

MATE RETENTION IN CASPIAN TERNS

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ABSTRACT.—Colonial seabirds that nest in stable, predictable environments tend to breed with the same mate for consecutive seasons. In some of these populations, mate retention has been shown to be correlated with previous reproductive success. Caspian Terns (*Sterna caspia*) were observed in northeastern Lake Michigan at several colony sites that vary in stability because of fluctuating water levels. Objectives of my study were to determine if (1) individuals tend to keep the same mate for consecutive breeding attempts, (2) mate retention is influenced by previous reproductive success or inter-year nest site stability, and (3) reproductive success is affected by mate change. Only 25% of the original pairs bred together for consecutive seasons, mate retention was independent of reproductive success the previous year but not of inter-year nest site stability, and I found no significant advantage in retaining the same mate for consecutive seasons. These results indicate that factors other than previous reproductive success (e.g., habitat stability) influence mate selection and retention in this population of Caspian Terns. Caution should be exercised in assuming that the relationship between mate retention and previous reproductive success holds for other species of colonial seabirds.

In birds that exhibit bi-parental care, selection of a breeding partner has great consequences for individual reproductive success. Data from long-term studies of marked individuals indicate that many colonial seabirds tend to keep the same mate for consecutive breeding seasons. Examples include Sphenisciformes (Richdale 1947, 1957), Procellariiformes (Richdale 1947, Fisher 1976, Macdonald 1977, Brooke 1978, Ollason and Dunnet 1978, Morse and Buchheister 1979, Boersma et al. 1980), Pelecaniformes (Nelson 1972, Fleet 1974), and Charadriiformes (Austin 1947, Coulson and White 1958, Tuck 1960, Dorward 1963, Coulson 1966, Mills 1973). While studying colony site tenacity in Caspian Terns (*Sterna caspia*) in the Great Lakes, I discovered that mate retention was low. Only a few other investigators of colonial seabirds have found mate changes to be common, and most examples are from pelecaniform populations (Snow 1963, Kepler 1969, Harris 1979). Previous research on mate retention in colonial seabirds has been conducted on birds that nest in stable and predictable environments. In contrast, Caspian Terns from the Great Lakes population nest in habitat that varies in stability because of fluctuations in water level. I report here the results of a two-year investigation of mate retention in Caspian Terns breeding in northeastern Lake Michigan. The purpose of my study was to determine if habitat instability is an important variable affecting pairing behavior in this population of colonial nesting birds.

Five questions were considered: (1) do Caspian Terns keep the same mate for consecutive breeding seasons? (2) is mate retention inde-

pendent of reproductive success in the previous season? (3) is mate retention independent of inter-year nest site stability? (4) is reproductive success affected by mate change? and (5) if the first nesting fails and terns re-nest in the same season, do they keep the same mate for the second nesting attempt?

STUDY AREA AND METHODS

The study area included four islands in northeastern Lake Michigan where 1,100 pairs of Caspian Terns (30% of the Great Lakes population) nested in 1978 and 1979. The colony sites were: (1) the northeastern point of High Island (45°45'N, 85°40'W), (2) Hat Island (45°47'N, 85°18'W), (3) Shoe Island, a gravel bar 1 km S of Hat Island, and (4) Ile aux Galets (45°41'N, 85°11'W). The islands varied in size from less than 1 ha (Shoe Island) to 3 ha (Ile aux Galets), 7 ha (Hat Island) and 1,430 ha (High Island). Distances between the islands ranged from 1–39 km and all four colonies were separated by >90 km from the only other Caspian Tern colony in Lake Michigan. During the two breeding seasons, colony size ranged from 125–520 pairs (\bar{x} = 278). Three other species of larids, Herring Gull (*Larus argentatus*), Ring-billed Gull (*L. delawarensis*), and Common Tern (*Sterna hirundo*) nested adjacent to the Caspian Terns (Scharf 1978). Water level on the Great Lakes fluctuates cyclically (Cohn and Robinson 1976) and breeding Caspian Terns are affected directly by these changes (Shugart et al. 1978, Cuthbert 1981). When water levels are above average, Shoe Island is submerged and parts of the other islands are vulnerable to storm damage.

