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THE TERN COLONIES OF THE DRY TORTUGAS KEYS

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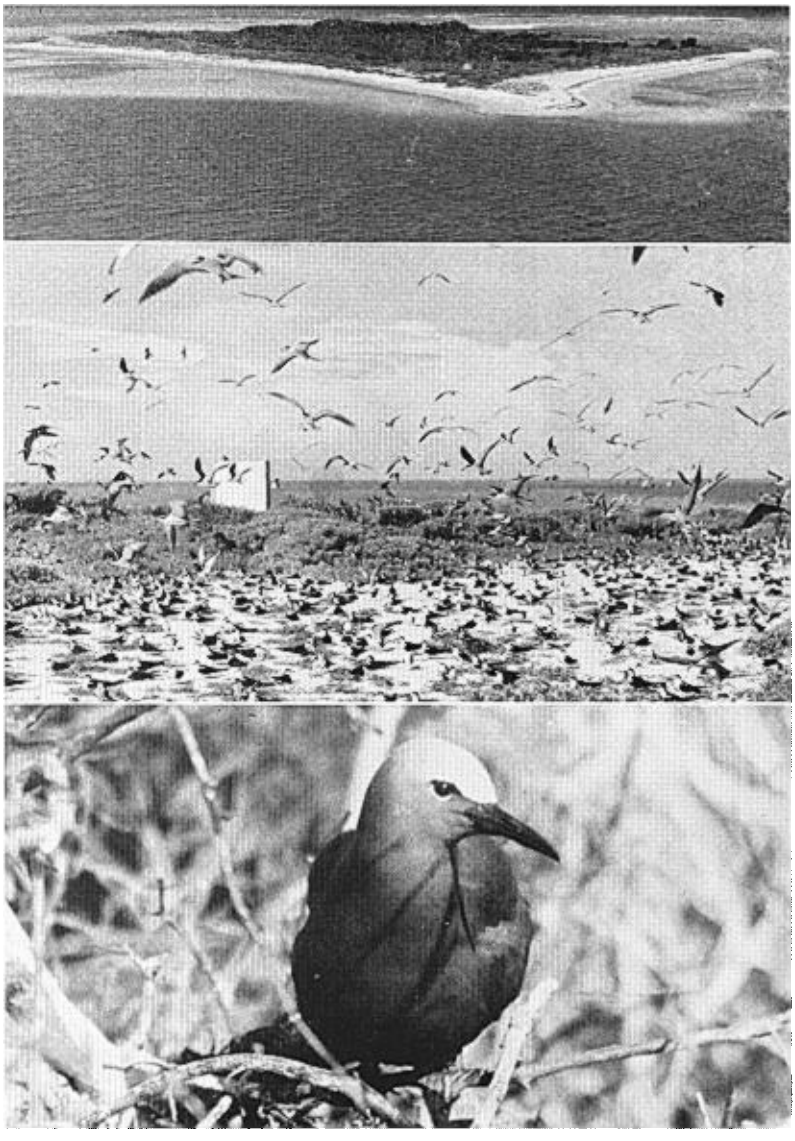
Plates 1, 2

ALTHOUGH they constitute one of the earliest-known bird concentrations of North America and have a reputation among ornithologists which is country-wide, the great colonies of Sooty and Noddy Terns (*Sterna fuscata fuscata* and *Anous stolidus stolidus*) of the Dry Tortugas probably remain the least visited of such natural wonders in the United States. This is, however, by no means because of preference. There are scores of ornithologists who would give a good deal to make the journey there, and indeed, cherish it as a primary objective. Not long ago one of the outstanding nature photographers of the country, in a letter to the writer, stated: "I've dreamed of getting there for twenty years." His attitude can be duplicated by many.

Of the three greatest avian sights on this continent, the Tortugas tern colonies are certainly the last in first-hand field contact, for there is little doubt but that both the Aleutian and Bonaventure Islands concentrations have been seen by more observers than these sandy keys in the Gulf of Mexico.

The term 'remote' well describes them. Although within seventy miles of an American city, itself something of an oddity among cities in being the most southern of any, they seem a great deal farther than miles indicate. Most visitors to Key West conclude that they are already at the end of everything generally, beyond which lies nothing but the heaving expanse of great waters. And yet, out beyond the horizon, lie these storied spots of sand and coral, some 68 miles still to the westward but to all intents and purposes of 99.9 % of Key West tourists, they might be on the moon! None the less, those who have persevered thereto would probably be unanimous in agreeing that the trip was well worth the effort, for in point of history, beauty, fascina-



(*Top*) BUSH KEY, DRY TORTUGAS FROM SOUTHEASTERN BASTION OF FORT JEFFERSON. NESTING SOOTY TERNS VISIBLE ON SANDY AREAS. (*Middle*) PORTION OF NESTING COLONY OF SOOTY TERNS. (*Bottom*) NODDY TERN AT NEST; TAKEN AT FOUR FEET WITHOUT BLIND.

tion and interest, the Dry Tortugas loom as one of the great highlights of a traveller's wanderings and, once having been there, he or she determines to return.

If one flies, the trip is as nothing, for 30 minutes out of Key West will land one at the massive, all but incredible bulk of old Fort Jefferson. If by boat, it is a different matter, entailing some five to eight or ten hours, depending on what manner of craft is utilized. The writer has been fortunate enough to make both sorts of trips on repeated occasions, and holds each one as an experience beyond compare. Having held intimate companionship with the avian dwellers there for the past two seasons (1945 and 1946) in making the first post-war population counts of their teeming myriads, he feels that this account of their status today, after another World War, will be of interest to many.

