents, and the U.S. Fish and Wildlife Service, Pacific Islands Office (Resources Northwest 1997). This plan could potentially benefit the megapode, should it be reintroduced there, by providing protected habitat in native limestone forest. In addition, efforts are currently underway on Saipan to develop HCPs that include the establishment of an upland mitigation bank to maintain and enhance habitat for native species. The CNMI government has also expressed an interest in developing a regional HCP (for Saipan and the northern Mariana Islands).

The U.S. Department of Agriculture-Wildlife Services on Guam is engaged in a brown tree snake interception program in an effort to prevent its colonization in the CNMI. Several local and Federal agencies have also conducted publicity compaigns in the CNMI to raise the general awareness of island residents, including port workers, about the dangers of brown tree snake colonization (G. Wiles, *in litt.* 1997).

Commonwealth Actions

In the early 1980's, the islands of Sarigan, Asuncion, Maug, and Uracus were declared wildlife sanctuaries in the CNMI constitution. After an evaluation by the CNMI-DFW, this was amended to include Guguan, and Sarigan was deleted. Sanctuary status provides protection by preventing any plans for settlement of these islands. Although regulations require DFW approval of any landings on these islands, they are remote, and not regularly patrolled.

The CNMI-DFW conducted a short-term study of the Saipan population (1985 to 1988), and has investigated the northern island populations during short trips. The results of these activities are summarized in Glass and Aldan (1988) and Stinson (1993).

The CNMI-DFW, in cooperation with the Service, has recently removed the majority of ungulates on Sarigan. Prior to the onset of this project, baseline surveys of the local bat and bird populations were conducted, along with preliminary surveys of local herpetofauna and plants (Fancy *et al.* 1998). After ungulate removal is complete, the CNMI-DFW and the Service are planning to conduct baseline surveys of the natural resources and pursue the development of a long term monitoring program.

Although regulations governing the prevention of brown tree snake infestation have been promulgated by the CNMI legislature, current prevention efforts have been restricted to maintaining trap lines at the ports and conducting night searches to detect the presence of snakes and investigating snake reports (A. Marshall, personal communication 1995). A sniffer dog program has recently been established in the CNMI. Two dogs and their handlers have been trained and are now checking cargo at the ports (S. Vogt, personal communication 1997).

The Guam Department of Agriculture is setting snake traps around the Guam airport for similar reasons (G. Wiles, *in litt.* 1997).

Non-government Actions

The most significant conservation activity to date was the reintroduction of megapodes to Saipan by local islanders in the 1960's and 1970's. Glass and Aldan (1988) interviewed five individuals who transported eggs from Pagan and other northern islands, and then released the hatched chicks on Saipan. This was apparently done without the assistance or knowledge of resource agencies.

10. Overall Recovery Strategy

The primary goal of this recovery plan is to protect existing populations of the Micronesian megapodes and the habitat on which they depend. The vast majority of the land remaining in the CNMI that is suitable habitat for the megapode is owned by the CNMI government and is controlled by the Marianas Public Land Corporation (MPLC). Steps should be taken to preserve remnant limestone forest in the large southern islands from the threat of development and larger tracts of limestone forest in the northern islands from destruction by feral ungulates. Megapodes will also need protection from the more direct threats of predation. Selective control of cats, rats, and monitor lizards may be warranted. Most importantly, all of the islands north of Guam will need to be protected from the introduction of the brown tree snake.

This plan also recommends the continuance of research into the life history and ecology of the Micronesian megapode. This basic information is essential to identify previously unnoticed limiting factors in megapode populations and lay the groundwork for expanding future populations.

Next, this plan proposes expansion of existing megapode populations within their current range and eventually reintroducing megapodes into their former range, if necessary. Expansion of current populations will require enhancement of nesting habitat and restoration of native forest.

Finally, the recovery plan recommends monitoring megapode populations to track and assess their recovery over time.

RECOVERY

1. Objectives

The ultimate objective of this recovery plan is to delist the Micronesian megapode. However, criteria for downlisting the megapode to threatened status are also provided. An endangered species is defined in Section 3 of the Endangered Species Act as any species which is in danger of extinction throughout all or a significant portion of its range. A threatened species is defined as any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Consideration for downlisting the Micronesian megapode to threatened status can occur when the following steps have been accomplished: (1) a brown tree snake interdiction and control plan must be in place, operational, and effective for all of the Mariana Islands; (2) current threats to all extant megapode populations must be assessed and controlled; and, (3) the comparatively large populations on Anatahan, Sarigan, Guguan, Pagan, and Maug must remain at their current population levels or be increasing for a period of 5 consecutive years.

Consideration for delisting can occur when the Micronesian megapode is represented by 10 populations distributed among both the northern and southern Marianas as follows:

a) at least 2 populations of 600 birds or greater. This will require maintaining the population on Sarigan, and restoring a large population on another island, such as Guguan, Anatahan or Agrihan;

b) at least 3 populations of 300 or greater. This will require maintaining or restoring populations on Anatahan or Agrihan (whichever is not used for 'a' above), and restoring the Alamagan population;

c) at least 2 populations of 200 or greater. This will require maintaining and restoring the populations on Pagan and Maug; and,

d) at least 3 populations of 50 or greater. This will include protecting and restoring higher populations on Aguiguan, Asuncion, and Saipan or Tinian.

In addition, these populations must be stable or increasing for 5 consecutive years after achieving these levels. Meeting these criteria will result in the Micronesian megapode being represented by over 2,650 individuals on 10 islands, and provide reasonable assurance that the species will not again become endangered within the foreseeable future throughout all or a significant portion of its range.

The order of tasks listed in the following step-down outline and narrative does not necessarily designate the order in which these tasks should be implemented. Priorities for action and recommended time-frames are contained in the Implementation Schedule for this plan.

2. Step-down Outline

1. Survey for, protect, and manage existing populations.

    11. Conduct surveys to assess status and distribution of megapodes throughout the Marianas and assess threats.

        111. Design and conduct surveys.

        112. Assess threats.

    12. Create and implement threat control measures.

        121. Control feral ungulates.

        122. Develop and implement a brown tree snake interdiction and control plan.

        123. Control other introduced predators.

124. Control poaching.

13. Protect essential habitat.

14. Gain public support for megapode conservation.

2. Conduct essential research on the ecology and biology of Micronesian megapodes.

21. Develop better understanding of habitat use and movements.

22. Develop better understanding of reproductive ecology.

3. Promote expansion of megapodes into suitable habitat.

31. Determine feasibility of enhancing reproduction on coral islands and establish enhanced nesting sites.

32. Develop methods of restoring native forest and conduct forest restoration programs.

33. Determine success of population enhancement activities and determine if translocations to additional islands are necessary.