To determine degree of mate retention between consecutive breeding seasons, in 1978 and 1979 I attempted to follow the nest histories of color-marked terns. In early June 1978, 24 pairs were captured with a monofilament line snare on their nests at Ile aux Galets and High Island, and were banded with unique color combinations of plastic leg bands and a U.S. Fish and Wildlife Service (USFWS) leg band.

Data on reproductive success of each tern were collected in the following manner: all nests of color-banded birds were numbered with wooden stakes and chicks were banded with USFWS bands when they were 2–3 days old. Nests were checked periodically from early incubation through banding of chicks. After the chicks were banded, I watched the color-marked parents and their offspring from blinds located on the edge of the colonies. Most of my efforts were concentrated at Ile aux Galets and High Island, but I visited the other islands every 8–10 days throughout the season to locate and monitor birds that were no longer nesting at their 1978 colony. Adults were considered to have failed to reproduce only if the entire nest contents failed to hatch or were destroyed. Terns that raised one or two chicks to fledging (40+ days) were recorded as having a successful reproductive season. All data were analyzed using the Fisher Exact Test (Zar 1974).

RESULTS

MATE RETENTION IN CONSECUTIVE BREEDING SEASONS

The identity of mates of color-marked terns was recorded in 1978 and 1979 to determine if Caspian Terns keep the same mate for consecutive breeding seasons. Only 25% (6/24) of the 1978 pairs were present in 1979 (Table 1). Of the remaining 18 pairs, 17 were no longer together; in one case, mate retention was undetermined because neither member of the pair was seen at any of the active colony sites. Of the pairs that were no longer together in 1979, two (12%) involved situations where one or both members were nonbreeders for the entire 1979 season. In the remaining 15 pairs (88%), one or both individuals were seen breeding with a new mate in 1979. Birds seen breeding with new mates could be divided into two categories based on whether or not the mate from 1978 was present in 1979. Six pairs (40%) had separated, even though their 1978 mate was present in the study area. An additional nine pairs (60%) were no longer together and one member of each of these pairs was not seen in the study area for the entire 1979 breeding season.

TABLE 1. Pair combinations in consecutive breeding seasons.

Pair combinations	Pairs (<i>n</i> = 24)	Percent
Same mate	6	25
New mate (previous mate present)	6	25
New mate (previous mate not seen)	9	38
Non-breeders		
Both individuals	1	4
One individual (previous mate not seen)	1	4
Both individuals not seen	1	4

MATE RETENTION AND PREVIOUS REPRODUCTIVE SUCCESS

The discovery that only one-fourth of the pairs in my sample remained together for consecutive breeding seasons raised the following question: is mate retention independent of previous success? Data were analyzed in two ways. First, I looked at pairs regardless of whether or not the original mate was present in the study area. Of 21 pairs where at least one member was found breeding in 1978, 17 had raised one or two chicks to fledging in 1979. Five (29%) of these successful pairs bred together again in 1979, but 12 pairs (71%) were not re-established the following year. Four pairs were unsuccessful in 1978. One of these remained together in 1979; three individuals from the other pairs were seen breeding with different mates in 1979. When these data were tested, I found that the null hypothesis that mate retention is independent of previous reproductive success held true ($P > 0.50$).

For the second analysis, I considered only the pair combinations where the original mate was known to be present in the study area. Birds that changed mates because the original mate died or disappeared were excluded from this analysis. The sample size was 12 pairs, of which 10 were successful in 1978. Of the successful pairs, five were noted breeding together again in 1979. The other five pairs, however, were no longer intact the following year and each member of the original pair bred with a new partner, even though its mate of the previous season was observed in the study area. Two of the pairs were unsuccessful in 1978. One of these remained together in 1979. The other pair separated and both individuals were seen breeding with different mates in 1979. These data also were tested and, again, the null hypothesis held true ($P > 0.50$).

REPRODUCTIVE SUCCESS FOLLOWING MATE CHANGE

To determine how mate change affects subsequent productivity of chicks, I examined the

TABLE 2. Reproductive success and mate retention in consecutive breeding seasons.

