TINIAN MONARCH POST-DELISTING MONITORING

PROGRESS REPORT AND TRIP REPORT FOR 7-17 MARCH 2007

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Tinian Monarch nest at the Santa Lourdes Shrine, March 2007. Photo by Eric VanderWerf.

INTRODUCTION AND BACKGROUND

The Tinian monarch (*Monarcha takatsukasae*), or Chichirican in the Chamorro language, was removed from the Federal List of Endangered and Threatened Wildlife and Plants on September 21, 2004 (69 FR 56367). The decision to delist the monarch was based on information from population surveys and demographic research, which indicated that the monarch has increased in number or is at least stable, that the primary listing factor, loss of forest habitat, has been ameliorated, and that the species is not currently threatened by any other factors.

Section 4(g)(1) of the U.S. Endangered Species Act, added in the 1988 reauthorization, requires the U.S. Fish and Wildlife Service (Service) to implement a system, in cooperation with the States or Territories, to monitor for no fewer than 5 years the status of all species that have recovered and been removed from the List of Threatened and Endangered Wildlife and Plants. The purpose of this post-delisting monitoring is to verify that a species delisted due to recovery remains secure from risk of extinction after it has been removed from the protections of the Act.

In keeping with that mandate, we developed a post-delisting monitoring plan for the Tinian monarch in cooperation with the CNMI Division of Fish and Wildlife (DFW), the U.S. Geological Survey Biological Resources Discipline (BRD), the U.S. Department of Agriculture Wildlife Services, and the Department of the Navy. A draft of this plan was also peer-reviewed by nine scientific experts familiar with the Tinian monarch, the brown treesnake (*Boiga irregularis*), and methods of monitoring bird and snake populations. The final version of the monitoring plan was completed on June 8, 2005, and is available on the Service's Endangered Species Program national web page (http://endangered.fws.gov/) and the web page of the Pacific Islands Fish and Wildlife Office (http://pacificislands.fws.gov/).

The monitoring plan calls for the status of the Tinian monarch to be monitored for at least a 5-year period from 2006 to 2010, and to be achieved through three complementary survey methods. First, roadside point counts based on the North American Breeding Bird Survey will be used to monitor the abundance and distribution of monarchs across the island. Second, an "early warning system" consisting of small-scale study plots will be used to annually measure survival and territory occupancy of individually color-banded monarchs in areas where brown treesnakes might be most likely to occur. Third, a large-scale island-wide survey using variable circular plot methods will be conducted at the end of the 5-year monitoring period in 2010 to assess the species' overall status and to allow evaluation of long-term trends in population size and distribution through comparison with two previous surveys of the avifauna on Tinian completed in 1982 (Engbring *et al*. 1986) and 1996 (Lusk *et al*. 2000).

The monitoring plan for the Tinian monarch also calls for regular field surveys for brown treesnakes on Tinian, and for tracking of land use and development on Tinian. If data from any aspect of this monitoring effort or from some other source indicate that the Tinian monarch is experiencing significant declines in abundance or distribution, that its survival or territory occupancy are declining significantly, or that it requires protective status under the Act for some other reason, the Service can initiate procedures to re-list the monarch, including, if appropriate, emergency listing.

PROGRESS REPORT

Implementation of most aspects of post-delisting monitoring for the Tinian monarch began in April 2006. This report provides an update on progress made toward implementing each aspect of the monitoring plan.

A. MONITORING THE TINIAN MONARCH

1. Breeding Bird Survey Point Counts

Roadside point counts using methods of the Breeding Bird Survey were conducted by Ton Castro of the CNMI Division of Fish and Wildlife in 2005-2006, but have not been conducted for the past three quarters due to logistical difficulties. Scott Vogt of the U.S. Navy, Honolulu has conducted quarterly point counts along two transects in limestone forest, but these transects encompass only a small portion of the monarch's range. Larger scale surveys as prescribed in the final post-delisting monitoring plan should resume as soon as possible. These surveys will provide detailed information about the seasonal variation in abundance of the monarch. Analysis of this data can begin at any time. The Pacific Islands Fish and Wildlife Office is available to help with analysis of this data, if needed. A map of the survey route(s) with locations of each station should be made to ensure consistency over time.

2. Small-Scale Early Warning System Plots

Study Plot Locations

Two "early warning system" plots were chosen in 2006, the Santa Lourdes Shrine near the town of San Jose, and the Airport Mitigation Area on the cross-island road north of the airport (Figure 1). These sites were chosen because they are located near areas where brown treesnakes might arrive on Tinian, such as the airport, seaport, cargo off-loading zones or staging areas, and/or sites that are the ultimate destination of materials brought from other islands. Both areas also should be good study sites because they contain remnants of native limestone forest that supports a high density of monarchs, are unlikely to be developed, are easy to find, and should be easy to monitor because they contain strips of forest habitat in which monarchs can be readily located.