331. Determine success of population enhancement.

332. Plan and implement translocation procedures.

4. Monitor megapode populations.

41. Develop methods for monitoring populations on southern islands and monitor.

42. Develop methods for monitoring populations on northern islands and monitor.

3. Step-down Narrative

1. Survey for, protect, and manage existing populations.

The possibility of megapode extinction will be greatly reduced by protecting and managing existing megapode populations and their habitat. Before populations can be properly protected and managed, however, megapode distributions must be defined and threats to each particular population identified.

11. Conduct surveys to assess status and distribution of megapodes throughout the Marianas and assess threats.

Megapode population surveys for both the southern and northern islands of the CNMI should be planned and carried out as soon as possible. These surveys should be designed to provide accurate population estimates and distributions for each island.

111. Design and conduct surveys.

The variable circular plot method is best suited for this type of survey and results from this method would be comparable with past surveys on the islands of Rota, Aguiguan, Tinian, and Saipan.

112. Assess threats.

The populations on each island will have threats unique to that island. The islands of Tinian and Saipan will have a greater threat of snake introduction, while Aguiguan and several of the northern islands suffer from damage to forests by feral ungulates. As surveys are being conducted biologists will be able to assess the types and degree of threats.

12. Create and implement threat control measures.

Introduced predators and ungulates represent two of the most prominent threats to the recovery of the megapode. A variety of introduced predators have contributed to the decline of megapode populations and continue to be a threat. Introduced ungulates have severely degraded megapode habitat on some islands and must be controlled if recovery objectives are to be achieved.

121. Control feral ungulates.

Damage to certain islands is so severe that the understory has been completely removed and trees stand dead with exposed roots due to the resulting erosion. Damage is most severe where pigs and goats or cattle are found together. Aguiguan, Anatahan, Alamagan, Pagan and Sarigan have serious problems with the destruction of native forest. Steps must be undertaken by CNMI-DFW to hold regular hunts on these islands (e.g., once a year) or, preferably, to undertake a complete eradication program on islands that are known to harbor feral ungulate populations. Work is currently in progress to eliminate goats and pigs from Sarigan through a cooperative agreement between the CNMI-DFW and the Service as a preliminary eradication project.

122. Prevent the introduction and establishment of brown tree snakes.

The introduction of the brown tree snake to any of the Mariana Islands north of Guam will lead to large-scale extinctions of native wildlife. Procedures to prevent the spread of this introduced predator from Guam are among the highest priorities for conservation of Mariana Island wildlife. Ultimate success may require the reduction of the snake population on Guam, along with effective elimination of stowaway snakes from private, commercial, military, and cargo airliners and ships traveling from Guam to other areas of the Pacific. The Brown Tree Snake Control Plan (BTSCP) is the first step in developing a coordinated plan for the control of this introduced predator by all Pacific Island governments (BTSCP 1996). Funding for implementation of the plan should be a high priority.

As reported in previous sections of this recovery plan, there have been numerous sightings of brown tree snakes on Saipan over the past few years and there is reasonable evidence to support the hypothesis of an incipient snake population on island (E. Campbell III, Wildlife Services, *in litt.* 1998). Saipan is particularly susceptible to the introduction of brown tree snakes from Guam, due to increasing tourism and development with concurrent increasing air and boat traffic from Guam. It is imperative that high priority be given to the building of snake exclosures, the use of fumigants, trapping, etc., in the airports and harbors of Saipan. In addition, CNMI-DFW should undertake regularly scheduled night searches and a massive public education campaign to ensure that snake sightings are promptly reported.

Given the present inability to control or eradicate snakes in the Mariana Islands, there is a need to monitor the abundance and distribution of brown tree snakes on Saipan. By taking action at an early stage of the snake infestation, managers may be able to predict when Micronesian megapode populations on Saipan are at direct risk from brown tree snake predation (E. Campbell III, *in litt.* 1998). Another important component of

Micronesian megapode preservation on Saipan is the development of appropriate management techniques that would reduce the risk of their predation by brown tree snakes (E. Campbell III, *in litt.* 1998).

Tinian is also believed to be vulnerable to brown tree snake introduction as it is subject to military and/or commercial flights and cargo arriving from Guam. Precautions outlined for Saipan should be applied to Tinian. The uninhabited islands from Aguiguan north are less likely to be invaded by the brown tree snake, provided appropriate preventative measures are taken. These include thorough inspections of ships, airplanes, helicopters, etc., prior to their arrival on these remote islands. Regulations that require precautionary inspections and issuance of permits for all visits to these islands should be considered by CNMI-DFW to assist in this effort.

123. <u>Control other introduced predators.</u>

Introduced predators such as cats, rats, and monitor lizards should be controlled in those habitats known to support active megapode populations, as well as other habitats into which growing populations might disperse. Whenever possible, as in the case with some of the small islands, efforts should be made to eliminate introduced predators entirely.

124. <u>Control poaching.</u>

Hunting of adult megapodes and collection of their eggs has in the past been a limiting factor to the stability and expansion of megapode populations. This may still be an important limiting factor in the northern islands where large megapode populations still exist, and may become a problem as megapode populations on inhabited islands expand. Both increased law enforcement activities and increased education of hunters and the general public will be necessary to counteract this threat.

13. Protect essential habitat.

Most of the native forest that is important habitat for the megapode is still owned by the CNMI government and under the control of MPLC. Examples include the Marpi area of Saipan, the island of Aguiguan, and the northern islands. The CNMI-DFW should attempt to negotiate with appropriate CNMI agencies for protected status of these areas.

14. Gain public support for megapode conservation.

Public education and involvement will be crucial to the success of recovery activities. Island residents could be involved in such tasks as feral animal control, forest restoration, and megapode reintroduction and monitoring. Special emphasis should be given to educating school children as to the importance of megapode conservation.

2. Conduct essential research on the ecology and biology of Micronesian megapodes.

There are still many questions about the life history of megapodes that will be important to answer to achieve recovery goals. The needed research may require several years and occur concurrently with actions to preserve existing populations.

21. Develop better understanding of habitat use and movements.

Although the general habitat type in which megapodes are usually found has been identified, how they use this habitat is not clearly understood. For example, foraging and nesting habitat need to be better understood, as well as territoriality within these habitats. Of particular importance is obtaining a better understanding of interisland movements by the megapodes. Studies of this nature may be best accomplished through banding or radio telemetry.