HISTORY

No account of present-day conditions at the Tortugas would be complete without at least a brief glance into their venerable history. The islands were first seen by European eyes, as far as is known, only twenty-one years after Columbus landed on San Salvador. On June 21, 1513, Ponce de León landed on "the eleven rocky islets" upon which, because of the great numbers of marine turtles found there, he bestowed the name Las Tortugas.

His historian, Herrera, states that aside from their securing as many "tortoises" as they wished, "there were killed many pelicans and other birds that amounted to five thousand."

Fifty-two years later, an English slave trader, one John Hawkins, came to the Tortugas on July 1, 1565. Again supplies of turtles and birds were secured and the numbers of each were so impressive as to find expression in the written record as follows: "The Capt. went in with his pinnesse, and found such a number of birds, that in halfe an houre he laded her with them; and if they had beene ten boats more, they might have done the like." Following this is a reference to the turtles and the observation that those "certeine islands of sand beare the name of Tortoises."

It will be noted that in neither of these ancient references are the numerous birds identified as terns. Indeed, it was not until more than two hundred and fifty years later that they were definitely named, but the writer has no doubt whatever that the teeming multitudes seen by Ponce de León and Hawkins were exactly what one sees there today. No good reason exists why this is not the case.

Since the birds, when identified, had apparently been using the

Tortugas as an ancestral breeding site, it is safe to assume that they "always had" and the finding of them in 1513 certainly makes these colonies one of the oldest bird rookeries of North America.

Though no doubt visited by fishermen, buccaneers and what-not, between 1565 and the 1800's, it remained for the indefatigable Audubon to really place the Tortugas colonies on the ornithological map by identifying the swarming birds as Sooty and Noddy Terns. He landed there on May 9, 1832, and what he found and described is too well known for further comment here.

A quarter century after Audubon's visit, Gustavus Wurdemann worked at the Tortugas (1857) studying and collecting birds (it was for him that the hybrid between Ward's Heron, *Ardea herodias wardi*, and the Great White Heron, *Ardea occidentalis*, was named).

In 1859 some ornithological collecting was done there by Capt. D. P. Woodbury, followed closely in the same year and the next by Dr. J. B. Holder. Though there is quite a gap after these workers, such interim represents the period of the War Between the States and the dark times which succeeded it. True, activities at the Tortugas were intense, but not of a nature connected with ornithological research. It was then that the now famous Dr. Samuel Mudd contributed his sacrificial efforts at combating the scourge of yellow fever which swept the garrison of Fort Jefferson, where he was a political prisoner.

Near the close of the last century, birds again occupied the study of some, and the most prominent worker of this period was W. E. D. Scott, who was active at the Tortugas in 1890. He prepared what appears to be the first real list of birds from that area. Just at the turn of this century, 1901–1902, a Dr. Joseph Thompson, U. S. N., was stationed at the Tortugas and, being interested in birds, made notes on the tern colonies and embodied them in a popular article which was produced in Bird-Lore, 5: 77–84, 1903.

It was not until the early years of this century that really intensive work began by modern ornithologists. One of the early photo-ornithologists, Herbert K. Job, visited the Tortugas in May, 1903, and stayed for several days on Bird Key, photographing and observing both the Sooties and Noddies. Some of his pictures appear in his volume 'Wild Wings' (1905) and are excellent. Job made an estimate of the bird population, one, if not the first, of the counts of this century, thus giving a basis for comparison (*see* Population).

Probably the most famous of the Tortugas studies was carried on by Dr. John B. Watson of Johns Hopkins University. His work on the behavior and homing instincts of the Sooty and Noddy Terns was a masterly endeavor (Papers from Dry Tortugas Lab. Carnegie Inst.,

2, 1908; Papers from Dept. Marine Biology, Carnegie Inst., 7, 1915). Watson first worked there in 1907 and again in 1910–1911–1912, and was assisted in 1913 by Dr. K. S. Lashley. Detailed studies of the colonies were carried on from 1913 to 1917 by Dr. Paul Bartsch of the U. S. National Museum, who contributed numerous papers on his observations, dealing with marine life as well as the birds. Much of his study is summarized in his paper on the breeding birds (Bird Rookeries of the Tortugas, Smithsonian Report, No. 2612, 1917). Soon after the termination of his work, World War I broke upon the scene and a considerable hiatus appears to have existed between that conflict and the year 1935.

In that year the Florida Audubon Society undertook an expedition to the Tortugas to make a population count of the tern colonies. Thereafter, through 1941, annual trips and counts were made, until World War II intervened and the Tortugas became an important anti-submarine base in the conflict against the U-boats operating in the Gulf of Mexico and Caribbean Sea. The findings of these groups appeared in various issues of the Florida Naturalist (vols. 9–15, Jan., 1936 and Oct., 1936–1941).

James O. Stevenson and Daniel Beard, Jr., of the National Park Service, did some work among the Tortugas terns during the period that the Florida Audubon observers were active. Beard carried on a rodent-control campaign against rats on Garden and Bush Keys, which had become a serious menace to the birds. Jack Russell of Sanford, Florida, assisted in this program.

In the war year of 1942 the Superintendent of Fort Jefferson, R. R. Budlong, estimated the tern population but no counts whatever were made in 1943–1944. In 1945 and 1946 the writer made the counts for the National Park Service, thus carrying on the efforts to keep abreast of the situation.