In 2007 work continued at the Santa Lourdes Shrine and the Airport Mitigation Area, and a third study site was added, an area of public land along the southwest coast just north of the seaport that contains tangan-tangan (*Leucaena leucocephala*) and mixed secondary forest (Figure 1). Addition of this third site will allow comparison of survival and territory occupancy between limestone forest and tangan-tangan habitats. This site is somewhat smaller than was desired and likely supports fewer than 20 monarch territories, but its proximity to the seaport makes it a good site to monitor for the potential arrival of brown treesnakes.

Several other sites with tangan-tangan habitat were considered as potential study sites but were not suitable for a variety of reasons. First, an area along the old runway just north of the airport that was considered in 2006 was visited again, but on more thorough examination the tangan-tangan habitat was found to be too patchy and few monarchs were present in the area.

Second, an area immediately west of the Santa Lourdes Shrine on the opposite side of 8th Avenue was considered, but information provided by Joe Lizama and Henry Cabrera of the CNMI Division of Fish and Wildlife indicated that this land has been designated as a homestead area, and that over 200 homestead plots have already been surveyed. This area is thus not suitable as a long-term study site for the monarch because the some of the land could be cleared if the homestead plots are released. Third, a large area along the southwestern coast near Tinian Beach and south of the western end of the runway is scheduled for development of a casino, and thus may be largely cleared. Fourth, an area of tangan-tangan south of the eastern end of the runway has been leased for cattle ranching, so access could be difficult. Fifth, an area south of the Dynasty Resort has tangan-tangan but is privately owned. Permission to work in the area could be requested from the owners, but continued access to the site in future years might not be guaranteed. There are extensive areas of dense tangan-tangan in the northern end of Tinian that are leased by the military, but since this area is not close to any locations where brown treesnakes are likely to arrive it does not meet one of the primary goals of the early warning system plots.

Mist-netting of Monarchs

A total of 37 monarchs were captured and banded from 8-17 March 2007, including 16 at the Santa Lourdes Shrine, 16 at the Airport Mitigation Area, and 5 five at the Seaport tangan-tangan site. This total included 31 adults, 7 of which were previously captured in 2006, two juveniles, and four nestlings. Additional monarchs that were banded in 2006 were also resighted (see section below on survival), but there was no need to recapture those birds, so in 2007 effort was focused on catching new birds that had not been captured before. Each bird was weighed, measured, inspected for health, molt, and breeding condition, fitted with an aluminum band and a unique combination of three colored leg bands, then released unharmed in the same location where it was captured.

Other bird species were captured incidentally, including 52 rufous fantails (*Rhipidura rufifrons*), 13 bridled white-eyes (*Zosterops conspicillatus*), 2 Micronesian honeyeaters (*Myzomela rubratra*), 2 collared kingfishers (*Todiramphus chloris*), 2 Mariana fruit-doves (*Ptilinopus roseicapilla*), 3 Micronesian starlings (*Aplonis opaca*), and one white tern (*Gygis alba*). These birds were fitted with an aluminum band, except the white tern, which was not banded because no bands of the appropriate size were available. All birds were released unharmed at the site of capture within one hour.

Avian Pox Virus

An unexpected result of the netting in 2006 was that 15 of the monarchs (39%) had scabby lesions on their feet and toes typical of those caused by avian pox virus (*Poxvirus avium*; Figure 4). Another seven monarchs (18%) had missing or deformed toes typical of healed pox lesions (Figure 5). These pox-like lesions were seen on monarchs again in 2007, but the prevalence of the lesions was lower in 2007 (11%) than in 2006 (39%; $X^2 = 8.49$, df = 1, p = 0.004). In 2006 there was some indication that prevalence of these lesions was higher at the Santa Lourdes Shrine (44%) than at the Airport Mitigation Area (36%). In 2007 prevalence was again higher at Santa Lourdes (19%) than at the Airport Mitigation Area (0%), and also was high at the Seaport tangan-tangan site (20%). The Santa Lourdes Shrine and the Seaport sites are closer to urbanized areas of Tinian where mosquito abundance may be higher due to the presence

of standing water in residential structures and abandoned machinery that provides mosquito breeding sites. These sites are also closer to populations of domestic birds such as chickens, which could serve as a reservoir for disease. Strangely, in 2006 and 2007 the pox-like lesions were observed only in monarchs and not in any of the other species captured.

