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Forest Bird and Fruit Bat Populations on Sarigan, Mariana Islands

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Abstract—We conducted the first quantitative surveys of forest bird and bat populations on the uninhabited island of Sarigan, Commonwealth of the Northern Mariana Islands. Severe habitat degradation has occurred on Sarigan because of overgrazing by introduced goats and pigs. Planting of coconut palms (*Cocos nucifera*) for copra production has also eliminated much of the island's native forest. We recorded five species of forest birds on Sarigan: Micronesian Honeyeater (*Myzomela rubratra*), Micronesian Megapode (*Megapodius laperouse laperouse*), Micronesian Starling (*Aplonis opaca*), Collared Kingfisher (*Halcyon chloris*), and White-throated Ground Dove (*Gallicolumba xanthonura*). Estimated population sizes (95% confidence interval) in 1997 were 1,821 (1,617–2,026) for Micronesian Honeyeater, 677 (545–810) for Micronesian Megapode, 497 (319–675) for Micronesian Starling, 107 (82–131) for Collared Kingfisher, and 170 (101–238) for Mariana Fruit Bat (*Pteropus mariannus*).

Introduction

The remote, uninhabited tropical Pacific island of Sarigan, Commonwealth of the Northern Mariana Islands (CNMI, Fig. 1), has received only cursory ornithological investigation, and no quantitative study. Checklists of birds based on short reconnaissance trips by CNMI Division of Fish and Wildlife personnel (Reichel & Glass 1991, Stinson 1994), and several unpublished reports in the files

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of the CNMI Division of Fish and Wildlife, provide the only information of forest birds from Sarigan. The islands of Sarigan, Asuncion, Maug, and Uracus were declared wildlife sanctuaries in the early 1980s by the CNMI constitution. After an evaluation by the CNMI Division of Fish and Wildlife, however, the constitution was amended and Guguan was substituted for Sarigan (USFWS 1997). Overbrowsing by feral goats (*Capra hircus*) and foraging by feral pigs (*Sus scrofa*) has severely degraded the forest understory on Sarigan. A proposal is now being considered to remove feral ungulates from Sarigan, and to manage the island for conservation of indigenous species. Estimates of bird populations provided by our study will provide a baseline for future comparisons should plans to remove ungulates from Sarigan proceed.

Study Area and Methods

One of the high islands of Micronesia, Sarigan is an inactive volcano with a highly eroded central zone. The 4.6-km^2 island rises steeply from sea level to a plateau at 330–350 m elevation. An apparent volcanic plug rises from the plateau