KEYS UTILIZED BY TERNS

Through one cause or another, the "eleven rocky islets" of Ponce de León's day in 1513, now number six. Eleven years ago there were seven, but Bird Key disappeared in the great Labor Day hurricane of 1935 and has not yet reappeared. For generations it was *the* key of the tern colonies. The studies of Job, Bartsch, Watson and others were all made thereon. Since 1935, however, two other islands have figured as nesting sites, with the terns now concentrating on but one. In 1937, Garden Key, where stands that monumental structure Fort Jefferson, was utilized to some extent, as was also Bush Key, a hundred yards or so across the channel. This is the first instance, in

modern times at least, that Garden Key was occupied. Similar nesting, to a lesser extent, occurred there in 1938 and 1939. In 1940 all nesting took place on Bush Key and has continued to be confined there through 1946.

Bush Key has an interesting history. At the turn of this century it was so small as to be hardly noticeable. John H. Davis (Ecology & Topography of the Sand Keys of Florida, Papers from Tortugas Lab., 33, Nov., 1942) states that "Lansing evidently found so little sand above the wash of the waves in 1904 that he gave no account of the island." Since then, however, it has grown considerably and again quoting Davis, shows "more changes in both topography and vegetation . . . than any other of the now existent Tortugas Keys."

From the above one might infer that Bush Key is of very recent origin. This, however, is by no means the case when one considers what Bartsch says about it. He mentions it as having been there in Audubon's time (1832) with the following reference. Commenting on Audubon's remarks anent the Noddy, Bartsch says that "This sketch is the more interesting on account of the fact that the birds no longer breed upon the key (Bush Key) on which he found them nesting, as all the vegetation, in fact, most everything shiftable above the sea, has long since been swept away by the waves."

This statement is of double interest, for it not only places Bush Key as having existed in 1832, but also shows that it was barren of vegetation as recently as 1917, that being the year Bartsch finished his work there! So then, 85 years prior to Bartsch's time, Bush Key was densely grown up, but at the beginning of this century was so small as hardly to be noticeable. Since Job, in 1903, mentions only Bird Key as the nesting place for both Sooties and Noddies, he must have overlooked Bush Key completely. However, in the succeeding years when it was building again, the growth of both key and vegetation must have been rapid for in 1915 it was found to be supporting *Suriana* and *Tournefortia* bushes "about 12 years old" (Davis). And yet, *two years later*, in 1917, Bartsch says that "Bush Key now appears as an elevated coral reef with piles of organic detritus heaped up in spots but barren of vegetation"! The only explanation of such rapid deterioration would appear to have been the result of a hurricane which took off the vegetation but left the key itself.

Today Bush Key comprises some twenty acres, which exceeds the extent of Garden Key (Fort Jefferson). In shape it is a well-defined diamond with a long sand spit extending from the eastern tip, pointing to the southward at almost a right angle to the body of the key. The western tip now comes very close to the edge of the channel

separating this key from Garden Key. There are two small ponds on it, the easternmost ringed about by white and red mangroves (*Laguncularia racemosa* and *Rhizophora mangle*, respectively), and some bay cedar (*Suriana maritima*). The western pond is much more in the open, with prickly pear (*Opuntia* sp.), glasswort (*Salicornia* sp.) and sea lavender (*Tournefortia* sp.) growing about the edges. The last two plants now cover large areas of the key and even in a single season their growth is marked and continues to be rapid. The Sooties use the bare sand areas and also breed in the short growth of *Salicornia* when this plant is about two or three inches high. When it reaches greater heights the birds do not use it. The Noddies confine their nesting entirely to bushes and mainly those of the bay cedar (*Suriana*).

ARRIVAL AND DEPARTURE

Not the least interesting phase of the Tortugas tern colonies is the character of arrival and departure of both Sooty and Noddy—to a minimum degree it is regarded by native fishermen somewhat as the advent of the swallows of Capistrano! In other words, if not held as a miracle, at least the conviction is extant that the birds arrive and depart on exactly the same day each year and, if it varies at all, it is held to be due to certain phases of the moon!

As in all migratory species, remarkable regularity attends the movements of the Tortugas terns. Generally speaking, they arrive about the middle of April and leave the middle of September, thus making a five-month stay at the nesting area. Dates vary from the first part of April to the last of that month for arrival, and from mid-August to late September for departure.

Very early arrivals sometime occur in late March. National Park Service records by J. B. Felton include March 27, 1940; early departure has been noted on August 9, 1911. Therefore, maximum dates can stretch over six and a half months; all such dates, of course, concern Sooties and Noddies alike.

Arrival is always at night and for about two weeks, more or less, the birds are to be seen or heard only after dark. Cruising about over the nesting key, they do not land but fly constantly, disappearing at daylight only to return again at dusk. The descent to the sands seems to be by common consent, and egg laying takes place the day after landing, or very shortly thereafter (the natives insist that the eggs are laid within a half hour of landing).

NESTING

Both the Sooty and Noddy lay but one egg as a rule. This fact is so well known now that it seems trite to call attention to it, but some confusion may exist by reason of past statements on the part of writers. One such was no less than Audubon, himself, who stated definitely: "The Sooty Tern always lays three eggs as its full number."

