Bird Populations at Eniwetok Atoll

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Bird observations made incidental to rodent ecology studies at Eniwetok Atoll, Marshall Islands, 1964 to 1967, are reported here. Eniwetok Atoll lies 11° north of the equator in the western Pacific, is isolated from any major overseas flyway and has a typical low island fauna of seabirds. The atoll, a chain of 40 islets surrounding an oval lagoon 20 miles wide and 25 miles long, with a total land area of 2.26 square miles (Fig. 1), is a haven for oceanic wanderers and lagoon and reef birds, as well as a stop-over point for some transoceanic migrants.

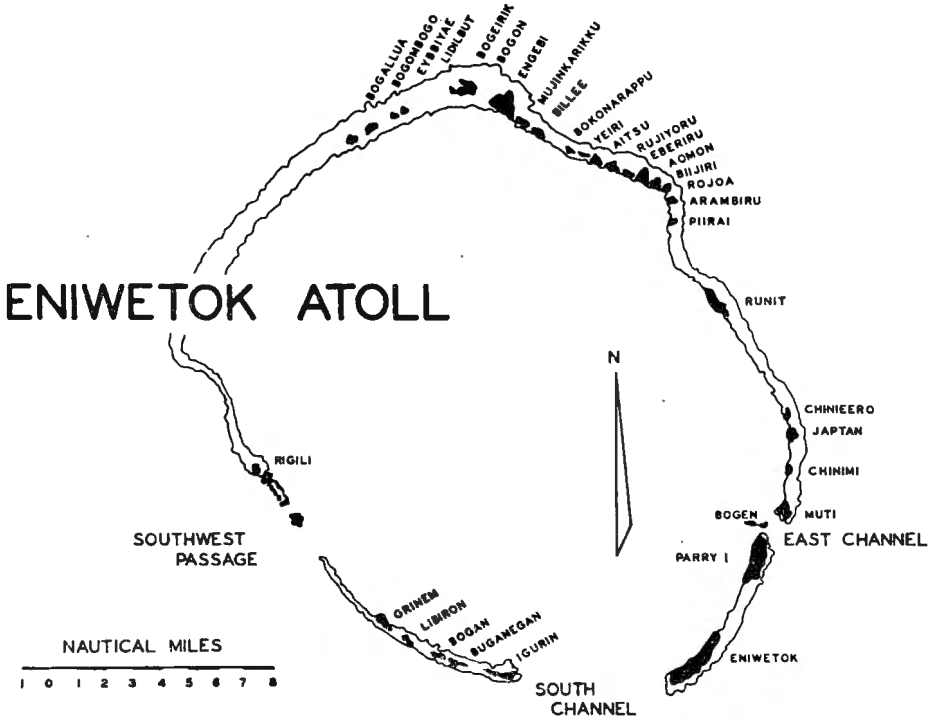

Fig. 1. Eniwetok Atoll with names of islets corrected to agree with U.S. Naval Oceanograhic Chart 6033 (1966).

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Observations made during August, 1964, by one of us (W.B.J.) as part of the University of Washington Radiobiology Resurvey Expedition to the Pacific, were limited because of the short time at any one islet. During June and July, 1965, all of us were at Eniwetok and made frequent observations on many of the islets. From July into early September, 1966, and June into early July, 1967, Jackson and Carpenter continued and expanded observations to include all of the islets of the atoll.

Much of our time was spent on uninhabited islets of the atoll, living there for two- or three-day periods. We were able to draw composite pictures of the populations of individual islets and daily behavior of several species. With the exception of four small islets (Sam, Tom, Yeiri, Percy), we have made ground surveys on all the islets of the atoll. During 1966 and 1967 helicopter surveys of the avian atoll population were attempted as well.

Vegetative cover on islets varies considerably. Those least disturbed by atomic test operations (e.g., Igurin) have a dense cover of coconuts (*Cocos nucifera*), *Pisonia grandis*, and a variety of shrubs. In contrast, islets in the northeastern quadrant suffered heavy damage, but regrowth by typical strand vegetation (chiefly *Tournefortia* (=*Messerschmidia*) *argentea* and *Scaevola taccada*) has occurred generally. St. John (1960), Hines (1962), and Palumbo (1962) give greater details of islet vegetation.