22. Develop better understanding of reproductive ecology.

Micronesian megapodes seem to be able to reproduce using all of the various external heat sources, but this needs confirmation. The success rate of the various methods needs to be determined. An understanding of these factors will be important in determining how best to expand megapode nesting areas in an effort to reach recovery objectives. Nest mounds in Palau should be investigated to determine the heat source, amount of shade, temperature above ambient, *et cetera.* An intensive study of color-banded individuals in which investigators monitor birds through reproductive seasons on Sarigan and Guguan should be conducted.

3. Promote expansion of megapodes into suitable habitat.

If the existing megapode populations can be restored to the capacity of existing habitat, the subspecies will be much more secure. Forest restoration may allow the expansion of populations even further. The islands on which to concentrate augmentation efforts will depend to a large degree on the success of preventing the establishment of brown tree snake populations on the southern islands.

31. Determine feasibility of enhancing reproduction on coral islands and establish enhanced nesting sites.

If Saipan birds once built sand nest mounds in strand, the best approach may be to re-establish contact between occupied habitat and a small northern beach. An alternative would be to bring sand or dark cinders to the native forest occupied by megapodes. Either approach may require close monitoring and protection from predation and disturbance. Should enhancing nesting with cinder piles or hatcheries prove feasible, the sites may need protective fencing and monitoring.

32. Develop methods of restoring native forest and conduct forest restoration programs.

Procedures to restore native forests are a high priority for natural resource conservation in the Mariana Islands. This has begun on Sarigan with an ungulate removal program. Natural resource surveys, monitoring, and forest restoration will follow after ungulate removal is complete.

Aguiguan and possibly Anatahan may be candidates for native forest restoration efforts if feral ungulates can be controlled or important habitat fenced. Programs will need to be well planned to insure availability of plant materials, labor, appropriate sites, and survival of plants. Restoration of forest on volcanic islands may require different methods than on coral islands.

33. Determine success of population enhancement activities and determine if translocations to additional islands are necessary.

If population expansion management techniques are successful, translocations onto other islands may not be necessary to meet delisting criteria. However, if populations fail to reach the criteria given in this plan, then translocation may be considered necessary.

331. Determine success of population enhancement.

Success of the population enhancement efforts will be primarily gauged by the monitoring techniques developed under task #4. Population enhancement efforts will be judged successful if megapode populations are secure from threats, increasing, and likely to attain the downlisting and delisting criteria.

332. Plan and implement translocation procedures.

If necessary, translocation procedures will be planned and implemented. Reintroductions using eggs are underway for the Polynesian megapode and may be helpful in developing techniques (Rinke 1993). Islands with suitable habitat should be identified and prioritized for translocations.

4. Monitor megapode populations.

Success of recovery efforts can only be determined through an adequate monitoring program which should include reproduction, survival, recruitment, and age and sex ratios. A monitoring program will also improve understanding of natural fluctuations in megapode populations, such as those due to drought, and act as an indicator of new threats.

41. Develop methods for monitoring populations on southern islands and monitor.

The southern islands of Tinian and Saipan are readily accessible to biologists and can be monitored on a regular basis. Aguiguan is less accessible, but is still not as remote as the northern islands. A survey method, such as the variable circular plot method, for monitoring megapodes on the southern islands should be developed and then repeated every 2 years until the megapode is delisted.

42. Develop methods for monitoring populations on northern islands and monitor.

The short duration of visits and rugged terrain often make quick reconnaissance surveys necessary for northern island trips. A "quick and dirty" procedure that is standardized would help maintain consistency and reduce observer variation and subjective biases. Megapode populations should be monitored at least every 3 years.

LITERATURE CITED

Asakura, A., T. Ohba, S. Miyano, T. Furuki, T. Kurozumi, and H. Harada. 1994. Outline of the biological expedition to the Northern Mariana Islands, Micronesia. Nat. Hist. Research, Special Issue, No. 1:1-11. Natural History Museum and Institute, Chiba, Japan.

Baker, R. H. 1946. Some effects of the war on the wildlife of Micronesia. Reprint from: Transactions of the Eleventh North American Wildlife Conference.

Baker, R. H. 1951. The avifauna of Micronesia, its origin, evolution, and distribution. Univ. Kansas Publ., Mus. Nat. Hist. 3:1-359.

Barratt, G. 1988. H.M.S. *Centurion* at Tinian, 1742: the ethnographic and historic records. Micronesian Archaeol. Surv. Rep. 26:1-79.

Brown Tree Snake Control Plan. 1996. Report prepared by The Brown Tree Snake Control Committee to the U.S. Aquatic Nuisance Species Task Force. 55 pp.

Clapp, R.B. 1983. [letter to T.K. Pratt, dated 3 October 1983], on file at CNMI Division of Fish & Wildlife, Saipan.

Clark, G. A. 1964. Life histories and the evolution of megapodes. Living Bird 3:149-167.

Collar, N.J., M.J. Crosby, and A.J. Stattersfield. 1994. Birds to Watch 2: The World List of Threatened Birds. Birdlife Conservation Series No. 4. Birdlife International, Cambridge, U.K.

CNMI. 1983. Aguiguan field trip report. unpublished rep. on file. CNMI Division of Fish and Wildlife, Saipan, 7 pp.

Craig, R.J. 1992a. Ecological characteristics of the native limestone forest on Saipan, Mariana Islands. Micronesica 25:85-97.

Craig, R.J. 1992b. Territoriality, habitat use and ecological distinctness of an endangered Pacific island reed-warbler. J. Field Ornithol. 63:436-444.

Craig, R.J. 1996. Seasonal population surveys and natural history of a Micronesian bird community. Wilson Bull. 108:246-267.

Craig, R.J., R. Chandran, and A. Ellis. 1992. Bird populations on Aguiguan: a ten year update. In Craig, R.J. (ed.) The Aguiguan Expedition. Proceedings: Marianas Research Symposium 1:8-15. Northern Marianas College.

Crome, F.H.J. and H.E. Brown. 1979. Notes on the social organization of the orange-footed Scrubfowl Megapodius reinwardt. Emu 79:111-119.

Dekker, R.W.R.J. 1988. Notes on the ground temperatures at nesting sites of the *Maleo Macrocephalon maleo* (Megapodiidae). Emu 88:124-127.

Dekker, R.W.R.J. 1989. Predation and the western limits of megapode distribution (Megapodiidae; Aves). J. Biogeography 16:317-321.

Dekker, R.W.R.J. 1990. Conservation and Biology of Megapodes (Megapodiidae, Galliformes, Aves). Ph. D. dissertation. University of Amsterdam, Amsterdam, The Netherlands.