This seems very strange. It appears hardly possible that Audubon could have been mistaken, but unless he was, the only alternative that presents itself is that the birds have changed their habits. This seems just as unlikely. At any rate, the Sooty now lays but one egg, *sometimes* two. In Watson's exhaustive studies, he found but 25 instances of two eggs among the thousands he saw and watched. It is interesting further to note that among these 25, only one of the multiple sets resulted in two young being hatched and brought up!

During the 1946 season the writer saw tens of thousands of Sooty nests on Bush Key and amongst that multitude of single eggs were nine examples of two in a nest.

Regarding the Noddy, Audubon makes the same astonishing statement that he does about the Sooty, viz.: "The Noddy, like most other species of Terns, lays three eggs . . ." Actually only one is laid. In none of the writer's observations, either since World War II or before it, has he ever seen two eggs in a Noddy's nest. It is, of course, true enough as Audubon says that "most terns lay three eggs." It might be qualified to the extent of saying that the medium-sized terns do, while the larger ones lay but one, and the smallest of all, the Least Tern (*Sterna antillarum antillarum*) lays two or three.

As already mentioned, the Sooty invariably nests on the ground and the Noddy just as invariably nests in bushes. In appearance the eggs of both are superficially similar but those of the Sooty are much more rounded and less elongated than the Noddy's. In the former, the ground color is white or creamy buff with numerous rather small markings of dark brownish or gray. These vary infinitely; no two eggs look exactly alike. Sometimes the spots spiral slightly; most of the time they are rounded and clearly defined. The size averages 50 x 35 mm.

The egg of the Noddy is ovate, sometimes markedly so, the ground color is buffy and the spots are far more sparing than those of a Sooty's egg. Frequently they are grouped about the larger end, and are dark reddish or brown, with some of lilac. Now and then an almost immaculate egg is seen. The size averages 52 x 35 mm.

According to Watson, incubation consumes 26 days for the Sooty

and about a week longer for the Noddy. Young are on the wing in two months. Both sexes incubate.

The outstanding feature of the Tortugas colonies is the tameness of the birds. In few other spots except such as the gannet rocks of Bonaventure, can one get so close to birds as here. Frequently one can touch Sooties with hand or foot, and the Noddy allows itself to be picked up from the egg. Indeed, with the latter, in order to get a picture of an egg, it is sometimes necessary to pick up the sitting bird and set it aside! The air all about one is full of birds from knee level on up, and the masses of them are so close at hand that occasionally a bird can be seized out of the air. The din is terrific, at times completely bewildering and unreal, and it keeps up all day and all night. Not a moment during the nesting season does quiet reign on Bush Key.

POPULATION COUNTS

Anyone landing on Bush Key during the nesting season can hardly fail to ask the question: "How many birds are here?" Comparatively few have done more than wonder about it, however, as counting them appears an utter impossibility at first glance. Literally, it is rather out of the question to ascertain exact numbers, but they can be fairly approximated, and this is the basis for what population figures have been secured.

Curiously enough, none of the Nineteenth-Century observers did anything about counting the terns. Just why, it is difficult to say unless large bird concentrations in that time were more or less the rule, and did not excite the enthusiasm they do now. In spite of his undoubted astonishment at the numbers of the Tortugas terns, Audubon either made no estimate at all, or omitted any reference to such if he made one. Illustrative of his impressions however, he remarks: "On landing, I felt for a moment as if the birds would raise me from the ground, so thick were they all round. . ."

It seems that it was not until the early years of this century that any population counts were made, and the first of these was by Herbert K. Job in 1903. In his already mentioned 'Wild Wings' (Houghton, Mifflin Co., 1905) Job estimated, or to quote him, ventured a "guess" at the population of Sooties at "six or eight thousand" and "of the noddies there are hardly a thousand," which, he adds, "is a great decrease from the numbers that were once here." This is all that he says and on what he bases his statement that there had been a "great decrease" he does not say. Probably it was the account of Audubon which would certainly lead one to believe that there were more than six or eight thousand birds there then. It is interesting to speculate

here, exactly why this decrease occurred. We can do no more than guess at it, but weather, egging, the feather trade, general shooting and lack of conservation all doubtless played a part.

None the less, this seems to have been the low ebb of the Tortugas colonies for all time and the writer wonders if the cause might not well be the occupation of the Tortugas by garrisons of soldiers and navy ships during the Spanish-American War. Great activity reigned about Fort Jefferson in 1898. The coaling docks at Garden Key were built then and in view of the tendency of many men in a remote spot to exploit the wildlife for both food and sport, it seems very likely that the terns were greatly reduced by this human invasion of their haunts. Be that as it may, Job's figures are the low point. It would be tremendously interesting if some comparable ones were available for the period of the middle and late 1860's, when Fort Jefferson was the focus of another war's activity, and so much of its history took place.

Used as a Federal outpost and prison, its garrison beset with idleness, tedium, and what was worse, yellow fever, the Tortugas terns must have come in for a share of suffering and depletion. The bodies of those soldiers dying either natural deaths, or plague-stricken, were buried on Bird Key, the nesting site of the terns, and it is not to be supposed that interference of this or other nature was without detriment to the annual avian summer residents.

Dr. Watson's celebrated studies in 1907 and 1908 included population estimates, and an improvement is to be noted between his figures and Job's—a considerable improvement, in fact, and an indication that cessation of military activities in the area may well have been to the advantage of the birds. Watson's counts showed in 1907 that there were 18,000 Sooties and 4,000 Noddies. In 1908 there were 20,000 Sooties and 1,400 Noddies. The Noddy count of 1907, by the way, together with one by Paul Bartsch in 1917 of an identical figure, and another in 1936 by the Florida Audubon Society, constitute the all-time high for this species in count histories. At no time has this bird exceeded 4,000.

