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COLONY DIFFERENCES IN RESPONSE TO TRAPPING IN ROSEATE TERNS[1]

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Both members of seabird pairs are normally required to fledge young. Seabirds that nest in sites accessible to predators usually have one parent in attendance during the egg/chick phase (Burger and Gochfeld 1991a). Time devoted to foraging can vary with individual skill and age, prey availability and abundance (Searcy 1978), and distance to foraging grounds (Safina 1990). Although average skill of similar-aged individuals should not vary from colony to colony (Ryder 1980), prey availability and abundance, and spatial distribution of foraging grounds may vary. Thus, the percent of time both members of a pair are present at the nest site may vary in different colonies.

In this paper, we examine parental behavior in response to trapping in Roseate Terns (*Sterna dougallii*) nesting in three of the six major colonies in the northeastern United States: Cedar Beach, New York; Falkner Island, Connecticut; and Bird Island, Massachusetts. Roseate Terns were listed on the United States' Endangered Species List in 1987. We were interested in differences among colonies in how often both parents were present, how soon a mate returned to the nest if one parent was temporarily removed, how soon a trapped bird returned to the nest after release, and the time during which the nest was left unguarded. We feel it is important to recognize and make management decisions based on colony differences where they exist.

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Our study follows directly from earlier work at Cedar Beach on trapping vulnerability of Common Terns (*Sterna hirundo*) and Roseate Terns (Burger and Gochfeld 1991b). Nisbet (1981a) reported that Roseate Terns at Bird Island required about three hours to return to the nest after trapping.

STUDY AREAS AND METHODS

In 1989–1990 we trapped, color-banded, and observed adult Roseate Terns at Cedar Beach, New York (40°37′N, 73°21′W); Falkner Island, Connecticut (41°13′N, 72°39′W); and Bird Island, Massachusetts (41°40′N, 70°43′W). Cedar Beach, the most western of the six major colony sites in the northeastern United States, is located 250 km west southwest of Bird Island. Falkner Island is about halfway between them.

The Cedar Beach colony (13 ha), contains 100–120 pairs of Roseate Terns, about 5,000 pairs of Common Terns, and 200 pairs of Black Skimmers (*Rynchops niger,* Burger and Gochfeld 1991a). Roseate Terns nest under dense vegetation or in tires, in subgroups of 5–30 pairs, interspersed among Common Terns which usually nest in the open (Gochfeld and Burger 1987, Burger and Gochfeld, 1991a). The Falkner Island (2 ha) colony is on an island in Long Island Sound about 5 km south of Guilford, Connecticut. Most terns nest on the low gravelly and rocky beach areas just above high tide. The colony contains 165–170 pairs of Roseate Terns and about 3,000–3,500 pairs of Common Terns. Roseate Terns at Falkner Island nest under rocks, in man-made boxes, or in half-buried tires (Spendelow 1982). Bird Island (0.6 ha), comprising about half of the Northeast regional population, is situated on a low island with substrates of cobble, clay soil, coarse sand,

TABLE 1. Comparison of Roseate Tern behavior at Cedar Beach, Falkner Island and Bird Island. Given are means ± 1 SE in min.

	Cedar Beach	Falkner Island	Bird Island	Kruskal-Wallis χ^2 (*P*)
Number of nests observed	106	186	58	
Time for Bird A to return after trap set (min)	2 ± 1.4	2 ± 0.2	No data	NS
Percentage of nests where both mates were present initially[b]	54	51	53	NS[a]
Mean time for Bird A to enter trap (min)	9 ± 2	5 ± 0.4	No data	NS
Mean time for Bird A to return after release (min)[b]	41 ± 6 (34)	115 ± 5.5 (134)	174 ± 3.3 (178)	125 (0.0001)
Percentage of Bird A's returning within 3 hr following release[c]	95	63	5	167 (0.0001)
Time for Bird B to return to nest when initially present (min)	2.2 ± 0.3	19 ± 4.7	No data	36.2 (0.001)
Time for Bird B to begin incubating or brooding when initially present (min)	5.0 ± 1.2	45.1 ± 8	No data	NS
Percentage of nests where Bird A did not return within observation period	2	5	15	11.9 (0.01)
Vulnerability time (min)	13 ± 4	30 ± 3.6	40 ± 9	45.2 (0.0001)

[a] Chi-square contingency test.
[b] Times longer than 180 min recorded as 180 min.
[c] Given in parentheses is median time.

and salt marsh. About 1,600 pairs of Roseate Terns nest with 2,000 pairs of Common Terns (Nisbet 1980). Roseate Terns at Bird Island nest in the higher, more densely vegetated sections, while Common Terns nest in the lower, more open parts (Nisbet 1981b).