Dekker, R.W.R.J. 1992. Status and Breeding of the Nicobar Megapode *Megapodius nicobariensis abbotti* on Great Nicobar, India. unpubl. rept. National Museum of Natural History, Leiden, The Netherlands.

Dekker, R.W.R.J. and T.G. Brom. 1992. Megapode phylogeny and the interpretation of incubation strategies. In Dekker, R.W.R.J. and D. N. Jones. (eds.) Proceedings of the First International Megapode Symposium, Christchurch, New Zealand, December 1990. pp 19-31. Zoologische Verhandelingen 278:1-78. Leiden.

Dekker, R.W.R.J., P.J.K. McGowan and Birdlife/World Pheasant Assoc. Megapode Specialists Group (compilers). 1995. International Union for the Conservation of Nature (IUCN), Gland, Switzerland (in press).

Engbring, J. 1988. Field Guide to the Birds of Palau. Conservation Office and Bureau of Education, Koror, Palau.

Engbring, J., and F.L. Ramsey. 1984. Distribution and abundance of the forest birds of Guam: results of a 1981 survey. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C.

Engbring, J., F.L. Ramsey, V.J. Wildman. 1986. Micronesian Forest Bird Survey, 1982: Saipan, Tinian, Aguiguan, and Rota. U.S. Fish and Wildlife Service Rept., Honolulu.

Falanruw, M.C.V. 1975. Distribution of the Micronesian Megapode *Megapodius laperouse* in the Northern Mariana Islands. Micronesica 11:149-150.

Falanruw, M.C., T.G. Cole, and A.H. Ambacher. 1989. Vegetation survey of Rota, Tinian, and Saipan, Commonwealth of the Northern Mariana Islands. Resour. Bull. PSW-27. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Dept. of Agriculture; 11 p.+13 maps.

Fancy, S.G., R.J. Craig, and C.W. Kessler. 1998. Forest bird and fruit bat populations on Sarigan, Mariana Islands. Micronesica. (In Press).

Farabaugh, S.M. 1982. The Ecological and Social Significance of Duetting. In Kroodsma, D.E. and E.H. Miller (eds.) Acoustic Communication in Birds., Vol 2. pp 85-124. Academic Press, New York.

Farrell, D.A. 1989. Tinian. Micronesian Productions, Saipan.

Fosberg, F.R. 1960. The vegetation of Micronesia. Bull. American Museum Natural History. Pp. 119.

Fritts, T. H., G. H. Rodda, and E. F. Kosaka. 1995. Recent sightings on Saipan. Brown tree snake update July 1, 1995.

Glass, P.O. and D.T. Aldan. 1988. Micronesian Megapode Surveys and Research. pp 131-153, In Division of Fish and Wildlife Progress Report: 1982-1987. CNMI Division of Fish and Wildlife, Saipan.

Glass, P.O. and E.C. Villagomez. 1986. Trip Report: Guguan, 8-20 September. CNMI Division of Fish and Wildlife, Saipan.

Hartert, E. 1898. On the birds of the Marianne Islands. Novitiates Zoology 5:51-69.

ICBP. 1992. Putting biodiversity on the map: priority areas for global conservation. International Council for Bird Preservation. Cambridge, U.K.

Jenkins, J.M. 1983. The Native Forest Birds of Guam. Ornithological Monogr. 31:1-61.

Jones, D.N., R.W.R.J. Dekker, and C.S. Roselaar. 1995. The Megapodes. Oxford University Press.

Kittlitz, F.H. 1836. Observations zoologiques faites pendant l'expedition de la corvette le Seniavine, Pp. 237-330. In Voyage Autour du Monde... Sur la Corvette Le Seniavine, dans les Annees 1826, 1827, 1828 et 1829, par Frederic Lutke, Capitaine de Vaisseau... Paris. [Reprinted 1971 by Da Capo Press, New York.].

Kobayashi, S. 1994. A taxonomic study of the Orchis from Alamagan, the Northern Mariana Islands, Micronesia. Nat. Hist. Research, Special Issue, No. 1:71-73. Natural History Museum and Institute, Chiba, Japan.

Lemke, T. 1983. Recent observations on the avifauna of the Northern Mariana Islands north of Saipan. Unpubl. manuscript, CNMI Division of Fish and Wildlife.

Lemke, T. 1984. Micronesian Megapode Surveys and Inventories. In Division of Fish and Wildlife Progress Report, 1984. CNMI Division of Fish and Wildlife, Saipan.

Linsley, L.N. 1935. Curious things about Guam: the mountain chicken. Guam Recorder 12:249-250. (not seen, in Baker 1951).

Ludwig, G.M. 1979. Fish and Wildlife Concerns and Recommendations for Northern Marianas Islands based on July 1978 Field Trip. unpubl. report, U.S. Fish and Wildlife Service, Honolulu.

Lusk, M. 1993. Field Trip Report: Aguiguan, 23-26 August. CNMI Division of Fish and Wildlife, Saipan.

Lusk, M.R. and C. Kessler 1996. Trip Report: Farallon de Medinilla, 3 - 4 November. U.S. Fish and Wildlife Service, Pacific Island Ecoregion, Honolulu, HI.

MacKinnon, J. 1981. Methods for the conservation of Maleo Birds, *Macrocephalon maleo* on the island of Sulawesi, Indonesia. Biol. Conserv. 20:183-193.

Marshall, J.T., Jr. 1949. The endemic avifauna of Saipan, Tinian, Guam, and Palau. Condor 51:200-221.

Mayr, E. 1942. Systematics and the origin of species from the viewpoint of the zoologist. Columbia University Press, New York.

McCoid, J. M. and D. W. Stinson. 1991. Recent snake sightings in the Mariana Islands. Elepaio 51:36.

Momiyama, T.T. 1922. Birds of Micronesia. Descriptions of two new genera and nine new subspecies of birds from Micronesia. Ornithol. Society Japan Pt.1:1-24. (not seen, in Baker 1951).

Ohba, T. 1994. Flora and vegetation of the northern Mariana Islands, Micronesia. Natural History Research, Special Issue, Number 1:13-69. Natural History Museum and Institute, Chiba, Japan.

Olson, S. L. 1980. The significance of the distribution of the Megapodiidae. Emu 80:21-24.

Oustalet, E. 1896. Les mammiferes et les oiseaux des Iles Mariannes. Nouv. Archives Museum Natural History, Paris 8(1896):24-74.

Owen, B. 1974. Environmental impact study on the terrestrial fauna and flora of Tinian with respect to the proposed establishment of a U.S. military base on that island. Unpubl. rept., Trust Territory Conservation Office. (not seen, in Glass and Aldan 1988).

