J. Field Ornithol., 60(3):350-357

RENESTING BY CALIFORNIA LEAST TERNS

BARBARA W. MASSEY
Department of Biology
California State University
Long Beach, California 90840 USA

JACK M. FANCHER
U.S. Fish & Wildlife Service
24000 Avila Road
Laguna Niguel, California 92656 USA

Abstract.—Breeding sites of Least Terns (*Sterna antillarum browni*) form five clusters along the California coast. Renesting in the seven-colony Los Angeles/Orange County cluster was generally at the same or an adjacent colony (89%). Moves outside the cluster have rarely been documented. The major cause of renesting was loss of chicks, mostly attributable to predation. Loss of eggs was rare until 1986, but rose significantly in 1986 and 1987 with increased predation by red foxes (*Vulpes fulva*) and American Crows (*Corvus brachyrhynchos*). The interval between loss of eggs and renesting was 4–16 d; after chick loss the interval before renesting was 5–12 d. Evidence of group adherence was found in renesting patterns at several colony sites.

REANIDAMIENTO DE *STERNA ANTILLARUM BROWNI* EN CALIFORNIA

Resumen.—A lo largo de la costa de California se pueden encontrar cinco congregaciones de anidamiento de la gaviota *Sterna antillarum browni*. En la congregación del condado Los Angeles/Orange individuos de la colonia 7 reanidaron, en el 89% de los casos, en la misma área o en una colonia adyacente. Movimientos fuera de una misma congregación raras veces han sido documentados. La causa principal de reanidamiento lo fué la perdida de polluelos, atribuible a depredación. La perdida de huevos resultó ser rara hasta el 1986. No obstante, aumentó considerablemente durante 1986 y 1987 a causa de depredación por parte de zorras rojas (*Vulpes fulva*) y cuervos (*Corvus brachyrhynchos*). El intérvalo entre la perdida de huevos y el reanidamiento resultó ser de 4–16 d., y de 5–12 d. cuando hubo perdida de pichones. Evidencia de adherencia grupal fué encontrada en el patrón de reanidamiento de aves en diferentes zonas de la colonia.

Least Terns (*Sterna antillarum browni*) nest in California from San Francisco Bay to the Tijuana River mouth just north of the Mexican border. There are 5 disjunct clusters of colonies with 60–350 km between them (Fig. 1). We have recently examined inter-colony movements and found that tenacity to a breeding site is a strong trait (Atwood and Massey 1988). First-time breeders have shown a predilection for their natal colony, and once an adult has nested at a site there is a strong tendency to return there the next year. When adults have switched to another site in successive years, 92% of the relocations were either within a distance of 15 km or to the next nearest site. Movements between clusters have seldom been documented.

Least Terns renest after loss of eggs or chicks (Massey and Atwood 1981), and pairs remain together throughout the breeding season. Only twice have we observed the formation of a new mid-season bond, in both instances after disappearance of a mate after the first clutch hatched. The

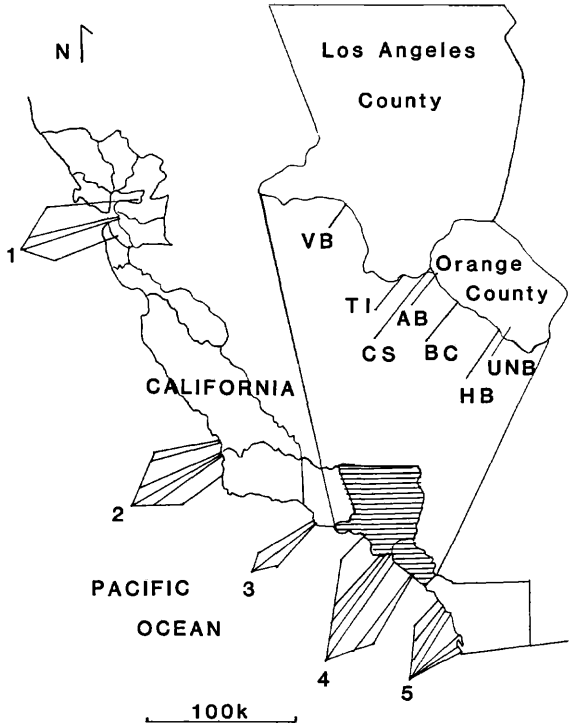

FIGURE 1. Clusters of Least Tern nesting colonies on the California coast. 1—San Francisco Bay group 2—San Luis Obispo/Santa Barbara County group, 3—Ventura County group, 4—Los Angeles/Orange County group, 5—San Diego County group. Enlargement shows Los Angeles/Orange County cluster: VB = Venice Beach, TI = Terminal Island, CS = Costa del Sol, AB = Anaheim Bay, BC = Bolsa Chica, HB = Huntington Beach, UNB = Upper Newport Bay.

second nesting wave usually begins in mid-June and has two components, renesters and 2-yr old terns breeding for the first time (Massey and Atwood 1981). Our data on banded adults and nesting phenology at colonies in Los Angeles and Orange Counties since 1978 have enabled us to examine the following parameters involved in renesting: circumstances that cause renesting, intervals between nesting attempts, percentage of renests at the same vs. a new site, probable causes for changing to another site, and group adherence.