The diagnosis that these lesions were caused by avian poxvirus should be regarded as tentative at this time, and this diagnosis should be confirmed clinically. Tissue samples were collected in 2006 from lesions on seven monarchs in order to conduct clinical tests. Drs. Dennis Triglia and Carter Atkinson of the U.S Geological Service Biological Resources Discipline in Hawaii attempted to test whether those lesions were caused by avian pox virus using tissue culture techniques, but the results were inconclusive. Three additional tissue samples were collected from monarchs in 2007. There is a newly developed genetic test for avian pox virus DNA (Thiel *et al.* 2005), and it is highly desirable to test these samples using the new genetic technique. This would require purchasing the appropriate DNA primers and contracting a genetic laboratory to analyze the samples, neither of which would be expensive. Tissue samples were collected from monarchs only if there was a loose scab that could be easily removed without injuring the bird or exacerbating the lesion.

Avian poxvirus is transmitted primarily by mosquitoes in Hawaii (van Riper *et al.* 2002, VanderWerf *et al.* 2006), but it can also be transmitted by physical contact with another bird or an infected surface, such as a branch or nest (Tripathy 1993). In order to prevent potential spread of disease among birds captured during this work, all equipment was sterilized with a 10% bleach solution after any bird with lesions was captured, including banding pliers, wing ruler, calipers, bird holding bags, and researcher's hands. We did not observe any mosquitoes at either site in 2006, but in 2007 a few mosquitoes were present at the Santa Lourdes Shrine. If clinical tests confirm that these lesions were caused by avian poxvirus it would be useful to sample mosquito populations in different areas of the island to determine where the disease may be coming from. If mosquito breeding sites are located the mosquitoes should be eradicated by removing the sites or by treatment with mosquito larvicides.

Avian pox virus is found worldwide, but to our knowledge it has not been reported previously in the Mariana Islands. Avian pox is fairly common in Hawaii and is thought to be one of the main threats to many Hawaiian forest birds (van Riper *et al*. 2002, Atkinson *et al*. 2005, VanderWerf *et al*. 2006). Pox also has been found recently in the Galapagos Islands (Thiel *et al.* 2005). Immunity to pox varies substantially among bird species, and many continental species are not seriously affected by pox. The degree of immunity to pox in birds from the Mariana Islands is unknown.

Survival Since 2006

Survival of Tinian monarchs from 2006 to 2007 was 61% overall, based on the number of birds banded in 2006 that were recaptured and/or resighted in 2007. There was no difference in survival rate between the Santa Lourdes Shrine (67%) and the Airport Mitigation Area (57%), ($X^2 = 0.08$, df = 1, p = 0.78), so data from both sites were combined for other comparisons of survival. This survival rate is somewhat lower than was expected based on studies of other Pacific island monarchs such as the Rarotonga monarch (*Pomarea dimidiata*) and the elepaio (*Chasiempis sandwichensis*), which average about 80% annual survival (Robertson *et al.* 1994,

VanderWerf and Smith 2002, VanderWerf 2004). However, the multiple peaks in breeding activity observed in the Tinian monarch (USFWS 1995) may cause them to have a higher reproductive rate than the Rarotonga monarch and the elepaio, which would help to balance the higher mortality rate observed thus far.

Survival of males (68%, n = 22) was somewhat higher than survival of females (50%, n = 15), though the difference was not significant due to the small sample sizes ($X^2 = 0.30$, df = 1, p = 0.59). Resightings of banded females indicated they had moved around more than males since 2006, so it is possible than some females not resighted in 2007 had moved out of the study areas. An effort was made to search surrounding areas for birds that might have emigrated, and two birds, both females, were found in territories adjacent to the study sites. So, it is possible that some birds missed in 2007 may be relocated in 2008, or that they may return to the study sites. Never the less, the indication of lower apparent survival of females is cause for some concern. In the future after more data have been compiled it will be possible to compare survival between males and females with more power. In the Rarotonga monarch and the Oahu elepaio females are known to experience higher predation than males because they are taken on the nest at night by black rats (*Rattus rattus*; Robertson *et al.* 1994, VanderWerf and Smith 2002). Rats are common at the Santa Lourdes Shrine and the Airport Mitigation Area and monarch nests are usually located less than two meters off the ground in small trees and shrubs (USFWS 1995, personal observation), so they would be easily accessible to a variety of predators including rats (*Rattus* spp.), feral cats (*Felis catus*), and monitor lizards (*Varanus indicus*).

Survival of birds with active pox-like lesions (86%, n = 14) was actually higher than survival of birds with inactive lesions (57%, n = 7) or survival of healthy birds with no lesions (40%, n = 15), but the difference was not significant due to small samples sizes ($X^2 = 1.54$, df = 2, p = 0.46). This result is surprising and the cause of this pattern is not known, but it indicates that these lesions are not limiting survival of Tinian monarchs at this time. However, it would still be valuable to confirm that these lesions were caused by avian pox virus, and to continue monitoring the survival rate of infected birds.