Pratt, H.D., J. Engbring, P.L. Bruner, and D. G. Berrett. 1980. Notes on the taxonomy, natural history, and status of the resident birds of Palau. Condor 82: 117-131.

Pratt, H. D. and P.L. Bruner. 1978. Micronesian megapode rediscovered on Saipan. 'Elepaio 39:57-59.

Pratt, T.K. 1983. Field Trip Report: Sarigan, 7-22 September. CNMI Division Of Fish and Wildlife, Saipan.

Quoy, J.R.C. and P.J. Gaimard. 1824-1826. Voyage autour de monde. Enterpres par ordre du roi. Execute sur les corvettes de S.M. l'Uranie et la Physicienne, pendant les annees 1817,1818, 1819, et 1820. Par M.Louis de freycinet, Capitaine de Vaisseax. Zoologie. Paris, Chez Pillet Aine, Imprimeur-Libraire: 712 p. (not seen, in Baker 1951).

Reichel, J.D., and P.O. Glass. 1988. Field Trip Report: Anatahan, 27-29 September. CNMI Division of Fish and Wildlife, Saipan.

Reichel, J.D., and P.O. Glass. 1991. Checklist of the Birds of the Mariana

Islands. Elepaio 51(1):3-11.

Reichel, J.D., C.G. Rice, and D.W. Stinson. 1989. Field Trip Report, Sarigan and Pagan, 25-27 April. CNMI Division of Fish and Wildlife, Saipan.

Reichel, J.D., S. Taisacan, S.C. Villigomez, P.O. Glass, and D.T. Aldan. 1987. Field Trip Report, Northern Islands, 27 May - 5 Jun. CNMI Division of Fish and Wildlife, Saipan.

Reichel, J.D., S. Taisacan, and P.O. Glass. 1988. Field Trip Report, Northern Islands, 22-31 Mar. CNMI Division of Fish and Wildlife, Saipan.

Resources Northwest, Inc. 1997. Draft Island of Rota Natural Resources Conservation Plan, June 5, 1997. Prepared for the Commonwealth of the Northern Mariana Islands. 80 pp.

Rice, C.G. 1993. Feral Ungulate Research. In Division of Fish and Wildlife Research and Management Program, Progress Report: 1987-1992. pp 303-324. CNMI Division of Fish and Wildlife, Saipan.

Rice, C.G. and D.W. Stinson. 1992. Field Trip Report: Chiba Institute Northern Islands Trip, 11-20 May, 24 May -9 June. CNMI Division of Fish and Wildlife.

Rice, C.G., D.W. Stinson, and R.J. Craig. 1990. Field Trip Report: Sarigan, 18-22 September. CNMI Division of Fish and Wildlife, Saipan.

Rinke, D.R. 1993. Progress report form the Brehn Fund Malau Conservation Project. Megapode Newsletter 7(2):10-12.

Savidge, J.A. 1987. Extinction of an island forest avifauna by an introduced snake. Ecology 68:660-668.

Stanley, D. 1989. Micronesia Handbook: Guide to the Caroline, Gilbert, Mariana, and Marshall Islands. Moon Publ., Chico, CA.

Steadman, D.W. 1989. New species and records of birds (Aves: Megapodiidae, Columbidae) from an archaeological site on Lifuka, Tonga. Proc. Biol. Soc. Wash. 102:537-552.

Steadman, D.W. 1992. Extinct and extirpated birds from Rota, Mariana Islands. Micronesica 25:71-84.

Stinson, D.W. 1990. Micronesian Megapode Research. Division of Fish and Wildlife Progress Report FY 1990, pp 29-31. CNMI Division of Fish and Wildlife, Saipan.

Stinson, D.W. 1992. Megapodes on Aguiguan: smashing the Glass Hypothesis? In Craig, R.J. (ed.) The Aguiguan Expedition. Proceedings: Marianas Research Symposium 1:43-46. Northern Marianas College.

Stinson, D.W. 1993. Micronesian Megapode Research. In Division of Fish and Wildlife Research and Management Program, Progress Report: 1987-1992. pp. 217-233. CNMI Division of Fish and Wildlife, Saipan.

Stinson, D.W., P.O. Glass, and E.M. Taisacan. 1992. Declines and trade in fruit bats on Saipan, Tinian, Aguijan, and Rota. Pp 61-67, In Wilson, D.E. and G.L. Graham (eds.) Pacific Island Flying Foxes: proceedings of an International Conservation Conference. U.S. Fish and Wildlife Service, Biological Report 90(23).

Stone, B.C. 1970. The flora of Guam. Micronesica 6:1-659.

Takatsukasa, S. 1932-1938. The Birds of Nippon. H.F.& G. Witherby, London.

Takatsukasa, S., and Y. Yamashina. 1932. Second report on the birds of the South Sea. Dobutsu. Zasshi 44:221-226.

Temple, S.A. 1985. Why endemic island birds are so vulnerable to extinction. In Temple, S.A. Bird Conservation 2. pp 3-6. International Council for Bird Preservation, U.S. Section and University of Wisconsin Press.

Todd, D. 1983. Pritchard's Megapode on Niuafo'ou Island, Kingdom of Tonga. Journal of the World Pheasant Assoc. 8:69-88.

U.S. Fish and Wildlife Service. 1970. Conservation of Endangered Species and other Fish and Wildlife. Federal Register 35(106):8491-8498.

U.S. Fish and Wildlife Service. 1983. Endangered and Threatened Species Listing and Recovery Priority Guidelines. Federal Register 48(221):51985.

U.S. Fish and Wildlife Service. 1990. Native forest birds of Guam and Rota of the Commonwealth of the Northern Mariana Islands Recovery Plan. U.S. Fish and Wildlife Service, Portland, OR. 86 pp.

U.S. Fish and Wildlife Service. 1996. U.S. Fish and Wildlife Service Wildlife Research Report for Navy-leased lands on the Island of Tinian, Commonwealth of the Northern Mariana Islands. Unpublished report prepared for the Department of the Navy. 104 pp.

U.S. Fish and Wildlife Service. 1997. Biological opinion of the U.S. Fish and Wildlife Service for gunnery and aerial bombardment practice at Farallon de Medinilla, Commonwealth of the Northern Mariana Islands. U.S. Fish and Wildlife Service, Pacific Island Ecoregion, Honolulu, HI. 14 pp.

U.S. Navy. 1949. (p.ii-28 from a handbook on the Marianas). School of Naval Administration, Stanford University. (on file at CNMI-DFW, Saipan).