From Bartsch's estimate in 1917 until 1935 when the Florida Audubon observers began their work, there is a gap in the records, but from then through 1946, a period of 11 years, there are only two seasons without a count, these being the war years of 1943–1944. This is, by a good deal, the most consecutive set of figures which have ever been compiled, and it is hoped that annual counts may be continued in the indefinite future.

Given below is a table listing the counts to date:—

Year	*Estimator*	*Sooty Tern*	*Noddy*
1903	Herbert K. Job	6000–8000	400
1907	John B. Watson	18,000	4000
1908	John B. Watson	20,000	1400
1917	Paul Bartsch	25,000	4000
1935	Fla. Audubon Soc.	30,000	3000
1936	Fla. Audubon Soc.	40,000	4000
1937	Fla. Audubon Soc.	100,000	2000
1938	Fla. Audubon Soc. & Beard	64,058	413
1939	Fla. Audubon Soc.	70,000	250
1940	Fla. Audubon Soc.	100,000	180
1941	Fla. Audubon Soc. & Peterson	100,000	1000
1942	Nat. Park Ser. (Budlong)	65,000	450
1945	Alex. Sprunt, Jr.	109,000	750
1946	Alex. Sprunt, Jr.	97,200	550

Counts in recent years have been based on the square-yard unit system. Striking an average of the breeding birds to the square yard, and ascertaining the area utilized, figures are computed therefrom. It seems to be the only reasonable way to undertake the work. This, of course, applies to the Sooty Tern. The nesting density varies considerably. In some of the favored areas it is amazingly crowded, in others very scattered. All grades of intermediate conditions may be encountered. Illustrative of this is that, during the 1946 season, the writer found a density of as much as five birds to a square yard as a maximum, and 0.5 to the square yard as a minimum. Much depends on the growth of *Salicornia* or other plants in which the Sooties are nesting. The final conclusion reached in June, 1946, was that 10,700 square yards averaged three nests per unit and that 16,500 square yards averaged one nest per unit. Thus, doubling for the pair of birds, we get 64,200 plus 33,000, or 97,200 Sooties.

A similar system cannot be used for the Noddy because of its bush-nesting habit. However, it is simplified by the fact that a 1-2-3 count can be made of the nests, or very nearly so. Then, too, the Noddies are in the tremendous minority. The writer has been under the impression that, in some recent counts, the Noddy has been more or less neglected or guessed at. In 1946, therefore, he made a particular effort to get as nearly accurate figures as possible. A careful search of Bush Key for individual nests was undertaken. Of course, a few nests in especially dense thickets of bay cedar (*Suriana*) were no doubt overlooked. It was possible also to check against the nest count by counting the actual birds during certain times of day when they congregate on the coaling docks of Garden Key for resting.

This is a marked habit of the Noddy, not shared by the Sooty. They pick out a favored location and line up thereon, side by side, and a close count is possible.

The 1946 Noddy nest count amounted to 246 actual nests. Allowance was made for overlooked ones, and a total of 275 arrived at. One count of resting birds amounted to 185, another to 242. Doubling these for a pair, we get 370 birds and 524 birds. Thus, the figure for the whole Noddy population (550) seems fairly accurate.

Whatever detriment the Tortugas terns may have suffered in past wars, World War II appears to have had no such effect. Modern conservation ideas and methods and the rigid protection afforded the birds since the Tortugas have become a national monument can be assigned as the principal reasons for the fact that virtually no damage resulted in the recent occupation of these islands by naval forces. Today the colonies are in splendid condition except for the uncertain situation surrounding the Noddy population—at the present time, an unaccountable one.

OTHER TERNS

Though one all but automatically considers the terns of the Tortugas as Sooties and Noddies, other species nest there also, at least occasionally. The one most apt to do so is the Roseate Tern (*Sterna dougallii dougallii*), thereby presenting a remarkable instance of avian distribution. Breeding in a rather local manner on the Atlantic coast from Sable Island, Nova Scotia, south to Virginia, it ceases to do so south of Cobb's Island in that state, and does not reappear as a nesting bird until it presents itself in the Gulf of Mexico at the Dry Tortugas!

The colony is never a large one and shows much fluctuation in numbers. Apparently, counts of these terns were not as interesting to members of the Florida Audubon Society's expeditions as were those of the Sooty-Noddy combination, but are given below as the only recent data available.

Year	*Birds*
1936	400
1937	—
1938	314
1939	80
1940	20
1941	—

There was no count at all in 1942–1943–1944. In 1945 the writer examined the Roseate colony with some care and found 85 nests. Checks with birds in the air above the nesting site varied from 160 to

180. The figure 170 can be accepted for the 1945 population. In 1946 not a single Roseate Tern was present at the Tortugas in June! For the several days the writer was there, a vigilant watch was maintained, all but hourly indeed, and not a bird was seen. The reason is unknown.

These birds, when present, always occupied the bare areas of the sandspit extending from the eastern tip of Bush Key.

Other occasional nesting terns are the Common Tern (*Sterna hirundo hirundo*) and Least Tern (*Sterna albifrons antillarum*). Neither occurs in any numbers much exceeding a dozen pairs each.