Identification of Males and Females

In order to compare the survival of males and females it is obviously necessary to determine the sex of each bird. The most reliable method of identifying females in the field is the presence of a brood patch, but this character is present only when a female is actively incubating eggs or brooding nestlings. Otherwise, monarchs can sometimes be sexed by observing certain behaviors, such as singing, which is done primarily by the male and only rarely by the female. Male monarchs are larger than females, so measurements can also be used to sex monarchs, though there is some overlap and it may not be possible to use measurements to determine sex in birds of intermediate size (Figure 6). Wing chord appears to differ more than other measurements between males and females and is thus the most reliable measurement to use for sexing, but even wing chord shows some overlap. A histogram of wing chord measurements of females sexed by the presence of a brood patch shows a normal bell-shaped distribution, but the frequency of wing measurements of females sexed by observation is skewed to the right, indicating some of the birds classified as females may actually have been males. Four of the five largest birds classified as females (with wing chords measuring 68mm) were captured in 2006; it would be useful to confirm the sex of these birds genetically using blood samples, which were

collected from all monarchs captured that year. Some of these birds were not resighted in 2007, so if their sex was incorrectly determined it could affect the survival rates calculated for males and females.

Territory Occupancy and Size

In 2006 there were thought to be 13 Tinian monarch territories in the area encompassed by the Santa Lourdes Shrine study site and 16 territories in the area encompassed by the Airport Mitigation Area study site, based on observations of banded birds and locations of territorial interactions between neighboring pairs. In 2007 these areas were found to contain 13 and 18 monarch territories, respectively (Figures 2 and 3). The number of territories thus has remained stable at the Santa Lourdes Shrine site, but may have increased slightly at the Airport Mitigation Area. However, considerably more time was spent resighting birds at the Airport Mitigation Area in 2007, so the apparent increase in number of monarch territories could be the result of increased effort and better information about the locations of territory boundaries. Moreover, all territories occupied in 2006 were occupied again in 2007, so there was no evidence of a decline in the number of monarchs inhabiting either site.

In 2007 the average territory size was 0.12±0.01 ha (n = 13, range = 0.06-0.21 ha) at the Santa Lourdes Shrine site and 0.13±0.01 ha (n = 18, range = 0.06-0.18 ha) at the Airport Mitigation Area. These sizes are remarkably similar to the average territory size in limestone forest habitat in 1995, which was 0.12±0.02 ha (n = 17, range 0.03-0.26 ha), indicating monarch population density has remained stable over this period (USFWS 1995). There were too few observations of banded birds at the Seaport tangan-tangan site to estimate territory size, but it should be possible to estimate territory size at that site next year after more work has been conducted, which will allow comparison of territory sizes between limestone forest and tangan-tangan habitats and further comparison with territory sizes in 1995.

The Santa Lourdes site was expanded in 2007 to include an additional territory in tangan-tangan just north of the cliff line because a monarch banded in 2006 had moved into this territory (Figure 2, territory 14). The size of the territory was not measured but it can still be used for monitoring survival and territory occupancy. Two more territories were added in limestone forest on the east and west ends of the study site along the same cliff line (Figure 2, territories 15 and 16), so a total of 16 territories have now been identified for monitoring at that site.

3. Large-Scale Variable Circular Plot Surveys

A single large-scale survey will be conducted at the end of the 5-year monitoring period in 2010 to assess the species' overall status and to allow evaluation of long-term trends in population size and distribution through comparison with the two previous surveys of the avifauna on Tinian completed in 1982 (Engbring *et al*. 1986) and 1996 (Lusk *et al*. 2000). To facilitate comparison of population estimates over time, surveys should use the same variable circular plot methods and the same 10 transects and 216 stations used in previous surveys. We hope that biologists in the CNMI who were involved with the previous surveys will be available to help locate the original transects. The USFWS Pacific Islands Office would welcome any assistance in conducting this survey and will be available to train surveyors in variable circular plot methods. Analysis of data from the Breeding Bird Survey point counts would help

determine the seasonality of monarch activity and which month might be best for conducting the island-wide survey in 2010.

ACKNOWLEDGEMENTS

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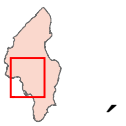
Figure 1. Location of the three study areas sampled during the 2007 sampling period for the Tinian Monarch Post-Delisting Monitoring Project.