Vogt, S. 1997. Brown tree snake quarantine and protection. Pp. 23-29 *In* Div. of Fish and Wildlife Progress Report, Annual Report, FY 1996. CNMI Div. of Fish and Wildlife, Saipan.

Wiles, G.J., C.F. Aguon, G.W. Davis, and D.J. Grout. 1995. The status and distribution of endangered animals and plants in Northern Guam. Micronesica 28(1):31-49.

Wiles, G.J., R.E. Beck, and A.B. Amerson. 1987. The Micronesian Megapode on Tinian, Mariana Islands. 'Elepaio 47:1-3.

Wiles, G.J., and P.J. Conry. 1990. Terrestrial vertebrates of the Ngerukewid Islands Wildlife Preserve, Palau Islands. Micronesica 23:41-66.

Wiles, G.J., T.O. Lemke, and N.H. Payne. 1989. Population estimates of fruit bats (*Pteropus mariannus*) in the Mariana Islands. Conservation Biology 3:66-76.

Yamashina, Y. 1932. On a collection of birds' eggs from Micronesia. Tori 7:393-413.

Yamashina, Y. 1940. Some additions to the "List of the birds of Micronesia." Tori 10:673-679.

IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows outlines actions and estimated costs for the Micronesian megapode recovery program, as set forth in this recovery plan. It is a **guide** for meeting the objectives discussed in the Recovery section of this plan. This schedule indicates task priority, task numbers, task descriptions, duration of tasks, the agencies responsible for committing funds, and lastly, estimated costs. The agencies responsible for committing funds are not, necessarily, the entities that will actually carry out the tasks. When more than one agency is listed as the responsible party, an asterisk is used to identify the lead entity.

The actions identified in the Implementation Schedule, when accomplished, should protect habitat for the species, stabilize the existing populations and increase the population sizes and numbers. Monetary needs for all parties involved are identified to reach this point, whenever feasible.

Priorities in Column 1 of the following Implementation Schedule are assigned as follows:

Priority 1 -	An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.
Priority 2 -	An action that must be taken to prevent a significant decline in species' population/habitat quality, or some other significant negative impact short of extinction.
Priority 3 -	All other actions necessary to provide for full recovery of the species.

Key to acronyms and symbols used in the Implementation Schedule:

CNMI-DFW	Commonwealth of the Northern Mariana Islands, Division of Fish and Wildlife, Saipan
GDAWR	Guam Division of Aquatic and Wildlife Resources, Department of Agriculture, Agana, Guam
FWS-PIE	U.S. Fish & Wildlife Service Pacific Islands Ecoregion Honolulu, Hawaii
DOD	Department of Defense
BRD	Biological Resources Division, U.S. Geological Survey
WS	U.S. Department of Agriculture, Wildlife Services
C	Continuous Task
O	Ongoing Task
*	Indicates lead agency

RECOVERY PLAN IMPLEMENTATION SCHEDULE FOR THE MICRONESIAN MEGAPODE

Prior-ity #	Task #	Task Description	Task Duration (Yrs)	Responsible Party	Total Cost	Cost Estimates ($1,000's)				
						FY 1998	FY 1999	FY 2000	FY 2001	FY 2002
1	111	Design and conduct surveys	2	CNMI-DFW*	20.0	10	10			
				FWS-PIE	10.0	5	5			
1	112	Assess threats	2	CNMI-DFW*	10.0	5	5			
				FWS-PIE	4.0	2	2			
1	121	Control feral ungulates	C	CNMI-DFW*	275.0	30	30	30	30	30
				WS	90.0	15	15	15	10	10
1	122	Develop and implement a brown tree snake interdiction and control plan	O	CNMI-DFW*	570.0	10	40	40	40	40
				GDAWR	570.0	10	40	40	40	40
				DOD	570.0	10	40	40	40	40
				FWS-PIE	85.0	10	10	5	5	5
				WS	125.0	10	10	10	10	10
				BRD	60.0	10	10	5	5	5
1	123	Control other introduced predators	C	CNMI-DFW*	250.0	20	20	20	20	20
				WS	50.0	5	5	5	5	5

RECOVERY PLAN IMPLEMENTATION SCHEDULE FOR THE MICRONESIAN MEGAPODE

Priority #	Task #	Task Description	Task Duration (Yrs)	Responsible Party	Total Cost	Cost Estimates ($1,000's)				
						FY 1998	FY 1999	FY 2000	FY 2001	FY 2002
1	124	Control poaching	C	CNMI-DFW*	75.0	5	5	5	5	5
				FWS-PIE	75.0	5	5	5	5	5
1	13	Protect essential habitat	5	CNMI-DFW*	36.0	12	6	6	6	6
				FWS-PIE	18.0	6	3	3	3	3
2	14	Gain public support for megapode conservation	C	CNMI-DFW*	36.0	8	2	2	2	2
				FWS-PIE	18.0	4	1	1	1	1
NEED 1 (Survey, protect, manage)					2,947	192	264	232	227	227
2	21	Develop better understanding of habitat use and movements	5	CNMI-DFW*	35.0	7	7	7	7	7
				FWS-PIE	10	2	2	2	2	2
				BRD	10	2	2	2	2	2
2	22	Develop better understanding of reproductive ecology	5	CNMI-DFW*	25.0	5	5	5	5	5
				FWS-PIE	7.5	1.5	1.5	1.5	1.5	1.5
				BRD	7.5	1.5	1.5	1.5	1.5	1.5
NEED 2 (Research)					95	19	19	19	19	19

RECOVERY PLAN IMPLEMENTATION SCHEDULE FOR THE MICRONESIAN MEGAPODE

Priority #	Task #	Task Description	Task Duration (Yrs)	Responsible Party	Total Cost	Cost Estimates ($1,000's) FY 1998	FY 1999	FY 2000	FY 2001	FY 2002
2	31	Determine feasibility of enhancing reproduction on coral islands and establish enhanced nesting sites	5	CNMI-DFW*	34.0	2	2	10	10	10
				FWS-PIE	10.0	0.5	0.5	3	3	3
				BRD	10	0.5	0.5	3	3	3
2	32	Develop methods of restoring native forest and conduct forest restoration programs	10	CNMI-DFW*	120.0	5	5	5	15	15
				FWS-PIE	36	1.5	1.5	1.5	4.5	4.5
				BRD	36	1.5	1.5	1.5	4.5	4.5
2	331	Determine success of population enhancement	5	CNMI-DFW*	20.0					
				FWS-PIE	10.0					
2	332	Plan and implement translocation procedures	5	CNMI-DFW*	105.0					
				FWS-PIE	80.0					
NEED 3 (Expand populations)					461	11	11	24	40	40
2	41	Develop methods for monitoring populations on southern islands and monitor	C	CNMI-DFW*	45.0	3	6		6	
				FWS-PIE	30.0	2	4		4	
2	42	Develop methods for monitoring populations on northern islands and monitor	C	CNMI-DFW*	56.0	6	10			10
				FWS-PIE	43.0	3	8			8