Observations were conducted in June–August at Falkner Island and in June at Cedar Beach in 1989 and 1990, and in June of 1990 at Bird Island. We timed trapping to coincide with the last 3–4 days of incubation or the first day of hatching to minimize risk of abandonment (after Nisbet 1981a). Before setting traps, we observed nests to determine if one or both parents were present. We then placed treadle traps over the nests, and moved to a location where our presence did not disturb the terns. Using binoculars or a telescope we watched from the dunes or high rocks at Cedar Beach (30–40 m away, no blind), Falkner Island (10–30 m away, from a blind), and Bird Island (10–30 m away, from the lighthouse balcony).

Bird A refers to the first mate trapped, which was usually the first bird to return after we set the trap; and Bird B refers to its mate. For each nest we recorded: time when the person setting the trap left the nest, time the first and second bird returned, time for Bird A to enter the trap, time for Bird B to return and commence incubation after Bird A was removed from the trap, and time for Bird A to return to the nest following release. Prior to release, all birds were banded with one incoloy and three Darvic colorbands (Spendelow et al. 1994) and color marked with a Magic Marker (which lasted about 2–3 days). Trapping, handling and release methodology was discussed in several meetings prior to each field season, and all procedures had been performed for at least ten years at each study site. We used the same traps at all sites. At Cedar Beach and Bird Island all birds were removed from the traps, processed, and released within 20 min of capture, whereas this time may have been slightly longer at Falkner for a few captured terns. However, most terns at all three sites were removed from the traps, handled, and released within 15 min. Birds were weighed and measured (bill, wing). The handling time for each bird was about 5 min.

Functionally, the important variable is whether the nest was unattended and thus vulnerable. We defined vulnerability time as the time when the nest was unattended because neither the trapped bird (A) nor its mate (B) had returned to the nest. If the trapped bird had not returned at the end of three hours we assigned a value of 180 min; thus our average times were minima.

We used regression models to determine the factors that contributed to variations in the time to return to the nest following release and in the vulnerability time (PROC GLM, SAS 1985). We used Kruskal-Wallis χ^2 tests to compare among colonies (SAS 1985).

RESULTS

Before trapping, both members of pairs were present at just over half of the Roseate Tern nests at all three colony sites, and the times for the first bird to return to the nest after the traps were set were similar at Cedar Beach and Falkner Island (Table 1). These times could not be recorded at Bird Island because of dense vegetation, but were usually similar to those at the other sites (0–5 min). The mean times for birds to enter the traps did not differ significantly among the colony sites. Thus the behavior of Roseate Terns with respect to returning to the nest after traps were set, or entering the traps, did not vary significantly among the colonies. However, the time for the second birds (Bird B) to return (if they were initially present) after their mates and the traps were removed differed significantly between Cedar Beach and Falkner Island (Table 1). At Bird Island, mates generally returned within 0–10 min.

The time Bird A remained in a trap before being

TABLE 2. Effect of time of day on Roseate Tern behavior (all measures in min, mean ± SE, sample size in parentheses below mean).

	Time of release				Kruskal-Wallis χ^2 (*P*)
	06:00–09:00	09:00–12:00	12:00–15:00	15:00–18:00	
Bird Island					
Time for A to return[b]	180 ± 3 (180) (9)	173 ± 10 (178) (37)	180 ± 1 (180) (12)	ND	NS
Vulnerability time	40 ± 10 (9)	50 ± 9 (37)	15 ± 10 (12)		79.2 (0.0001)
Cedar Beach					
Time for A to return[b]	32 ± 6 (28) (38)	40 ± 11 (36) (44)	67 ± 12 (65) (15)	147 ± 12[a] (142) (9)	15.4 (0.001)
Vulnerability time	12 ± 4 (38)	23 ± 13 (44)	16 ± 10 (15)	12 ± 8[a] (9)	NS
Falkner Island					
Time for A to return[b]	141 ± 16 (180) (13)	112 ± 7 (136) (88)	112 ± 10 (120) (43)	ND	17.7 (0.0001)
Vulnerability time	30 ± 7 (12)	36 ± 5 (88)	16 ± 4 (31)		5.4 (0.06)

[a] Sample sizes below 10 individuals.
[b] Given in parentheses median.
ND = no available data.

removed did not vary significantly among colonies (median = 1.3 min at Falkner Island; median = 2.0 min at Cedar Beach, unknown for Bird Island), but the time Bird A was held for processing did (median = 14.5 min at Falkner Island; median = 7.1 min at Cedar Beach; median = 15 min at Bird Island). Most trapped birds returned within 3 hr at both Cedar Beach and Falkner Island, but only 5% of the trapped birds returned within this period at Bird Island (Table 1). The average time for Bird A to return following release was 41 min at Cedar Beach, 120 min at Falkner Island, and 174 min at Bird Island. Vulnerability time was much less at Cedar Beach than at the other colonies (Table 1).

Thirty-six percent of the variance in time for Bird A to return to the nest after release following trapping ($F = 30.7$, $P < 0.0001$) was a function of colony ($F = 58.4$ $P < 0.0001$), time of day ($F = 4.8$, $P < 0.03$), and presence of the mate at time of trapping ($F = 4.4$, $P < 0.03$). Nests were most vulnerable from 09:00–12:00 compared to other times of day (Table 2).