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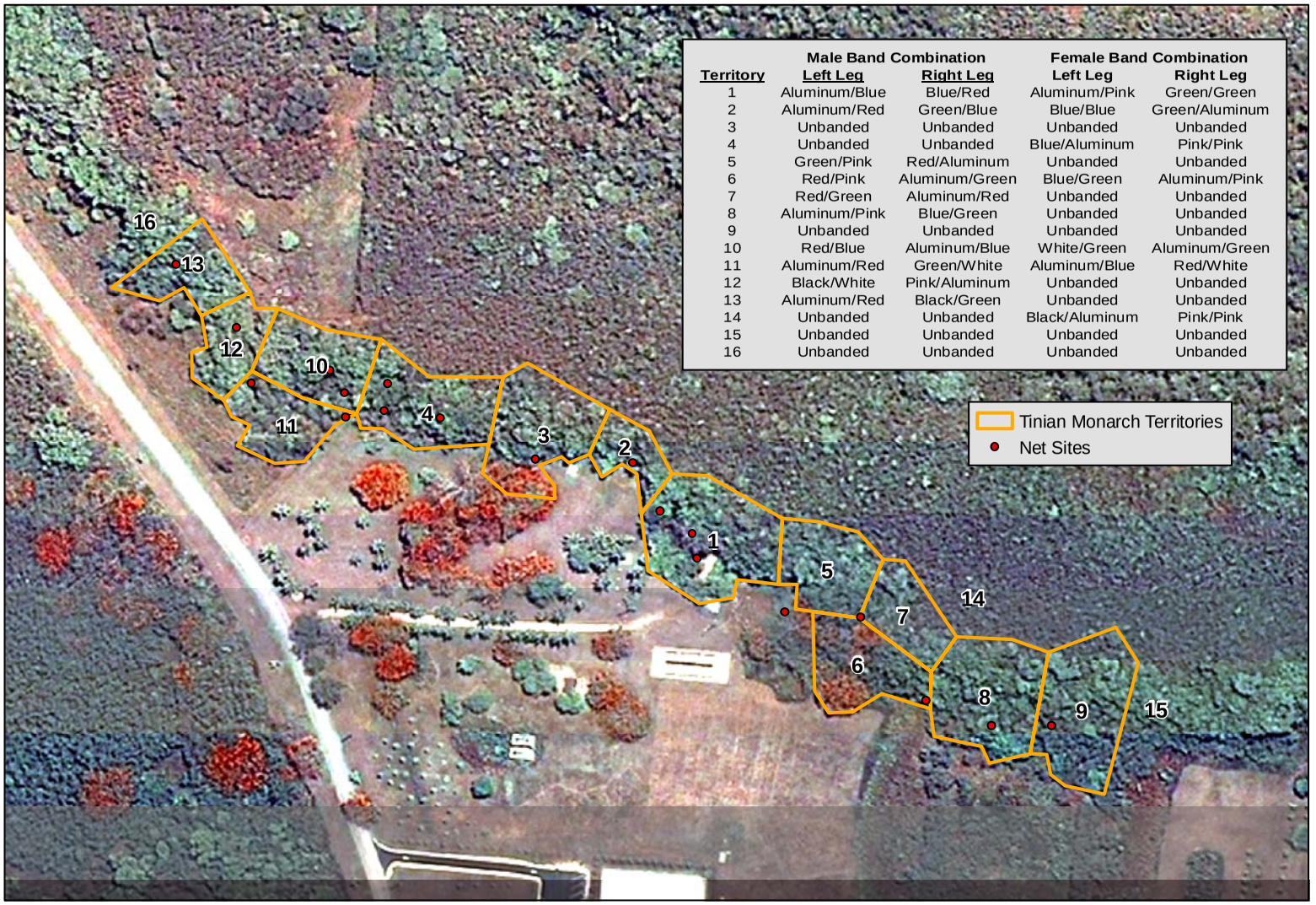
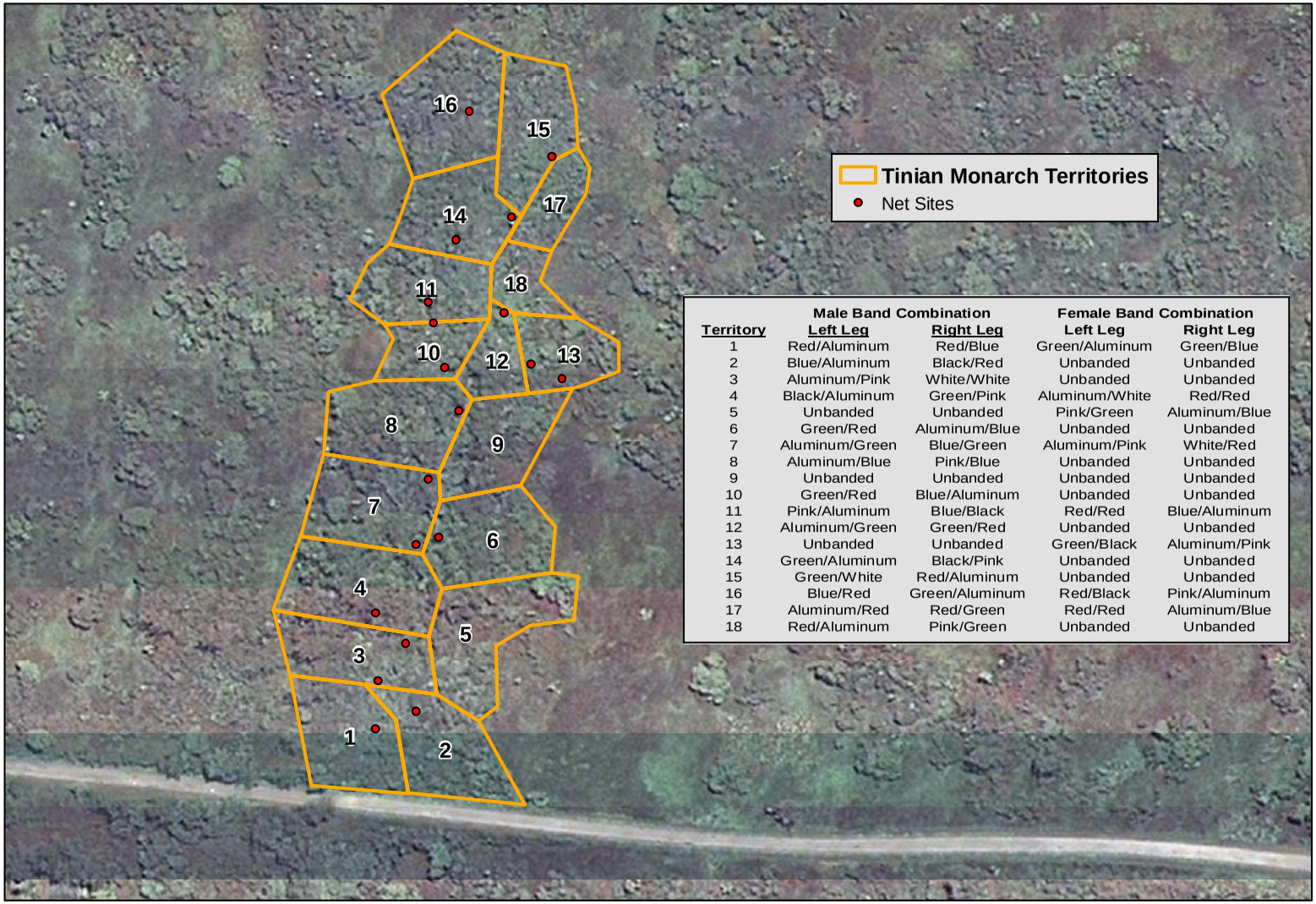