STUDY AREA AND METHODS

The study area was the Los Angeles/Orange County cluster of seven colonies (Fig. 1). The Venice and Huntington Beach sites are on oceanfront beaches and considered to be closest to natural, pre-development habitat. Terminal Island and Costa del Sol are landfills, never intended

TABLE 1. Number of pairs of Least Terns nesting in Los Angeles and Orange County colonies 1980–1987.

Colony sites	1980	1981	1982	1983	1984	1985	1986	1987	Total
Venice Beach	157	150	170	145	83	96	104	109	1014
Terminal Island	0	37	65	82	116	60	79	40	479
Costa del Sol	0	18	21	22	4	33	4	0	102
Anaheim Bay	40	42	18	4	21	20	49	69	263
Bolsa Chica	23	62	90	140	102	118	70	80	685
Huntington Beach	80	112	98	88	70	45	69	58	620
Upper Newport Bay	3	0	0	9	6	0	22	42	82
Total	303	421	462	490	402	372	397	398	

as breeding sites. The sites in Anaheim Bay, Bolsa Chica and Upper Newport Bay are islands designed specifically for Least Tern nesting. Colony size ranged from 3 to 150 pairs (Table 1).

Systematic banding of chicks began in major southern California colonies in 1976; color banding of breeding adults began in 1978. At four colonies (Venice Beach, Terminal Island, Costa del Sol, Huntington Beach) the phenology of nesting was followed by marking nests and noting laying date, clutch size, hatching date, and renesting, as well as identifying color-banded adults. The other three sites were less often visited and renesting not as thoroughly documented.

For this report we examined the records of Least Terns nesting in Los Angeles and Orange Counties from 1980 through 1987. The actual number of renests is greater than shown here, as less than half the adults were banded and thus identifiable when they renested. Only confirmed renesting attempts have been analyzed, sighting of a banded bird in a colony was not considered conclusive evidence of renesting. The data are reported for pairs; when both members of a pair were banded, they were considered as a unit. There were four instances of pairs renesting twice in a season; only the first renest was included in our tabulations.

RESULTS

Causes of failure of initial nesting attempt.—From 1980–1987 90 instances of renesting were documented in Los Angeles and Orange Counties (Table 2). At all colonies there were both nest failures and renesting attempts.

In 78 of the 90 renests, circumstances that led to renesting were known; 21 pairs (27%) renested after losing eggs, 7 (9%) after abandoning eggs, and 50 (64%) after losing chicks. The other 12 pairs had been observed on eggs early in a season, and then seen renesting later, without our knowing whether they lost eggs or chicks.

Predation on a large scale (causing destruction of more than half the eggs or chicks and usually by a single predator) occurred four times and accounted for 31% of the documented second attempts. Egg predation by

TABLE 2. Site selection by renesting pairs of California Least Terns in Los Angeles and Orange Counties (n = 90).

Initial nesting site	Renesting site			Total
	Same colony	Adjacent colony	Other[1]	
Venice Beach	20	6	0	26
Terminal Island	0	3	1	4
Costa del Sol	4	14	0	18
Anaheim Bay	2	5	0	7
Bolsa Chica	0	0	2	2
Huntington Beach	21	5	7	33
Total	47 (52%)	33 (37%)	10 (11%)	90

[1] Another colony in the LA/Orange County cluster.

a red fox (*Vulpes fulva*) destroyed 15 of 16 clutches at Anaheim Bay in 1982. In 1986 a vandal at Huntington Beach was responsible for loss of eggs from 32 of 53 nests. In 1987 a fox took the eggs from 17 of 32 nests at Huntington Beach. There were color-banded adults at 31 of the above nests; 17 were found renesting. An American Kestrel (*Falco sparverius*) took all chicks from the 33-nest colony at Costa del Sol in 1985, resulting in 11 documented renests.

Abandonment occurred in four instances after adults were trapped on the nest, once after ants invaded a nest, twice for reasons unknown.

Interval between nesting attempts.—The interval between loss of eggs and relaying was known in 21 cases. The range was 4–16 d with ⅔ occurring at 7–9 d. The interval between loss of chicks and renesting was documented in 11 cases, all at Costa del Sol in 1985. All chicks were killed in a period of 4 d; renesting took place 5–12 d later at the adjacent Terminal Island breeding site.