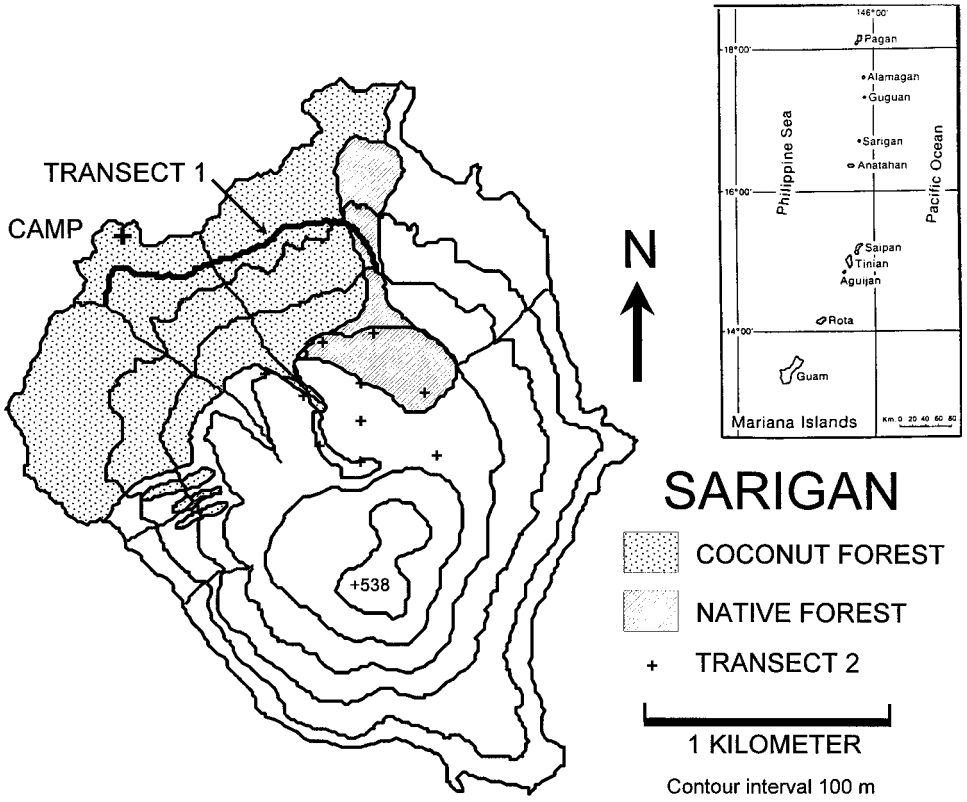

Figure 1. Location of coconut and native forests, and bird survey transects, on Sarigan, Mariana Islands.

to 538 m. The steep eastern and southern slopes are precipitous and sparsely vegetated with grasses and ferns, whereas the western and northern slopes are more gentle and support native and introduced forest (Fig. 1).

Sarigan was used as a penal colony during the German administration, and by the end of 1904 when prisoners were moved to Saipan, 17,200 coconut palms (*Cocos nucifera*) had been planted for copra production (Farrell 1991). Coconut forest now covers 133.4 ha on Sarigan, and comprises 82% of the forested area. The understory within coconut forest has been severely damaged by goats and pigs, and little palatable vegetation can be found within 1.5 m of the forest floor. The native tree *Hibiscus tiliaceus* is common in ravines. Other native species found scattered throughout the coconut forest include *Aglaia mariannensis, Ficus tinctoria, Erythrina variegata, Pandanus* spp., and *Barringtonia asiatica*.

Native forest dominated by *Pisonia grandis* occurs primarily on an extremely rough former lava flow with 1 to 3 m basalt blocks along the north ridge of the island. Other tree species in native forest are *Aglaia mariannensis, Hibiscus tiliaceus, Ochrosia mariannensis, Erythrina variegata, Pandanus* spp., and *Barringtonia asiatica*. The understory consists primarily of ferns. Small copses of native forest also occur on the plateau around the edges of former cultivated fields (Ohba 1994). Most of the plateau is covered by a swordgrass (*Miscanthus floridulus*) and short *Chrysopogon acicularis* grassland. Including the small copses on the plateau, native forest covers 29.1 ha, or 18% of the forested area on Sarigan.

Numerous reconnaissance hikes throughout all forested areas of Sarigan were made by RJC and two biologists during 18-22 September 1990, and by SGF, CWK, and five other biologists during 10-15 March 1997. To estimate bird densities, we used the variable circular-plot (VCP) method with 8-min counts at each survey station (Reynolds et al. 1980, Buckland et al. 1993). Comparisons of bird densities between 1990 and 1997 were made for two transects established in 1990 by RJC. Transect 1 consisted of 20 stations at approximately 100-m intervals (determined by pacing) east of camp (Fig. 1). Most stations were in coconut forest between 40 and 200 m elevation, but the last three were in native forest on the north ridge. Counts in 1990 were conducted on 19 September and repeated the next day. Transect 2 consisted of 10 stations spaced at ca. 100-m intervals in forest copses on the plateau (Fig. 1), and was surveyed on 21 September 1990 and 13 March 1997.

In 1997, we conducted 8-min counts in addition to those along Transects 1 and 2 throughout coconut and native forests of the island. Observers walked U-shaped transects along elevation contours, with transects starting and ending along the ridge upslope from base camp, and conducted counts approximately 100 m apart (as determined by pacing) along transects. The southern tip of the island was explored on 20 September 1990 to search for incubation mounds of the Micronesian Megapode (*Megapodius laperouse*), but this area and the steep, unforested southern and eastern slopes of Sarigan were not surveyed in 1997 because it is unlikely that many forest birds occur there.

Survey data were analyzed using the program DISTANCE (Buckland et al. 1993) and the approach described by Fancy (1997). Detection distances from VCP counts in 1990 and 1997 were pooled for the purpose of estimating effective area surveyed for each species (Fancy 1997). For Micronesian Honeyeaters, we found that different observers and forest type (coconut or native) significantly affected detection distances, and we used observer and forest type as covariates as described by Fancy (1997). For Micronesian Megapodes, we found no differences in detection distances among observers, but detection distances in coconut forest was about twice that in native forest, and we included forest type as a covariate. No adjustments for observer or forest type were made for other species because they did not significantly affect detection distances or because of inadequate sample size (Buckland et al. 1993).