During the more than seven months' actual residence over four years, we noted 17 species from four orders. In comparing our data with those of other observers of the atoll, notably Woodbury (whose University of Utah crew made observations from February to May, 1962), some significant differences in extent of observations and population estimates were noted. The clarification and consideration of these differences, therefore, becomes as important as reporting our observations.

Scientific names used herein follow Baker (1951). All specimens were deposited in the Bowling Green State University Biology Museum. During 1965–1967 about 2100 terns were banded in cooperation with the Smithsonian Institution, Pacific Ocean Biological Survey Program. Islet names used throughout the paper were taken from U.S. Naval Oceanographic Chart 6033 (revised January, 1966).

Procellariiformes. During 1964, 1965, and 1967 we noted no members of this order at any time either on or over the lagoon or seaward side of the atoll. In 1966 we collected, at separate times and locations, two Wedge-tailed Shearwater (*Puffinus pacificus*) (MLC 289, 5 August 1966; MLC 290, 26 August 1966). Both animals were of the light phase and alone when collected. Woodbury (1962) notes that several thousand individuals of this species were seen on two occasions by his crew at the north end of the atoll in April. Members of this order evidently pass the atoll on migration routes during the spring or in their wandering but are not resident.

Pelecaniformes. In 1966 we found nesting Red-tailed Tropicbirds (*Phaethon rubricauda*) on eggs (Fig. 2) at three sites in the atoll (August 1–14); about 12 individuals were seen in all. In 1967 a nearly fledged young was seen on July 3. This is in contrast to similar periods in 1964 and 1965 when this species was never seen by us and to 1962 when the University of Utah crew noted some 32

Fig. 2. Incubating Red-tailed Tropicbird on Mujinkarikku Islet. Note single egg under right side of bird.

individuals at different times and points around the atoll.

In 1964 six adult White-tailed Tropicbirds (*P. lepturus*) were noted over Igurin Islet. One was collected (MLC 195, 27 July 1965), but no nests of this species were seen. This specimen appears to be the first collected from the Marshall Islands. In 1967 four adults were seen over Grinem Islet on July 8.

The Brown Booby (*Sula leucogaster*) was sighted on can buoys around the atoll on several occasions in all four years; and during the helicopter survey in 1966, six birds were flushed from Libiron Islet. However, evening observations on the seaward edge of the atoll on several occasions failed to demonstrate the flock's return to night roosts. The Red-footed Booby (*Sula sula*) was sighted in 1967, and one young bird was collected (BGSU 3506, 3 July 1967).

Our observations differ markedly from the previous sightings of large booby flocks at Eniwetok. The large flocks (300 birds) seen in 1962 on Libiron Islet were not seen by us prior to 1967, nor were they seen in 1959 by Richardson (MS) or in the spring of 1965 by Pearson and Knudsen (1967). In addition, the 300 boobys sighted by Woodbury in 1962 were recorded as *S. leucogaster*, with no *S. sula* indicated. This, too, differs from our observations as will be shown below.

Frigatebirds (*Fregata minor*) were sighted singly and in pairs at several points on the atoll to the north and west. One male bird (BGSU 3505, 3 July 1967) was collected. Six birds (4♀♀) soared in view for an hour on July 27, 1965, moving from north to south past our camp on the lagoon beach at Igurin Islet. On the helicopter survey in 1966, eight birds were flushed from Grinem Islet.

Prior to 1967 nothing was seen by us of the flock of 300 to 500 birds (largely subadults) reported by Woodbury (1962); however, Pearson and Knudsen (1967) noted 250 birds (80 percent adults) on Libiron Islet in May, 1965. No nests were found by any of us.

In 1967 overnight observations were made by us of a flock of more than 500 boobys and 200 frigatebirds on Libiron Islet. Approximately 80 percent of the boobys were *Sula sula*; the other 20 percent, *S. leucogaster*. The following are observations from field notes: "During the afternoon of July 2 the number of frigatebirds over the islet increased from 40 to nearly 100 and then diminished to zero. The frigatebirds (200 or more) finally returned with the booby flock from the seaward (west of the atoll). There were several instances of diving attacks by frigatebirds on boobys but no boobys were seen to disgorge food.... The boobys headed straight into their roost in the islet trees. Night observations showed that most boobys were roosting in the dense *Scaevola* scrub on the periphery of the islet. The frigatebirds continued circling the islet until nightfall. Night observations found most frigates roosting in the central *Pisonia*, *Cordia*, *Cocos* forest area...."