PREDATION

The Tortugas tern colonies are as free from human molestation as any bird concentration could well be, perhaps any in the world. The custodian of the Fort Jefferson National Monument is in permanent residence only a few hundred yards from Bush Key, and any disturbance there, night or day, could and would be immediately dealt with. The once prevalent practice of "egging" is now as much history as Fort Jefferson itself, and need never again be considered as a menace to the birds. Only through a too enthusiastic attention by visitors could the human element become detrimental and this phase is watched carefully by the National Park Service which has definite rules of procedure governing visitors.

Therefore, natural enemies are the only sort with which the terns have to contend and, viewing the past consequences of these, they appear to be innocuous on the whole, with a few exceptions. One of the latter was the presence of the Norway rat (*Epimys norvegicus*) at the Tortugas, brought in by Cuban fishing schooners, or visiting spongers, fishermen, and the like. Probably not noticed for some time because of vegetation and the secretiveness of these rodents, they nultiplied in numbers until, in 1937, Jack C. Russell, doing biological research for the National Park Service at the Tortugas, estimated that rats destroyed 90 % of the Noddy eggs and young (Fla. Nat. 9: 8). Obviously, control was in order and was instituted before the birds returned in 1938. Dan Beard, then of the Park Service, was concerned therewith. The campaign was an unqualified success. All surveys since have revealed a virtual absence of rats on Bush Key, though a few remain amidst the gigantic pile of Fort Jefferson. Neither in 1945 or 1946 did the writer find any evidence of rats among the nesting terns on Bush Key. That menace, therefore, has been removed, and any possible recurrence is being watched for.

Sand-crabs (*Ocypoda arenaria*) and Man-o'-war-birds (*Fregata*

magnificens) constitute the present natural enemies, aside from weather, of the Tortugas colonies. Unfortunately, few specific data on the depredations of either can be given now. That the Man-o'-war-bird does take young terns is certain; it has been seen to do so, but not to the extent of serious inroads. Curious contradictions appear in the accounts of the behavior of these sable pirates. Members of the Florida Audubon expeditions have stated definitely that they have actually witnessed the capture of young Sooties by them (Robinson, G. D., Fla. Nat., 13: 7). And yet, Mr. C. Raymond Vinten, Co-ordinating Superintendent of Southeastern National Monuments, found a half-starved Man-o'-war-bird on Bush Key in 1937, with a broken wing. He says that: "It was roosting in an area where the ground was covered with hundreds of eggs and chicks, but it was starving whiles urrounded with an abundance of food within easy reach." Thus does behavior differ.

In June, 1946, the writer saw Man-o'-war-birds swoop low over the sands of Bush Key on several occasions, seize something and swallow it, and immediately fly out over the water and drink. Mr. Vinten and the writer's son also observed this maneuver independently, but although the plain inference is that young Sooty chicks were seized, we never could quite get a definitely satisfactory instance.

Much the clearest statement of positive predation by Man-o'-war-birds, is that of Daniel B. Beard in The Auk, 56: 327, 1939. Beard watched it on several occasions and leaves no room for doubt as to its indulgence. The Sooty chicks are seized by the attacker swooping low and grasping the vietim without a break in the flight. Beard saw 18 chicks thus secured in one evening. (He also refers to the habit of the Man-o'-war-bird in immediately drinking after swallowing a chick.) Though apparently the damage from this cause is not considerable, more study is needed to arrive at a certain percentage of the take, and with that in hand, clearer ideas of what might be done can be formed.

Damage by the sand-crab is undoubtedly considerable. These ghostly creatures, swift and silent, are very abundant on Bush Key and appear to be increasing annually. As mentioned above, there are no figures available, but future observers would do well to give careful attention to this situation if time permits. Bartsch has seen young Least Terns mutilated by having their wings clipped off by this crab which, of course, would be fatal even if the crab were driven off. No doubt its tactics with Sooty chicks are similar. It is when the latter are hatching that most of the predation occurs.

Another such enemy, at least at times, appears to be the hermit

crab, and of it, Robinson (1940) says that: "Bush Key has become the happy hunting ground for thousands of hermit crabs which were found to be feasting upon the newly hatched sooties, or partially hatched ones." It seems strange indeed that this creature would be able to 'get away' with such actions. Evidently it is only when very young birds, unattended, are available to it, and this would not appear to be often. The adult Sooty could certainly repel any attack by one of these crabs, and, as a matter of fact, the young bird itself, when able to move at all, must be immune by its own movements. Robinson, however, sounds very clear on the matter, but it is the only such observation which the writer has been able to find on such predation. On none of the several trips made to Bush Key has the writer ever seen any evidence of it, nor has he seen any noticeable numbers of these crabs. True, they were not looked for particularly but it would seem that any marked concentration of them would not have been overlooked. As far as the 1945 season is concerned, the writer cannot recall having seen a single hermit crab, but in 1946 one was noted. They are very common on Garden Key, at Fort Jefferson, where their depredations militate against successful growing of flowers and vegetables in the little kitchen garden of headquarters. Little wire fences must surround the plants, else they are soon consumed. The common species of this crab there is *Cenobita diogones*, and it usually inhabits the shell of the West Indian top shell (*Livonia pica*).

Some of the young Sooties are lost by attacks of adult Sooties, while roaming about the key, once they can move around. Intrusion into the colony after the young have hatched always causes a dispersal of the young in all directions, and one can frequently see a youngster set upon, pecked and buffeted unmercifully. While some mortality in such a huge concentration is inevitable, it is by no means excessive and, indeed, one must reach the conclusion that it is rather light on the whole.