Results

We recorded five species of forest birds on Sarigan: Micronesian Honeyeater (*Myzomela rubratra*), Micronesian Megapode, Micronesian Starling (*Aplonis opaca*), Collared Kingfisher (*Halcyon chloris*), and White-throated Ground Dove (*Gallicolumba xanthonura*). White Terns (*Gygis alba*) and Pacific Golden-Plovers (*Pluvialis dominica*) were also observed in forest, but are not discussed here because they are not true forest species. The most common species on Sarigan was the Micronesian Honeyeater, with an estimated population of 1,821 (95% confidence interval, 1,617–2,026) birds on Sarigan. We observed honeyeaters foraging on coconut flowers and in all of the common tree species on Sarigan, and they were particularly abundant near flowering *Erythrina* trees on the plateau.

Table 1. Comparison of bird densities (birds/ha) between 1990 and 1997 on two transects on Sarigan, Mariana Islands.

Species	Transect	Year	Stations sampled	Number Detected	Density Mean	Density SE	t-test[a] t	t-test[a] P
Micronesian Honeyeater	1	1990	40	139	29.28	2.06	7.41	0.0001
		1997	13	49	10.35	1.52		
	2	1990	10	3	4.29	2.18	3.99	0.0005
		1997	18	69	23.19	4.21		
Micronesian Megapode	1	1990	40	45	3.45	0.61	0.12	0.90
		1997	13	16	3.61	1.18		
	2	1990	10	13	7.05	1.16	0.52	0.61
		1997	18	20	6.02	1.31		
Micronesian Starling	1	1990	40	20	3.01	0.75	4.03	0.0002
		1997	13	0	0.00	0.00		
	2	1990	10	11	6.62	2.09	0.87	0.39
		1997	18	30	10.03	2.66		
Collared Kingfisher	1	1990	40	33	0.56	0.10	1.11	0.27
		1997	13	15	0.78	0.19		
	2	1990	10	3	0.20	0.10	0.09	0.93
		1997	18	5	0.19	0.11		

[a] t-test for differences between years for each transect.

Table 2. Density (birds/ha) of forest birds and fruit bats in coconut and native forest on Sarigan, Mariana Islands, March 1997.

Species	Forest type	Stations sampled	Number Detected	% stations Occupied	No./station Mean	No./station SE	Density Mean	Density SE
Micronesian Honeyeater	Coconut forest	86	286	91.9	3.326	0.207	10.33	0.703
	Native forest	50	183	92.0	3.660	0.352	15.24	1.402
Micronesian Megapode	Coconut forest	86	120	61.6	1.395	0.165	3.885	0.461
	Native forest	50	49	56.0	0.980	0.150	5.468	0.855
Micronesian Starling	Coconut forest	86	19	12.8	0.221	0.073	1.675	0.547
	Native forest	50	62	48.0	1.240	0.230	9.392	1.755
Collared Kingfisher	Coconut forest	86	68	52.3	0.791	0.101	0.679	0.087
	Native forest	50	32	34.0	0.640	0.153	0.550	0.133
White-throated Ground Dove	Coconut forest	86	1	1.2	0.012	0.012		
	Native forest	50	0	0	0.0	0.0		
Mariana Fruit Bat	Coconut forest	86	14	10.5	0.163	0.059	0.591	0.218
	Native forest	50	43	46.0	0.860	0.167	3.120	0.616

Density in native forest was 48% higher than that in coconut forest ($t = 3.07$, $P = 0.003$). Comparisons between 1990 and 1997 for Transects 1 and 2 indicated a shift of birds from coconut forest to native forest on the plateau: density in 1997 on Transect 2 was 5.4 times higher than in 1990 ($t = 3.99$, $P = 0.0005$), but the 1997 mean density for Transect 1 was only 35% of that in 1990 (Table 1) ($t = 7.41$, $P = 0.0001$). This may be a seasonal shift, as honeyeaters were attracted to the many flowing *Erythrina* trees in the mixed forest in March 1997, whereas RJC observed them foraging primarily on coconut palm flowers in 1990.