The reason for the lack of frigate or booby flock sightings by our group in previous years is not fully known. That the birds utilized only Libiron Islet as a roost site is probable. Their approach from the seaward side of the atoll might not readily be seen from even the nearby islets of Bogan and Grinem. However, why we had not seen some portion of the flock in previous years remains in question, for in 1967 there were 20 or more frigatebirds and several boobys on the roost islet throughout the day.

Ciconiiformes. Reef Herons (*Egretta sacra*) in three color phases were noted by us on and about nearly every islet. Of the 57 herons observed for plumage pattern in 1966, 48 percent were white; 28 percent, black; 24 percent, mottled. No distinction was made among the several forms of mottling. In 1967 about 60 percent were white; 10 percent, mottled. These ratios compare favorably with those cited by Fosberg (1966) for the northern Marshall Islands and contrast markedly with the Pearson and Knudsen (1967) 20:30:50 ratio. This may be explained by the molting of young birds into adult plumage.

We found a nest and nestling in an abandoned photographic bunker on Runit Islet, 1965, and were able to follow its development. The bird had apparently hatched shortly before our visit on June 13 and could not stand in the nest. On our return on July 1, the bird was able to walk outside the nest. By our final visit, July 29, the young bird had joined its parents on the reef. The conclusion of Woodbury that the herons nest singly is substantiated by this and additional observations of abandoned nests. In 1967 active nests were found on five islets; all contained three eggs and/or young (Fig. 3). During June all stages from eggs to fledgling young were found. The Reef Herons were never observed to feed or roost in *Cocos*, and only infrequently were they seen inland on the islets. The preferred feeding location was the reef and abandoned landing craft.

Charadriiformes. (Charadriidae, Scolopacidae). The following shore birds were seen: Pacific Golden Plover (*Pluvialis dominica*) (MLC 194, 16 July 1965; MLC 197, 28 July 1965; and BGSU 3501, 15 June 1967), Turnstone (*Arenaria interpres*), Wandering Tattler (*Heteroscelus incanum*), Bristle-thighed Curlew (*Numenius*

Fig. 3. Reef Heron nest with three nearly fledged young in deserted instrument bunker on Runit Islet.

tahitiensis), Bar-tailed Godwit (*Limosa lapponica*). Plovers and turnstones were apparent on every islet in varying numbers, often in flocks of 30 or more; tattlers were present also, though not always apparent. All tattlers which were closely observed were *H. incanum*; one was collected (BGSU 3503, 27 June 1967). This does not preclude the possibility that *H. brevipes* may occur at Eniwetok, as suggested by Jane Church, Pacific Ocean Biological Survey (personal communication) and Pearson and Knudsen (1967), though it was never identified by us. The larger islets not frequented by man had curlew populations. Only one godwit was seen, in 1965.

It would be possible for shorebirds using the Japan-Marianas or Nearctic-Hawaiian Flyways to land on Eniwetok, but only the above species are found throughout the year. These birds may represent non-breeding groups, though this has been questioned by Medway (personal communication); and some plovers and turnstones were in alternate plumage and had enlarged gonads during our observations. The size of these aggregations showed relatively little variation during the successive annual observation periods.

An apparently little known instance of curlew feeding behavior was recorded in Igurin Islet where on two occasions we saw a curlew grasp a snail (*Nerita* sp.) with the tip of the beak, raise the head, swing the bill laterally and then across the back, and finally hurl the snail downward against the rocks. This process was repeated several times untill the bird was able to remove the snail from the broken shell, and several snails were treated in this manner while we watched. Although curlews were seen on a number of islets, the behavior was noted in feeding birds only on the Igurin reef. Marshall (1951) in his report on Arno Atoll briefly describes similar behavior involving crabs. Recently a similar

motion pattern by Egyptian vultures in throwing stones at eggs has been described by van Lawick-Goodall (1966).

Charadriiformes (Laridae). The Common Noddy (*Anous stolidus*) (BGSU 3502, 25 June 1967), White-capped Noddy (*Anous tenuirostris*) (BGSU 3504, 3 July 1967), White Tern (*Gygis alba*), Black-naped Tern (*Sterna sumatrana*) (MLC 193, 16 July 1965 and 288, 16 July 1966), Sooty Tern (*Sterna fuscata*) (MLC 196, 28 July 1965; 286, 31 July 1966; and 287, 31 July 1966), and Crested Tern (*Thalasseus bergii*) were observed.