Weather is a factor of danger to the colonies, but in view of their location, not as serious as might be expected. Though, of course, the place is well in the hurricane belt, these fierce storms are not often experienced during egg time or even when most of the young are being reared. August sees the youngsters well along, and the terns usually leave the Tortugas soon after mid-September. These two months are the most dangerous hurricane periods. Occasional high tides sweep part of Bush Key but are not a serious menace. All things considered, the Tortugas are as free from a combination of the usual sources of danger as any locality of heavy nesting of which the writer knows. The very fact that the birds have used these islands for centuries is conclusive proof of their natural safety.

FEEDING DISTANCES

As might be expected in birds as active as the Sooty Tern, their feeding territory is very extensive. They are capable of long sustained flight and are as nearly tireless as any creature can be.

The writer's observations have frequently revealed Sooties in some numbers as far east of the Tortugas as Rebecca Shoal, which lies 19 miles from Bush Key. On June 20, 1945, my notes state: "Sooty Terns feeding about 10 miles east of Rebecca, 28–30 miles from Tortugas." Again on June 21, 1946: "Several Sooties abeam of Rebecca Light; about 30 feeding over disturbance in the water, 3 to 4 miles east, smaller groups 2 miles further east." Finally, under same date: "One Sooty at Smith Shoal, 8 miles NW of Key West" (this would be about 60 miles from Bush Key).

Earle R. Greene in his 'Birds of the Lower Florida Keys,' states that he saw two Sooties off the Bay Keys in the Great White Heron Refuge near Key West on June 26, 1941, and that "These were probably wanderers from the Tortugas colony." Of that, there is no possible doubt.

The writer has no data on feeding ranges west of the Tortugas, or north and south, but there is no reason to believe that distances in those directions are not as great as the easterly wanderings. Doubtless they are. The Noddy apparently does not range as far as the Sooty and generally one is within only a few miles of the Tortugas before any are noted. This doubtless has its exceptions.

Anyone who has studied the Sooty Terns cannot fail to be impressed with the vitality and unceasing energy displayed by them. Even when not feeding they indulge in soaring high over Fort Jefferson, where they can be watched in the late afternoon from the parade-ground or the top of the Fort, mingling with the Man-o'-war-birds in the air. As Watson well puts it: "It is the most restless and noisy bird I know, and almost as much so at night as during the day . . . How the bird maintains its vigor with no more continuous rest than it takes is a mystery. This peculiarity of the sooty has led to the popular nickname of 'wide-awake tern'." This is certainly most true. All through the summer, the clamor of the colony is easily heard at headquarters house at the Fort, night and day, and is as much a part of the place as the breaking of the surf on the beach of an ocean resort.

THE FUTURE

All things considered, one would assume that the future of the Tortugas colonies would be about as certainly safe as that of great

bird rookeries could be. This is true regarding hereditary return to the area, as the years have shown, and nothing is likely to change that, but certain topographic conditions on Bush Key at present give one to think. As has been stated, the Sooty Tern nests either on perfectly open sand or in very short vegetation about two or three inches high. The plant which is now very prevalent there and which is being used in such heights this season is the glasswort (*Salicornia*). It offers no drawback at such stage of growth but when it becomes higher the terns do not use it, as difficulties are encountered in depositing the egg. It grows rapidly and is doing so on Bush Key at the moment.

The comparisons between the 1945 and 1946 seasons' counts show only a slight decrease in the nesting Sooties, not enough to worry about. However, it may be that next season will witness a very sharp drop—this because of the ever increasing spread of the above-mentioned plant. The writer was nothing short of amazed this season at the way it had increased and covered wide areas which, a year before, had been bare sand. A similar condition exists with the sea-lavender (*Tournefortia*), though not quite to such a marked degree.

Thousands of Sooties were using the short *Salicornia* this season (1946). If similar increase in growth continues, and there is no reason why it should not, next year will exhibit growth much too high for the terns to use. This is already the case in many hundred of square yards. Some sand areas will be present, of course, but the amount of this season's yardage will be greatly cut down by next. Where will the Sooties go?

As far as the writer knows, only one experiment in preparing ground artificially for the birds has been attempted, and that was a complete failure. After one of the seasons when the Sooties nested on Garden Key, it was noted that the vegetation increased there, and before the next season it was cleared off. Not a bird returned to it! Nor have any since. Would a similar attempt at clearing on Bush Key result in a similar desertion?

There is an impression current among some that the vegetation in an area used by these terns will become "burned up" by an excess of fertilization, and that eventually, such an area will become quite bare. So far, the reverse has been true on Bush Key. The terns use it yearly, and the vegetation is increasing rapidly. Just what the end will be is problematical.

Only three islands of the Tortugas group have been used by the Sooty-Noddy combine as far as we know. These are Bird, Garden and Bush Keys, of which only the last two now remain. There are

(*Top*) WARNING SIGN ON BUSH KEY, JUNE, 1945. NODDIES ON TOP OF SIGN. (*Middle*) SAME IN JUNE, 1946, SHOWING GREAT INCREASE OF VEGETATION (SEA LAVENDER, *Tournefortia*) IN ONE YEAR. (*Bottom*) INCUBATING SOOTY TERN.

two others which now offer suitable Sooty nesting ground—East and Hospital Keys. East Key is about four and a half miles from Bush Key to the eastward. Sea-oats (*Uniola*) and sea-lavender (*Tournefortia*) and some bay cedar (*Suriana*) are the principal growths, and there is a great deal of the goat's-foot vine (*Ipomea pes-capra*) running along the beach. It comprises some 85,000 square yards.