The Micronesian Megapode was common in both forest types (Table 2), with an estimated total population of 677 (545–810 95% CI). The effective area surveyed around each station in native forest was half as large as that in coconut forest, but megapode density was similar between the two forest types ($t = 1.62$, $t = 0.11$). Megapodes seemed to be more common in dense patches of *Hibiscus* and near the base of small cliffs along ravines. Most foraging was on the ground, but we also observed megapodes foraging along the branches of *Hibiscus* trees. We observed several breeding chases and one copulation during March 1997 surveys. We found no difference in density of megapodes between 1990 and 1997 on either transect (Table 1).

Mean density of Micronesian Starlings in native forest was 5.6 times higher than that in coconut forest (Table 2; $t = 4.23$, $P = 0.0001$). Total population size on Sarigan is estimated at 497 (319–675) starlings. We found a higher density of starlings on Transect 1 in 1990 than in 1997 (Table 1), possibly because of greater abundance of coconut palm flowers during the 1990 surveys.

Collared Kingfishers were observed in all forest types, and had similar densities in coconut and native forest ($t = 0.85$, $P = 0.39$). Total population size for the island is estimated at 107 (82–131) kingfishers. No differences in density between 1990 and 1997 were found on either transect (Table 1).

We detected only one White-throated Ground Dove in 1990 and one in 1997 during VCP counts, but the species is difficult to census because it is secretive and

rarely vocalizes. During five days of reconnaissance surveys in 1990, RJC recorded five White-throated Ground Doves and three doves were heard during the 1997 trip. We were unable to estimate population size for this species because of the small sample size and its secretive habits.

Mariana fruit bats (*Pteropus mariannus*) were not quantified during VCP counts in 1990, but we detected 55 bats during counts in 1997. Density of bats was 5.3 times higher in native forest than in coconut forest ($t = 3.94$, $P = 0.0002$), and total population size was estimated to be 170 (101–238) bats. One group of 15 bats hanging from a *Terminalia catalpa* tree and observed from <10 m away were all males. Several groups of bats were observed foraging on *Erythrina* flowers on the plateau. We often observed bats foraging or roosting in coconut trees near our camp after sunset.

Discussion

The five species of forest birds on Sarigan are found on most of the islands of the Mariana archipelago, and except for the widespread kingfisher, all are endemic to the Mariana Islands or Micronesia. The only species of forest bird known from any of the Mariana Islands north of Saipan but not found on Sarigan is the Nightingale Reed-warbler (*Acrocephalus luscinia*), which occurs on Alamagan and formerly on Pagan (Reichel & Glass 1991). No paleontology studies have been conducted on Sarigan to determine whether the Nightingale Reed-warbler or other bird species ever occurred there (cf. Steadman, 1999).

Densities of the Micronesian Honeyeater and Collared Kingfisher on Sarigan were much higher than those reported by Engbring et al. (1986) for the Mariana Islands of Saipan, Tinian, Rota, and Agiguan, even after bird densities on the four southern islands were adjusted by excluding open fields. Mean density of Micronesian Honeyeater in forested areas on Sarigan was 11.2 birds/ha, compared to densities (birds/ha) of 1.6 on Tinian, 2.4 on Saipan, 4.9 on Rota, and 7.3 on Agiguan (Engbring et al. 1986). Engbring et al. (1986) found Micronesian Honeyeaters to be much more abundant in native forest and diverse secondary vegetation than in the homogenous stands of tangantangan (*Leucaena leucocephala*) that cover much of Saipan and Tinian. However, Craig (1996) reported lower numbers of Micronesian Honeyeaters in native limestone forest on Saipan than in disturbed sites. Nectar is the principal food of the Micronesian Honeyeater, and we found the highest density in native forest on the plateau where numerous *Erythryna* trees were flowering.

The density of Collared Kingfishers on Sarigan was 3.0-5.1 times higher than that for vegetated areas on Tinian, Saipan, Rota, and Agiguan (Engbring et al. 1986). The taxonomic status of kingfishers in the Marianas is in a state of confusion (Pratt et al. 1987), and it is not clear which subspecies of Collared Kingfisher occurs on Sarigan.