Woodbury's observations indicated that several colonies each of 4,000 Common Noddys and one of 14,000 Sooty Terns were existent on the atoll islets in 1962. Richardson (MS) also had noted the breeding colony of Sooty Terns on Aitsu Islet in February 1959. During our studies in 1964 and 1965 no colonies of this size were noted. Likewise Bushman (personal communication) in March 1965 and Pearson and Knudsen (1967) in early 1965 noted no large colonies. Similarly at nearby Bikini Atoll, August 1964, no sootys were seen by Jackson. A search for the sooty colony on Aitsu Islet in 1965 revealed only four birds and no active nests. Since in 1962 (March-May) the population of sootys on this islet never dropped below 10,000 birds (Woodbury), we concluded that sootys no longer used the atoll as a major nesting site.

However, in 1966 we found a nesting colony in July and August on Rujiyoru Islet that we estimated to be in excess of 16,000 birds. We, therefore, are forced to revise our conclusions on the Eniwetok sooty colony. A marked vegetation recovery had taken place on Aitsu Islet (not Rojoa as incorrectly reported by Pearson and Knudsen, 1967), apparently making it unsuitable for sooty nesting, and forcing the shift to an adjacent, still grassy islet.

In 1967 the colony was on Lidilbut Islet, over ten miles northwest of the 1966 site. The colony had been established on Lidilbut Islet by the time of our arrival, June 10, and increased in size during our stay; and from our banding activities the colony was estimated at 16,000 breeding individuals.

The sootys apparently vary in some way from an annual breeding regime. The 1959 and 1962 colonies were breeding in the March to May period; the 1966 colony was breeding in the July to September period; in 1967, in June and July. These data are similar to those of the Smithsonian Institution for other areas of the Pacific where breeding seasons seem extremely variable (Charles Ely, personal communication). In other parts of the world breeding occurs at six-, nine-, and twelve-month intervals (Ashmole, 1965). A satisfactory reason for the apparent variation on Eniwetok does not seem to exist, though food supply, precipitation, or even vegetational appearance may be factors. Far more observations are necessary for the understanding of breeding in Pacific Sooty Tern populations.

Several interesting behavioral aspects of the sooty breeding colony were noted. In 1966 upon approaching the islet on which the colony was located, we noted a large number of immature birds in the air over the islet and out to several hundred meters over the lagoon. This is notable because immature birds made no appearance elsewhere in the atoll. While adults were seen in groups of twenty or more passing over nearly every other islet on their way to or from the ocean, immatures were not seen at a distance greater than 0.5 mile from the colony. It should be noted that in previous years no more than 50 adult sootys

Fig. 4. Incubating Sooty Tern on Rujiyoru Islet. Note close proximity of other nest sites with single eggs.

had been seen during our entire stay; in 1966 and 1967 it was unusual to see less than that number every day. In contrast to Woodbury's observation that there was "overflow" of adult birds to neighboring islets in their daily feeding patterns, we did not see birds on any islet other than Rujiyoru in 1966 or Lidilbut in 1967; we observed very little feeding activity in the vicinity of the atoll.

In general our observations on behavior of adults on the nest and of nestlings were similar to those of Woodbury. In 1966 the colony area was bordered by large *Scaevola* clumps but included only small bushes within its borders. We saw a large difference in the age of nests within the colony. One group of terns had eggs which were just hatching or in the late stages of development; another segment of the colony had eggs which had been recently laid or were in the very early stages of incubation (Fig. 4). There was probably a difference of two weeks or more in time of laying in these two parts of the colony. In addition, many young would soon have been flying or had just taken to the air. We also noted that the actual nesting colony was restricted to areas of living and flourishing grass (*Lepturus*); areas of brown grass were sharply avoided.

The shape of the 1967 colony was triangular, with the earliest nesters to the back center of the area and later nesters spreading onto the upper beach and crest of a sand spit. Clumps of *Tournefortia*, (2–4 m in height) separated segments of the breeding colony (Fig. 5). Few nests were under these bushes, but the young congregated there. The size of the colony on July 5 was approximately 90 by 94 by 118 meters.