Hospital (Sand) Key is slightly northeast of Bush Key, distant about two miles. Though small, it seems to be constant, as a hospital was once built there in 1870 to serve Fort Jefferson, the brick foundations of which are still visible in part though very close to, and in, the water. The writer examined this key in 1946 and found not a single shred of vegetation on it. A more completely desolate spot would be hard to imagine, but it is typical Sooty nest area. It may be that this spot will yet be host to the terns.

The Noddy of course, is not affected by the bush growth except advantageously, as increase of bushes affords additional nest sites. At any rate, the season of 1947 seems to point to inevitable changes of some sort and is awaited with great interest.

ADDENDA

Since the above discussion was written and accepted by The Auk, the writer has accomplished the 1947 population survey at the Dry Tortugas. A brief résumé of it will be of interest here, as a follow-up.

As indicated above, the writer was under the strong impression that some shift would take place among the Tortugas terns in 1947, mainly because of the greatly increased spread of vegetation on Bush Key where they have bred for years. This impression—indeed, almost a conviction—was sustained. For the first time since 1940, the Sooty and Noddy Terns nested on Garden Key (Fort Jefferson) as well as Bush Key. There were more nesting birds on the former than the latter!

Again using the square-yard unit in estimating the population, the following results were obtained:

Bush Key—Square yards utilized, about 7000
Nesting density varied from 1 to 6 nests per sq. yd.
Total number of Sooties, 30,112

Garden Key—Square yards utilized, about 10,000
Nesting density varied from 2 to 7 nests per sq. yd.
Total number of Sooties, 34,158

Total number of Sooties in 1947, 64,270

The rather wide discrepancy between the population figures of this season and last may be accounted for as follows:

1. Fewer birds arrived this year for nesting. All personnel at Fort Jefferson were agreed on this point.
2. The hatch had progressed much farther at the time of the writer's visit this year, thus making it much more difficult to estimate, or measure nesting densities, as the young were roaming about in large numbers.
3. The prevalence of vegetation on both keys made it more difficult to see eggs and young. Many of both were *under* bushes, tall grass and branching plants.

NODDY TERN.—This species showed a decrease in 1947. Actual nest count was made on both Garden and Bush Keys, as this species was also using both keys. The results were as follows: Nests on Bush Key, ninety-two; on Garden Key, nine. Allowing a 10 % omission error, a total of 112 nests would be reasonably accurate. Also allowing for non-breeders or unmated birds, if any, the total Noddy population would not have exceeded 250.

ROSEATE TERN.—This species, completely lacking in 1946, again appeared at the Tortugas this year. Three keys were utilized by them as follows:

Bush Key (the usual location on the sand-spit at east end)	54 nests
Long Key	67 nests
Hospital (*Sand*) *Key*	21 nests
Total	142

Total Roseate Tern population—284 birds

Man-o'-war-bird predation in 1947 was found to be serious. Far more so than in any of the past three seasons in which the writer has worked. Numerous instances were noted of young Sooty chicks being seized and swallowed. The particular times of day this occurred were early morning and late afternoon. The 1947 Man-o'-war-bird population was about one hundred individuals, with a preponderance of females and immatures.

Predation by both sand crab (*Ocypoda arenaria*) and hermit crab (*Cenobita diogones*) was found to be at a minimum. No evidence of rat damage was seen at all.

One Smooth-billed Ani (*Crotophaga ani*) was seen on Bush Key. Search was made for the possible nest, though but one bird was seen

at a time. This was unavailing. The only other land bird observed was a Barn Swallow (*Hirundo rustica erythrogaster*) on Bush Key, June 22.

Dates of the 1947 survey were June 20 through June 26, 1947.

Vegetation on Bush Key continues to spread, and practically the whole island is now clothed to high-water mark, with one or two small sand areas still existing. Should no hurricane occur this season there is no reason to believe that there will be any cessation of this growth, and with Garden Key nesting sites rather fully occupied, it remains to be seen what the season of 1948 will present!

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THE SEASONS OF BIRD SONG—THE CESSATION OF SONG AFTER THE NESTING SEASON

BY ARETAS A. SAUNDERS

IT is well-known that when the breeding cycles of birds are over, usually from middle to late summer, song gradually ceases. But only a few detailed studies of this phenomenon have been made and published, and there is much still to learn. The first of these studies in America, to my knowledge, is that of Bicknell (1884–1885). Since then the chief publications on this subject that have come to my attention are those of Fry (1916), Baerg (1930), Vaurie (1946) and my own (1926 and 1938). Some of these studies have been for a single season only, but the authors have recognized the desirability of making such studies over a period of years in a single locality.

The time of cessation for each species, and the manner in which it takes place, varies from year to year, evidently according to weather conditions. Just which conditions are the important ones is something still to be solved. The direct cause of cessation seems to be the approach of the postnuptial molt, and since the time of cessation varies with the years it is probable that the time of molt does also. This leads to the conclusion that the weather conditions that cause the difference are more deep-seated than the change from warm to cool, or fair to rain, from day to day. These local changes often affect the amount of singing from one day to another, but they cannot cause the change in the birds' physical condition that comes with the postnuptial molt and causes complete cessation of song.

More studies of this subject, from various different localities, and covering a period of years, are highly desirable. There is not only