RECOVERY PLAN IMPLEMENTATION SCHEDULE FOR THE MICRONESIAN MEGAPODE

Priority #	Task #	Task Description	Task Duration (Yrs)	Responsible Party	Total Cost	Cost Estimates ($1,000's)				
						FY 1998	FY 1999	FY 2000	FY 2001	FY 2002
NEED 4 (Monitor)					174	14	28	0	10	18
TOTAL COST					3,677	236	322	275	296	304

APPENDIX A

AGENCY AND PEER REVIEWERS

Washington, D.C. Agencies

Chief, U.S. Fish and Wildlife Service
Division of Endangered Species
Arlington Square Building
4401 N. Fairfax Dr., Room 452
Arlington, VA 22203

Chief, U.S. Fish and Wildlife Service
Division of Refuges and Wildlife
4401 N. Fairfax Dr., Rm. 670
Arlington, VA 22203

Chief, Office of Public Affairs
U.S. Fish and Wildlife Service, DOI
Main Interior Building
1849 C. St, NW, Room 3447
Washington, D.C. 20240

Environmental Protection Agency
Hazard Evaluation Division - EEB (TS769C)
401 M St., SW
Washington, D.C. 20460

Lawrence Mason
Office of International Affairs (IA, Mail Stop 860 ARLSQ)
U.S. Fish and Wildlife Service
Washington, D.C. 20240

Biological Resources Division
Office of Research Support
4401 N. Fairfax Dr., Room 725
Arlington, VA 22203

Ms. Peggy Olwell
National Park Service
Wildlife and Vegetation
P.O. Box 37127
Washington, DC 20013

Pacific Island Recovery Team

Tino Aguon *
Division of Aquatic and Wildlife Resources
Guam Department of Agriculture
P.O. Box 2950
Agana, Guam 96910

Earl Campbell *
USDA-APHIS-Wildlife Services
Hawaii Field Station
P.O. Box 10880
Hilo, HI 96721

Robert Craig *
19 Chaplin Street
Chaplin, CT 06235

John Engbring *
U.S. Fish and Wildlife Service
Olympia Field Office
3704 Griffin Lane SE, Suite 102
Olympia, WA 98501-2192

Peter Luscomb *
Honolulu Zoo
151 Kapahulu Avenue
Honolulu, HI 96815

Ben Camacho
Division of Fish and Wildlife
Lower Base
P.O. Box 10007
Saipan, MP 96950

Gary J. Wiles *
Division of Aquatic and Wildlife Resources
Department of Agriculture
P.O. Box 2950
Agana, GUAM 96910

Pacific Avifauna Recovery Coordinating Committee

Sheila Conant
General Science Department
University of Hawaii
2450 Campus Road, Dean Hall, Room 2
Honolulu, HI 96822

Scott Derrickson
National Zoological Park
Conservation and Research Center
Front Royal, VA 22630

Andrew Engilis, Jr.
Ducks Unlimited
9823 Old Winery Place, Suite 16
Sacramento, CA 95827

Robert Fleischer
National Zoological Park
Department of Zoological Research
Smithsonian Institution
Washington, D.C. 20008

Jon Giffin
Division of Forestry and Wildlife
Department of Land and Natural Resources
Central Tree Nursery
P.O. Box 457
Kamuela, HI 96743

Dr. James Jacobi
Biological Resources Division
Hawaii Field Station
Box 44
Hawaii Volcanoes, HI 96718

Lloyd Kiff
The Peregrine Fund, Inc.
5666 West Flying Hawk Lane
Boise, ID 83709

J. Michael Scott
Idaho Cooperative Fish and Wildlife Research Unit
College of Forestry, Wildlife, and Range Science
University of Idaho
Moscow, ID 83843

U.S. Fish and Wildlife Service

Biodiversity Joint Venture Coordinator
U.S. Fish and Wildlife Service
P.O. Box 50088
Honolulu, HI 96850

Listing and Recovery Program Leader
U.S. Fish and Wildlife Service
Pacific Islands Office
P.O. Box 50088
Honolulu, HI 96850

Federal Aid Coordinator
U.S. Fish and Wildlife Service
P.O. Box 50088
Honolulu, HI 96850

Field Supervisor, Pacific Islands Ecoregion
Refuges and Wildlife
U.S. Fish and Wildlife Service
P.O. Box 50088
Honolulu, HI 96850

Senior Resident Agent
U.S. Fish and Wildlife Service
Division of Law Enforcement
P.O. Box 50223
Honolulu, HI 96850

Other Federal Offices - Hawaii

Ms. Lauren Bjorkman
USDA - Natural Resources Conservation Service
P.O. Box 50004
Honolulu, HI 96850

Commander, Pacific Division
Naval Facilities
Engineering Command
Building 258
Makalapa
Pearl Harbor, HI 96860-7300

Dr. William J. Hoe
USDA-APHIS-PPQ
Terminal Box 57
Honolulu International Airport
Honolulu, HI 96813

Mr. Kenneth Nagata
c/o USDA
P.O. Box 2549
Kailua-Kona, HI 96740

Melvin N. Kaku **
Department of the Navy
Pacific Division
Naval Facilities Engineering Command
Pearl Harbor, HI 96860-7300

Commonwealth of the Northern Mariana Islands

Commander
U.S. Naval Forces Marianas
PSC 489, FPO AP 96536-0051

Mike Fitzgerald
Military Affairs Coordinator to the Mayor
San Jose Village
Tinian, MP 96952

Honorable Joseph Inos
Mayor of Rota
Office of the Mayor
Rota, MP 96951

Honorable Herman Manglona
Mayor, Municipality of Tinian and Aguiguan
P.O. Box 59
Tinian, MP 96952

Leslie Morton **
Natural Resources Manager
U.S. Naval Forces Marianas
PSC 489, FPO AP 96536-0051

Arnold Palacios, Former Director *
Division of Fish and Wildlife
Commonwealth of the Northern Mariana Islands
Saipan, MP 96950

David Quitugua, Director
Division of Fish and Wildlife
Commonwealth of the Northern Mariana Islands
Saipan, MP 96950