Correlation with open areas does not seem a valid reason for the site of colony location, since large, treeless, grassy areas existed on Rujiyoru, Aitsu, and adjacent islets which were similar to those utilized on Lidilbut. Further, the colony in 1967 utilized a beach crest and sand spit area when open inland areas

Fig. 5. Sooty Tern nesting ground at Lidilbut Islet.

were available; in 1966 the colony was isolated from beach areas by a relatively heavy strand of scrub vegetation over 30 meters wide. We have no ready explanation for this yearly shift in nesting area. The possibility that there are two populations of Sooty Terns which nest in alternate periods is partly invalidated, since several banded birds from 1966 were noted in the 1967 colony. From our knowledge this is the only known population with such wide shifts in colony area and breeding season. The need for further study and recovery of banded individuals from the Eniwetok population seems more pressing in light of this new observation.

Woodbury's estimate for the atoll of 12,000 to 15,000 Common Noddys and 8,000 White-capped Noddys is high when compared to the 4,600 Common and 3,400 White-capped Noddys estimated by us in 1966. Further reductions occurred in 1967 generally. For example, at Chinimi Islet only 50 *Anous stolidus* were recorded as opposed to 300 to 400 on this small islet in previous years. Nesting birds on Engebi and Aomon also were notably absent; in areas where previously 400 to 500 *Anous* were noted, less than 200 were seen this year. The reason for this apparent decline in size of population is unexplained. Vegetational recovery (following complete or partial destruction by testing of atomic devices) seems not to be detrimental to the noddys, since the densest populations occur on the most heavily vegetated islets.

We noted that each colony of Noddy Terns had birds in all stages of growth from egg to fledgling. There seemed to be no set nesting season for noddys nor a stereotyped nesting pattern. *Anous stolidus* nested on bare sand beaches, in scrub vegetation (*Pemphis*, *Tournefortia*, *Scaevola*, *Pisonia*, *Cordia*), on the ground in the center of islets (usually near the bases of trees or in connection with patches of *Triumfetta*), and in coconut palms. The diversity of nest material and

Fig. 6. Ground nest of Common Noddy Tern on Igurin Islet with nestling. Note the mollusk shells and coral fragments incorporated into nest.

Fig. 7. Nest of White-capped Noddy Tern in *Tournefortia* on Engebi Islet.

location of some ground nests is documented by detailed observations from several islets (Table 2) (Fig. 6). While coral and shell fragments were most commonly observed in ground nests, they also occurred in tree nests 1–4 m high. *A. tenuirostris* nests were built only in trees, most commonly in large *Tournefortia* trees, and had a deeper cup and greater proportion of leaf material than those of *A. stolidus* (Fig. 7); they lacked the coral and shell fragments also characteristic of nests of the latter species.

Black-naped Terns were noted on posts and coral projections near several islets. Nesting colonies were found on Engebi, Runit, Igurin, and Bogombogo. The population was estimated as not greater than 300 birds in 1966.

A previously unnoticed colony was found on Bogon Islet on the atoll's northern perimeter in 1967. Two hundred plus birds occupied the sand spit area connecting Bogon with the remnants of Bogeirik Islet in the Koa Crater area. Some 10 nests with eggs or young were seen. This is the largest aggregation of this species we saw in four years.

An unusual factor of nesting behavior was noted during nocturnal observation. The Black-naped Terns normally nest on the bare sand beach several yards from the nearest cover and close to the high tide line. During the day no young were seen on a particular stretch of beach at Igurin; at night, however, four young, each with an adult bird, were noted on this stretch of beach. Since the young were unable to fly, the young must have retreated to the shelter of the nearby *Scaevola* thicket during the day and returned to the shelter of their parents on the beach at night.

We found the White Tern on nearly all islets, as Woodbury had also (1962). They were more numerous than the White-capped Noddy, though not as numerous as the Common Noddy. We estimated their numbers at about 1,400 birds for the atoll in 1966. The largest aggregation was on Libiron Islet.

The Crested Tern is apparently only a casual visitor to Eniwetok, as the birds we saw were flying over the lagoon. No nesting sites or roost areas were noted.

That colonial terns may act as an important source of nutrients for the atoll ecosystem has been suggested by Richardson (MS.) and Fosberg (1954, 1957). In view of the large nesting tern colonies now occupying islets which suffered removal of soil and vegetation during weapons testing, the relationship between the bird colonies and plant succession may be a key to understanding the rapid recovery of the atoll communities. Although we have not yet accumulated sufficient data to quantitatively describe the successional relationships, it is clear that several vegetative communities exist on the atoll and that vegetative succession is occurring. As described in the species accounts, concentrated tern colonies occur in all basic community types. White-capped Noddys nest mainly in larger trees; Sooty Terns on grassy plains; Black-naped Terns, on the beaches; and Common Noddys and White Terns colonize several of the stages. Although some colonization of the islets is undoubtedly seasonal, the quantity of excreta produced by the piscivorous adults and young in the decade following weapons testing must be large indeed. We concur with Richardson and Fosberg that the bird colonies have had a definite accelerating effect on the primary and secondary successional changes.