Renesting at the same vs. a new site.—Eighty of the 90 pairs renested at the same or an adjacent site (Table 2). The majority (52%) stayed at the same site; of the 43 pairs that moved, 33 (81%) went to an adjacent colony. There was only one instance of a pair moving from one end of the cluster to the other (Huntington Beach to Venice Beach). Site selection for renesting was not random; Venice Beach and Huntington Beach pairs showed a significant preference for renesting at the same site whereas birds in the other colonies usually moved (Pearson and Likelihood Ratio $\chi^2 = 52$, $P < 0.001$). Of the 43 pairs that relocated, 26 (60%) went to Terminal Island.

Four pairs nested three times during a season (only the first attempt was included in our calculations); two stayed at the same colony throughout, two moved with each attempt.

Group adherence.—The renesting locations of 12 banded pairs at Huntington Beach in 1986 showed evidence of group adherence. The terns nested initially in a dumbbell shaped pattern with 18 pairs in a cluster on the west side of the sanctuary, 31 pairs on the east side, and four nests

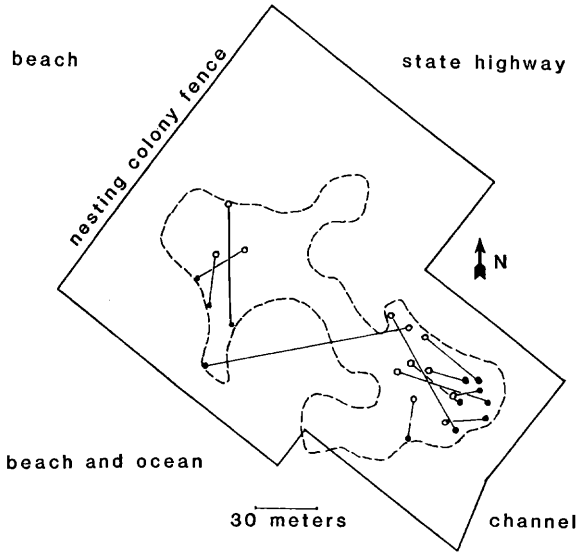

FIGURE 2. Renesting sites of 12 pairs at Huntington Beach in 1986. Open circle = first attempt, closed circle = renest. Dashed line depicts the total area used by all nesting Least Terns in 1986. The total number of nests in the colony was 94.

between the two clusters. In renesting, three marked pairs in the west-side group stayed together, and eight of nine pairs on the east side renested in close proximity (Fig. 2). Only one pair crossed over from the east to the west group. The likelihood of this being a random occurrence is $P = 0.018$ (Fisher's Exact Test).

Evidence of group adherence was also seen among terns in the central colonies. Nine banded birds that nested at Terminal Island in 1984 moved to Costa del Sol to breed in 1985. After losing all chicks to a predator there, they all renested at Terminal Island, to which they returned in 1986. In 1987 the Terminal Island site was beset by predators and many pairs relocated. Ten went to Anaheim Bay to breed; none were seen at any other colony, including Venice Beach, the adjacent colony to the north.

DISCUSSION

Predation on eggs and chicks was the major cause of nest failure in this study. Storms and/or high tides, responsible for much egg loss on the eastern seaboard (Hagar 1937, Loftin and Thompson 1979), caused only occasional losses in California during the period of this study. Starvation caused many chick deaths in 1982 when the severe El Niño phenomenon of that year apparently reduced the Least Tern food supply (Atwood and Kelly 1984), but renesting was minimal, as might be expected when food is scarce.

Loss of eggs to predators was an uncommon occurrence in Los Angeles and Orange County before 1986, with only one instance of a colony being decimated (Anaheim Bay 1982). In the past 5 yr, however, there has been a rapid spread in the range and density of the red fox, an introduced species in southern California. Foxes are now well established in most saltmarshes and are a major threat to eggs at several colonies (California Least Tern Recovery Team, unpublished data). American Crows (*Corvus brachyrhynchos*) have also been increasing in numbers in Los Angeles and Orange Counties and were responsible for the abandonment of the Terminal Island colony in 1987 (California Least Tern Recovery Team, unpublished data).

After egg loss Least Terns renested very quickly; the earliest documentation was 4 d, considerably less than the 9-d minimum interval reported for Common Terns (*Sterna hirundo*) (Hays 1984). Renewal of courtship behavior has been seen as soon as 1 d after loss of eggs; in 1982 after fox predation at Anaheim Bay, pairs were courtship feeding and scrape-making at an adjacent colony site on the following morning.