Margarita Wonenberg
Secretary
Department of Natural Resources
Commonwealth of the Northern Mariana Islands
Saipan, MP 96950

Jeffrey Schorr
Field Representative, CNMI
Department of the Interior
P.O. Box 2622
Saipan, MP 96950

Resident Secretary
Department of Lands and Natural Resources
Rota, MP 96951

Governor Frolian C. Tenorio
Commonwealth of the Northern Mariana Islands
Office of the Governor
Capitol Hill
Saipan, MP 96950

Guam

Honorable Carl Gutierrez
Governor, Territory of Guam
Agana, Guam 96910

Michael Kuhlmann, Chief
Division of Aquatic and Wildlife Resources
Department of Agriculture
P.O. Box 2950
Agana, GUAM 96910

Rufo J. Lujan, Former Chief *
Division of Aquatic and Wildlife Resources
Department of Agriculture
P.O. Box 2950
Agana, GUAM 96910

Libraries

Northern Marianas College
Library
P.O. Box 1250
Asterlaje Campus
Saipan, MP 96950

University of Guam
RFK Memorial Library
UOG Station
Mangilao, Guam 96923

Other Interested Parties

Bishop Museum
Department of Zoology
1525 Bernice St.

P.O. Box 19000A
Honolulu, HI 96817-0916

Rene' W.R.J. Dekker *
National Museum of Natural History
P.O. Box 9517
2300 RA LEIDEN
The Netherlands

Steven G. Fancy, PhD. **
Biological Resources Division
Hawaii Field Station
Box 44
Hawaii Volcanoes, HI 96718

Field Museum of Natural History
Department of Zoology
Bird Division
Roosevelt Rd. at Lake Shore Dr.
Chicago, IL 60605
Attn: David Willard

Holly Freifield *
Department of Geography
University of Oregon
Eugene, OR 97403

Philip O. Glass *
U.S. Fish and Wildlife Service
17629 El Camino Real
Houston, TX 77058

Mr. Robert Gustafson
Museum of Natural History
900 Exposition Blvd.
Los Angeles, CA 90007

Darryl N. Jones
Australian Environmental Studies
Griffith University
Nathan, Qld 4111
Australia

Dr. Ann P. Marshall *
U.S. Fish and Wildlife Service
Pacific Islands Office
P.O. Box 50088
Honolulu, HI 96850

James D. Reichel *
Montana Natural Heritage Program
1515 E. 6th Ave.
Helena, MT 59620

Clifford G. Rice *
U.S. Army Construction Engineering Research Laboratories
P.O. Box 9005
Champaign, IL 61826-9005

Benigno Sablan, Former Secretary *
Department of Natural Resources
Commonwealth of the Northern Mariana Islands
Saipan, MP 96950

Mr. Fred C. Schmidt
Head, Documents Department
The Libraries
Colorado State University
Ft. Collins, CO 80523-1879

Mr. Derek Stinson*
12106 SE 314th Place
Auburn, WA 98092

Jan Tenbruggencate
Honolulu Advertiser
P.O. Box 524
Lihue, HI 96766-0524

Dave Worthington *
U.S. Fish and Wildlife Service
Pacific Islands Office
P.O. Box 50088
Honolulu, HI 96850

Environmental Organizations

Marianas Audubon Society
P.O. Box 4425
Agana, Guam 96910

Dr. Steven Montgomery
Conservation Council of Hawaii
P.O. Box 2923
Honolulu, HI 96802

Mr. Michael Sherwood
Earth Justice
180 Mongomery St., Suite 1400
San Francisco, CA 94109

Ms. Marjorie F.Y. Ziegler
Earth Justice
212 Merchant St., Suite 202
Honolulu, HI 96813

David T. Aldan *
Division of Fish and Wildlife
Commonwealth of the Northern Mariana Islands
Saipan, MP 96950

Donna O'Daniel, Former Fish and Wildlife Biologist *
U.S. Fish and Wildlife Service
P.O. Box 26
Tinian, MP 96952

Scott Johnston *
U.S. Fish and Wildlife Service
4401 Fairfax Dr.
Arlington, VA 22203

(*) Persons and Agencies who provided information necessary for the development of the Plan.

(**) Persons and Agencies who provided comments on the Draft Plan.

APPENDIX B

SUMMARY OF COMMENTS

The U.S. Fish and Wildlife Service received comments on the Draft Recovery Plan for the Micronesian Megapode from Department of the Navy, the Biological Resource Division of the U.S. Geological Survey, the State of Hawaii's Land Use Commission and Office of Hawaiian Affairs, and one private individual. Many of the editorial and organizational comments provided have been incorporated in the text of this document. Additional comments are addressed specifically below.

Comment 1: The population criteria for delisting, namely populations of various sizes on at least 10 different islands in the Marianas seems arbitrary. Additional explanation and justification for the population target levels would make the population levels seem less arbitrary.

Service Response: Recovery-level population numbers have been derived for this recovery plan utilizing guidelines outlined by the IUCN (International Union for the Conservation of Nature, 1996 Red List Categories). According to one of the general criteria, an endangered species with fragmented or isolated subpopulation structures can be reclassified as "vulnerable" when 10 or more populations are established. The establishment and maintenance of stable populations on 10 of the 15 original islands is deemed reasonable and prudent for the protection of this species based on said guidelines and best scientific knowledge at the present time.

Comment: The Navy has already developed and implemented a brown tree snake (BTS) control plan for the Navy and Department of Defense (DOD) controlled points of egress on Guam, as well as interdiction procedures for military exercises carried out in the Mariana Islands. DOD presently funds the U.S. Department of Agriculture, Wildlife Services for BTS operational control on Guam and other Pacific Islands. It is not clear ... if additional funding is being looked at or if this is taking into account DOD money that has already been spent.

Service Response: The recovery implementation schedule is merely an attempt by the Service to provide a rough estimate of what it would cost to implement the various recovery tasks. Implementation schedules do not take into account monies that have been previously spent. Task 122 of the implementation schedule reflects an estimate of the fraction of future BTS dollars that will directly impact the recovery of the megapode.

Comment: The assessment of threats cannot be accomplished by field biologists as collateral duty while performing surveys. It is suggested that the assessment of threats be included under essential research in the step-down narrative.

Service Response: The step-down narrative is designed to provide general guidance to assist biologists in the implementation of conservation measures. Due to the remoteness of many of the megapode populations, it will be necessary for biologists to concurrently collect survey and monitoring data *and* conduct the needed research during individual expeditions.

Region 1
U.S. Fish and Wildlife Service
Ecological Services
911 N.E. 11th Avenue
Portland, Oregon 97232-4181

April 1998