We found Micronesian Megapodes throughout all of the forested areas on Sarigan, and our population estimate of 677 is higher than previous estimates

from short reconnaissance surveys (USFWS 1997). Megapodes were often observed in pairs, and although there are no differences in plumage between the sexes, in many cases the slightly larger bird of the pair seemed to have bright yellow legs compared to the duller yellow legs of the smaller bird. We observed only two birds that we were certain were juveniles because of their much smaller size. Megapodes spent most of the time scratching the ground and in leaf litter, but we observed several birds foraging along the branches of *Hibiscus* trees 1–4 m above the ground. We frequently found piles of feces below trees where megapodes were observed roosting, and it seems that some individuals return to the same roosting locations.

Micronesian Megapodes use all four of the incubation strategies described by Dekker (1990): burrow nesting in cinder fields, burrow nesting at geothermal sites, building a mound of soil and vegetative matter, and nesting within a burrow between the roots of trees (USFWS 1997). We spent much of our time on Sarigan searching for megapode nesting locations, but none were found. We doubt that megapodes on Sarigan build large incubation mounds because we never found any despite searching all of the forested areas at least once, and eggs laid in mounds would probably be predated by the many monitor lizards (*Varanus indicus*) and feral pigs on the island. We also investigated numerous burrows, cinder fields, and caves and cracks in rock cliffs, but no evidence of megapode nesting was found.

Our estimate of 170 fruit bats on Sarigan is similar to the 125–155 estimate reported by Wiles et al. (1989), despite different counting methods. Wiles et al. (1989) based their estimate on the amount of bat habitat available on Sarigan and counts of foraging and roosting bats made during four days on the island in 1983. Our estimate is based on a more rigorous method, but may be biased because several characteristics of fruit bats violate assumptions of the VCP method (Buckland et al. 1993). VCP counts are rarely used to census fruit bats because (1) bats often occur in groups; (2) may be inactive and difficult to detect during daytime surveys; (3) have a tendency to circle an area and possible be counted more than once at a counting station; and (4) may react to the observer, particularly on islands with high hunting pressure.

Removal of feral ungulates, feral cats (*Felis catus*), and rats (*Rattus* spp.) from Sarigan is likely to benefit most species of forest birds, particularly those associated with native vegetation, and the Mariana Fruit Bat. Goats and pigs have removed virtually all of the understory vegetation on the island except for some ferns and a few unpalatable plants, and we observed goats foraging in trees >2 m above the ground. The species that would probably respond most quickly to recovery of the understory vegetation would be the endangered Micronesian Megapode because of an expected increase in ground moisture and the number of invertebrates, fruits, and seeds available on the forest floor. However, all species would benefit from recovery of the native forest on Sarigan, and the island could become an important refugia for endemic birds as the southern islands come under increasing pressure from development.

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References

Buckland, S. T., D. R. Anderson, K. P. Burnham & J. L. Laake. 1993. Distance Sampling: Estimating Abundance of Biological Populations. Chapman and Hall, New York.

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

Dekker, R. W. R. J. 1990. Conservation and biology of megapodes (Megapodiidae, Galliformes, Aves). Ph.D. Diss., Univ. of Amsterdam, The Netherlands.

Engbring, J., F. L. Ramsey & V. J. Wildman. 1986. Micronesian forest bird survey, 1982: Saipan, Tinian, Agiguan, and Rota. U.S. Fish and Wildlife Service, Honolulu, Hawaii.

Fancy, S. G. 1997. A new approach for analyzing bird densities from variable circular-plot counts. Pacific Science 51: 107–114.

Farrell, D. A. 1991. History of the Northern Mariana Islands. Public School System, Commonwealth of the Northern Mariana Islands.

Ohba, T. 1994. Flora and vegetation of the Northern Mariana Islands, Micronesia. Natural History Research, Special Issue, No. 1: 13–69.

Reichel, J. D. & P. O. Glass. 1991. Checklist of the birds of the Mariana Islands. 'Elepaio 51: 3–11.

Reynolds, R. T., J. M. Scott & R. A. Nussbaum. 1980. A variable circular-plot method for estimating bird numbers. Condor 82: 309–313.

Steadman, D. W. 1999. The prehistory of vertebrates, especially birds on Tinian, Aguiguan, and Rota, Northern Mariana Islands. Micronesica 31: 319–345.

Stinson, D. W. 1994. Birds and mammals recorded from the Mariana Islands. Natural History Research, Special Issue, No. 1: 333–344.

USFWS. 1997. Technical/Agency draft recovery plan for the Micronesian Megapode (*Megapodius laperouse laperouse*). U.S. Fish and Wildlife Service, Portland, Oregon. 73 pp.

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

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