DISCUSSION

We found differences among colonies in the behavior of Roseate Terns: trapped birds took less time to return at Cedar Beach, intermediate time at Falkner Island, and longer time at Bird Island. Whereas most trapped birds returned to their nests within 3 hr of release at Falkner and Cedar Beach, this was not true at Bird Island. These differences are remarkable in a metapopulation breeding in a small geographical area. That the behavior of the terns prior to trapping and handling was similar among the colonies indicates similarities in normal attentiveness at the nest. The differences in return time following release may relate to differences in colony configuration or nest density, predator presence, human disturbance, and distance to foraging grounds. Roseate Terns released at Cedar Beach returned to the nests in less time (41 min) than at Falkner Island (120 min) or Bird Island (174 + min). Cedar Beach colony is adjacent to a heavily-used bathing beach, and the birds do not rest on the shore because of human activities (Burger and Gochfeld 1991a); a Roseate Tern that returns to the colony returns directly to its territory. However, both of the other colonies are on islands with only researcher-induced human disturbance, and both have suitable nearby rocky or sandy shores for resting outside the nesting area. Thus, a bird that returns to Falkner or Bird Island may loaf nearby or out of sight of its nest. Many of the birds that came back to Falkner after trapping were first observed on the beach at least 5 m from their nest. Many of the birds trapped at Bird Island rested on the rocks throughout the day of trapping. The presence of suitable loafing sites on Falkner and Bird Islands (and their absence at Cedar Beach), does not explain why birds choose to use them rather than to return to their nests.

Other potential reasons for the differences in responses of trapped birds may have involved previous trapping history. Birds at Cedar Beach and Falkner Island were much more likely to have been trapped previously, and therefore might have habituated to trapping. However, at Cedar Beach, previous trapping experience did not affect subsequent behavior (Burger and Gochfeld 1991b).

When Roseate Terns at Cedar Beach were released following trapping they flew out over the ocean, bathed briefly, and returned to land near the nest. Usually they did not land on the beach, nor leave to forage. Once on the territory, the sight of an unincubated clutch may have stimulated immediate incubation. At Bird (Nisbet 1981a) and Falkner Islands, adults returned from bathing, settled on the shore and preened before they flew to the nest. Roseate Terns at Falkner also were confronted with more trapping disturbances (5 per hr). At Cedar Beach and Bird Island fewer intrusions were

made into each area to trap; although the greatest behavioral differences were between these two sites.

Roseate Terns resting on the beach on the day of trapping at Bird Island did not spend much time preening, and some spent long periods hunched up, which suggests a prolonged behavioral response to the trauma of trapping. The reasons for the colony differences are unclear. The possibility exists that differences in handling methods may have contributed to these differences, although we minimized handling time (similar among colonies) and trauma.

At Cedar Beach, trapped birds usually returned within an hour (80%) and resumed incubation. At Falkner and Bird Islands the released birds returned an average of over two hours later, leaving the absent mate to resume incubation when it returned. Thus at Falkner and Bird Islands the B birds, if not present initially, took longer to return to the nests (probably from their normal foraging activities) than did the B birds at Cedar Beach. Distance to foraging ground may be a factor in determining both return times for B birds and vulnerability times (Richards and Schew 1989). Safina (1990) showed that terns at Cedar Beach had a greater variety of foraging habitats surrounding the colony than are available at Falkner Island. Terns at Bird Island usually travel longer distances (8–25 km) to forage (Nisbet 1981a). Terns at Cedar Beach can forage closer to the colony than do those at the other colonies, possibly accounting for a more rapid return of mates.

In comparing the behavior of Roseate Terns at Cedar Beach in this study (1989, 1990) with 1988 data (Burger and Gochfeld 1991b), we found differences in time for Bird A to return (12.9 vs. 41 min), but not in vulnerability time (10.5 vs. 13 min). In the 1970s the median time for return at Bird Island was 3 hr (range = 20 min to 18 hr, Nisbet 1981b); it was longer than 3 hr in 1990.

This study found significant colony differences in the time for a trapped bird to return to the nest, and in the time a nest was vulnerable when neither parent was present. The terns returned earliest at Cedar Beach, and latest at Bird Island. Cedar Beach has mammalian predators, while the other two do not. The short vulnerability times at Cedar Beach may be a reflection of increased mammalian predation pressures. The longer vulnerability times at Falkner and Bird Islands suggest that researchers should carefully monitor their trapping methods to reduce adverse effects on the nesting terns, and that trapping should be limited to early morning or late afternoon hours when eggs or chicks are less vulnerable to heat or cold stress. Reproductive success is consistently higher at Bird Island than at Cedar Beach (Nisbet et al. 1990) suggesting that trapping is not adversely affecting productivity there as reported by Nisbet (1981a). Our data are being used to limit and refine trapping procedures at these colonies. The data indicate that colony differences in responses to trapping should be considered in planning trapping at other colonies.

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