Figure 2. Estimated locations of Tinian monarch territories in the Santa Lourdes study site in March 2007.



Territory	Male Band Combination		Female Band Combination	
	Left Leg	Right Leg	Left Leg	Right Leg
1	Red/Aluminum	Red/Blue	Green/Aluminum	Green/Blue
2	Blue/Aluminum	Black/Red	Unbanded	Unbanded
3	Aluminum/Pink	White/White	Unbanded	Unbanded
4	Black/Aluminum	Green/Pink	Aluminum/White	Red/Red
5	Unbanded	Unbanded	Pink/Green	Aluminum/Blue
6	Green/Red	Aluminum/Blue	Unbanded	Unbanded
7	Aluminum/Green	Blue/Green	Aluminum/Pink	White/Red
8	Aluminum/Blue	Pink/Blue	Unbanded	Unbanded
9	Unbanded	Unbanded	Unbanded	Unbanded
10	Green/Red	Blue/Aluminum	Unbanded	Unbanded
11	Pink/Aluminum	Blue/Black	Red/Red	Blue/Aluminum
12	Aluminum/Green	Green/Red	Unbanded	Unbanded
13	Unbanded	Unbanded	Green/Black	Aluminum/Pink
14	Green/Aluminum	Black/Pink	Unbanded	Unbanded
15	Green/White	Red/Aluminum	Unbanded	Unbanded
16	Blue/Red	Green/Aluminum	Red/Black	Pink/Aluminum
17	Aluminum/Red	Red/Green	Red/Red	Aluminum/Blue
18	Red/Aluminum	Pink/Green	Unbanded	Unbanded

Figure 3. Estimated locations of Tinian monarch territories in the Airport Mitigation Area study site in March 2007.

0 50 100 Meters

0 50 100 Yards

1:2,000

UTM Zone 55, WGS84

Figure 4. Photo of Tinian monarch foot with active pox-like lesion, March 2007.

Figure 5. Photo of Tinian monarch foot with healed or inactive pox-like lesions. This bird had active lesions in April 2006 but they had healed by March 2007.