We have long known that pairs renest after loss of small chicks (Massey and Atwood 1981); we now have evidence that they may renest even after loss of fledglings. One Venice Beach pair seen feeding a fledgling in late June renested there in mid-July. There was no indication that the pair was starting a new cycle after successfully raising a first brood, as has been reported for Common Terns (*Sterna hirundo*) (Hays 1984, Wiggins et al. 1984); no juvenile was ever seen near the nest. Four additional pairs presumably renested after loss of fledglings, based on the date of hatching of the first brood and the renesting date (30–40 d later).

The preference shown by Least Terns for renesting at the same site is comparable to their fidelity to a nesting site from one year to the next (Atwood and Massey 1988). The pattern is particularly noticeable at long-established colonies in traditional beach settings like Venice Beach and Huntington Beach. At Venice Beach three pairs have renested in the same scrape after losing their chicks. At Huntington Beach the locations of 17 renesting pairs have been mapped: ten renested within 30 m of their original nest, five within 60 m, only two moved farther than 60 m. The four breeding sites between Venice Beach and Huntington Beach are on filled land, one (Costa del Sol) on a site created for housing that was only marginally suitable for nesting. Terns at these sites have shown a greater tendency to move.

Renesting outside of the cluster has been documented twice and probably accounts for a small percentage of the total second attempts.

Choice of a renesting site is apparently in some measure influenced by the status of a colony at the time pairs are preparing to renest. If chick-rearing has been successful and most of the young have fledged, or conversely if there has been destruction of almost all nests, the tempo of activity at a site is reduced to a very low level, with only a few adults vocalizing and few or no chicks on the ground. The attraction of the site is probably much diminished. Such was the case at Anaheim Bay in 1982

and Costa del Sol in 1985, in both instances renesting was at another site. But at Huntington Beach in 1986 and 1987, even after loss of more than half the clutches there were still many viable nests, and the level of activity was apparently high enough to invite renesting.

Both site tenacity and group adherence are important adaptive traits in larids; when the breeding site is in a stable environment site tenacity insures a group of closely associated pairs, but when the colony must relocate, group adherence acts to keep them together (McNicholl 1975). In stable colonies with strong site tenacity, group adherence is masked. Renesting can help separate these two traits. Austin (1951) found evidence of group adherence in Common Terns when a cluster of banded pairs that lost nests to a predator renested close together in another part of the colony rather than dispersing. We observed similar behavior at Huntington Beach in 1986.

Venice Beach birds, which show the greatest site tenacity (Atwood and Massey 1988), have not been known to renest anywhere except Terminal Island, the closest adjacent colony, and usually have returned to Venice Beach the following year. We believe that the behavior of the Venice Beach birds most closely reflects the natural behavior of undisrupted Least Terns. Site tenacity is very strong when nesting is orderly and the birds are successful; and the Venice Beach colony has generally been very successful, producing at least one fledgling per pair for nine of the past ten seasons (California Least Tern Recovery Team, unpublished data). When nest sites are temporary, and/or disturbance and predation are regular problems, the terns have relocated more often, both for renesting and in subsequent years. The mobility may affect a pair's breeding success and the pair bond; we are investigating both possibilities.

ACKNOWLEDGMENTS

We are grateful to Jon Atwood, Dennis Minsky, Lyle Massey and Kathy Keane for their many hours of field work in Least Tern colonies and for stimulating discussions on what was occurring. We thank Dave Bradley for doing the statistical analyses and Jon Atwood for critical reading of the manuscript that resulted in many constructive changes. Charles Collins has, over the years, been responsible for most of the chick-banding sessions; we also thank him for comments on the manuscript in an earlier form.

LITERATURE CITED

ATWOOD, J. L., AND P. R. KELLY. 1984. Fish dropped on breeding colonies as indicators of Least Tern food habits. Wilson Bull. 96:34–47.

———, AND B. W. MASSEY. 1988. Site fidelity of Least Terns in California. Condor 90: 389–394.

AUSTIN, O. L. 1951. Group adherence in the Common Tern. Bird-Banding 22:1–15.

HAGAR, J. A. 1937. Least Tern studies—1935 and 1936. Bull. Mass. Audubon Soc. 21: 5–8.

HAYS, H. 1984. Common Terns raise young from successive broods. Auk 101:274–281.

LOFTIN, R. W., AND L. A. THOMPSON. 1979. An artificial nest structure for Least Terns. Bird-Banding 50:163–164.

MASSEY, B. W., AND J. L. ATWOOD. 1981. Second wave nesting of the California Least Tern: age composition and reproductive success. Auk 98:596–605.

McNicholl, M. K. 1975. Larid site tenacity and group adherence in relation to habitat. Auk 92:98–104.

Wiggins, D. A., R. D. Morris, I. C. T. Nisbet, and T. W. Custer. 1984. Occurrence and timing of second clutches in Common Terns. Auk 101:281–288.

Received 19 May 1988; accepted 1 Oct. 1988.