In both 1966 and 1967, with the assistance of helicopters, we were able to make comprehensive surveys of the bird population over the entire atoll (Table 1). Intensive ground surveys were accomplished on all but four islets during these two years and supplemented the aerial estimates.

Table 1. Summary of Avian Populations at Eniwetok Atoll During 1966 and 1967

Species	1966	1967
Noddy Terns (*Anous spp.*)	10,360	8,255
White Terns (*Gygis alba*)	1,550	1,106
Black-naped Terns (*Sterna sumatrana*)	260	408
Sooty Terns (*Sterna fuscata*)	16,000	16,000
Crested Terns (*Thalasseus bergii*)	5	2
Reef Heron (*Egretta sacra*)	71	67
Bristle-thighed Curlew (*Numenius tahitiensis*)	50	18
Golden Plover (*Pluvialis dominica*)	183	139
Tattler (*Heteroscelus incanum*)	22	24
Turnstone (*Arenaria interpres*)	129	102
Brown Booby (*Sula leucogaster*)	5	100
Red-footed Booby (*Sula sula*)	0	400
Frigatebird (*Fregata minor*)	21	200
White-tailed Tropicbird (*Phaethon lepturus*)	6	8
Red-tailed Tropicbird (*Phaethon rubricauda*)	9	17

Table 2. Composition and location of some ground nests of the Common Noddy Tern on several islets (numbers refer to nests per catagory)

Substrata of ground cover	Aomon (1)	Bogen (2)	Igurin and Buganegan (3)	Construction material	Aomon	Bogen	Igurin and Buganegan
Triumfetta (ground vine)	25	1	1	sticks (local woody vegetation)	30	7	6
Lepturus (grass)	1	2	6	leaves (local vegetation)	17		3
Triumfetta and *Lepturus*	4	1	2	grasses	7		
				feathers	3		
Sand		3	4				
				gravel	2		
Sand and *Triumfetta*		3		coral	1	2	6
				drift wood		3	6
Sand and *Lepturus*		1					
				algae		1	7
Pemphis (shrub)			1	sponge			1
Ipomoea (morning glory)			1	mollusk shells or fragments			3
				cowry			
				Strombus			1
				Conus			1
				pelecypod		5	8
				other	4		11

1) 30 nests sampled. 2) 11 nests sampled. 3) 15 nests sampled.

The principal differences in population estimates with those of Woodbury were not in migratory species but in those resident on the atoll. The Noddy Terns, which by 1966 had decreased about 50 percent from Woodbury's 1962 census, decreased another 2,000 birds between 1966 and 1967. This is reflected by a marked decrease in nesting activity in 1967. White Terns similarly decreased.

This population decline remains unexplained at this time, especially in light of the marked vegetation recovery on most islets in the last decade which would provide increased numbers of nest sites for most species. In contrast, populations of Sooty and Black-naped Terns seem to have remained about the same.

This report, covering an aggregate of four years of observations, provides the most comprehensive ecological coverage of Eniwetok avian populations. While considerable controversy remains concerning the taxonomic status of Eniwetok's birds, very little concerted effort has been made with regard to the collection of specimens from the northern Marshalls; even recent collections by the Pacific Ocean Biological Survey Program were insufficient in this area (King, 1967). Many possibilities for expanded avian ecological studies exist, and the facilities of Eniwetok Marine Biological Laboratory could be used to great advantage in continuing the study of Pacific avifauna.

Summary

Observations of bird diversity and populations were made at Eniwetok Atoll during portions of 1964, 1965, 1966, and 1967; populations were found to differ markedly from those previously reported for the atoll. While some differences in the number of migratory or wandering birds were noted, the principal decrease was in the resident species. Vegetational recovery and growth were probably responsible for a shift in the nesting site of one tern species but did not seem to be responsible for the reduction of the other species. No adequate explanation could be discovered. The breeding cycle of Sooty Terns (*Sterna fuscata*) on Eniwetok was reviewed and found to be irregular.

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