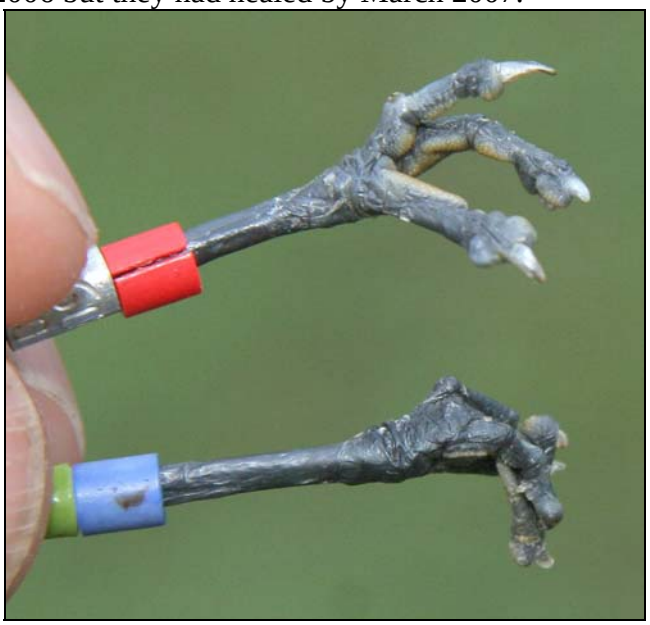


Figure 6. Histograms showing size distribution of male and female Tinian monarchs captured in 2006 and 2007. Males are generally larger than females, though there is some overlap. Wing chord differs between the sexes more than other characters. In the upper right panel females are separated into those sexed by presence of reproductive characteristics (R), observation (O), and morphometrics (M), and indicates some females classified as females based on observation actually may have been males.

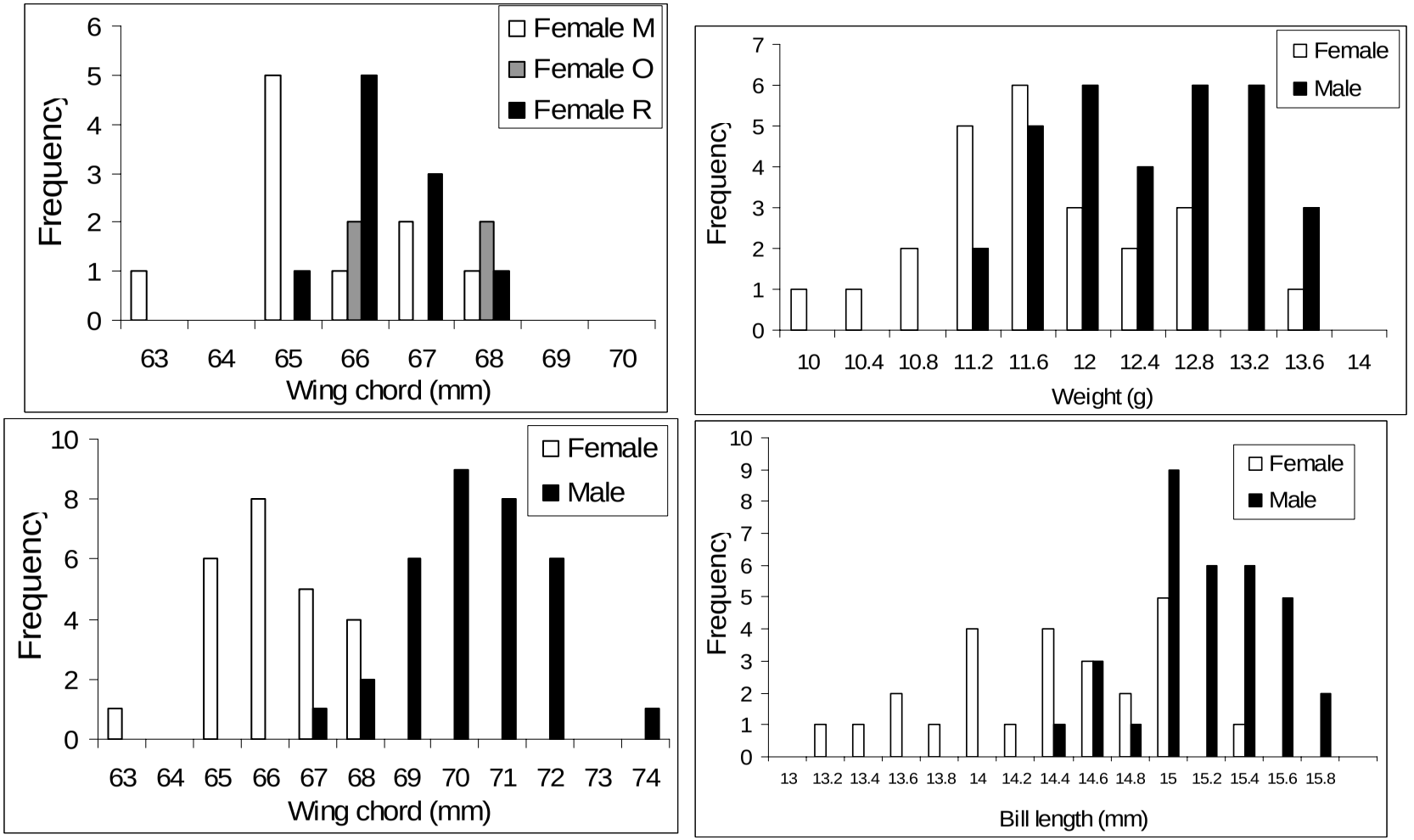


Figure 7. Sketch map of the Santa Lourdes Shrine study site showing approximate boundaries of Tinian Monarch territories, identity of birds in each territory, net locations, nest locations, and various landmarks such as caves and distinctive trees that can be used as reference points. The map is not to scale and sizes of territories in this sketch should not be used for analysis.

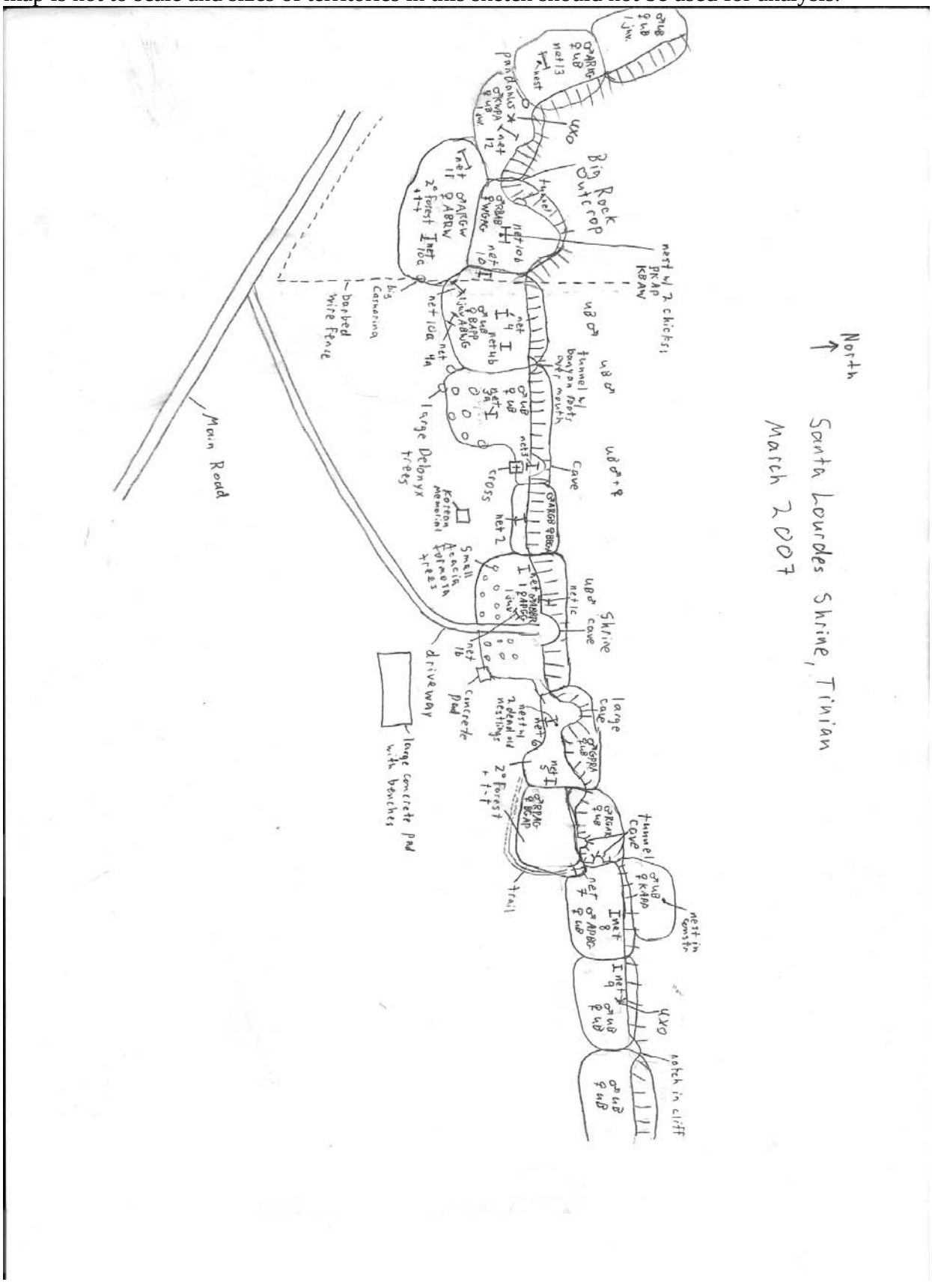


Figure 8. Sketch map of the Airport Mitigation study site showing approximate boundaries of Tinian Monarch territories, identity of birds in each territory, net locations, nest locations, and various landmarks such as caves and distinctive trees that can be used as reference points. The map is not to scale and sizes of territories in this sketch should not be used for analysis.