1978	1979	
	Successful	Unsuccessful
Successful terns		
Retained mate	6	4
Changed mate	4	8
Unsuccessful terns		
Retained mate	2	0
Changed mate	1	1

$n = 26$.

breeding success of 26 color-marked terns with known mates and breeding history in 1978 and 1979 (Table 2). The sample of two terns that failed to reproduce in 1978, and of one tern that changed mates in 1979, was too small to analyze. Of 22 terns that were successful in 1978, 12 changed mates and 10 kept the same partners in 1979. Of those that changed mates, only four (33%) were successful, whereas six (60%) of the birds that bred with the same mate raised at least one chick to fledging. Although these data suggest that there may be an advantage to retaining the same mate for consecutive seasons, the hypothesis that reproductive success is independent of mate retention held true ($P > 0.50$).

MATE RETENTION IN RE-NESTERS

As the study progressed, an additional question developed: if Caspian Terns fail to reproduce and then re-nest within the same season, do they keep the same mate for the second attempt? Although the sample was small, the results were interesting. Six of the 24 pairs failed to reproduce. Of these, one pair separated and did not attempt to breed a second time. The five other pairs remained together and re-nested, and four of them raised at least one offspring to fledging.

MATE RETENTION AND INTER-YEAR NEST SITE STABILITY

Because large portions of the two primary colony sites (High Island and Ile aux Galets) were submerged or significantly altered by winter storms between the 1978 and 1979 breeding seasons, I was able to examine if mate retention is influenced by whether or not birds can return to the same nest site. In 1979, I located at least 1 breeding member from each of 21 of the 1978 pairs. Twelve of the 1978 nest sites were no longer available because of high water or changes in beach configuration. Of the 12 pairs associated with these sites, 11 (92%) were no longer together and only 1 (8%) was still intact. In contrast, the nest sites of nine pairs were not noticeably different between the two

years; five pairs remained together and four were found nesting with new partners. The hypothesis that mate retention is independent of inter-year nest site stability was tested and rejected ($P < 0.05$). These results suggest that habitat stability may influence mate retention in this population.

DISCUSSION

My results are not consistent with similar studies on mate retention in numerous other species of seabirds. For example, my findings indicated that mate retention between breeding seasons occurs in about 25% of the pairs. This is in contrast to 95% retention reported for the Northern Fulmar (*Fulmarus glacialis*; Ollason and Dunnet 1978); 80% for the Common Tern (Austin 1947), White Tern (*Gygis alba*; Dorward 1963), Silver or Red-billed Gull (*Larus novaehollandiae*; Mills 1973), and Manx Shearwater (*Puffinus puffinus*; Brooke 1978); 75% for the Common Murre (*Uria aalge*; Tuck 1960); 71% for the Fork-tailed Storm-Petrel (*Oceanodroma furcata*; Boersma et al. 1980); 67 and 68%, respectively, for Leach's Storm-Petrel (*O. leucorhoa*; Morse and Buchheister 1979) and the Red-tailed Tropicbird (*Phaethon rubricauda*; Fleet 1974); and 64% for the Black-legged Kittiwake (*Rissa tridactyla*; Coulson 1966).

I also found that Caspian Terns often change mates, even though offspring are raised to fledging in the previous breeding season. Coulson (1966) suggested that in kittiwakes, mate retention is advantageous unless the pair is incompatible (fails to hatch eggs). He proposed that changing mates is an adaptive behavior for unsuccessful pairs because they are more likely to breed successfully with a new mate. I found, however, that most pairs which failed to reproduce and then initiated a second nest did not change mates; Caspian Terns that changed mates did not significantly improve their reproductive success in the subsequent season. A number of investigators have found that in certain populations of seabirds, individuals that fail to reproduce are more likely to change mates than birds that successfully produce offspring (Coulson 1966, Mills 1973, Fleet 1974, Brooke 1978, Ollason and Dunnet 1978, and Boersma et al. 1980). To my knowledge, nothing has been reported about whether or not mate retention is influenced by previous reproductive success in other species of terns. Nevertheless, studies on the Masked Booby (*Sula dactylatra*; Kepler 1969) and the Flightless Cormorant (*Nannopterum harrisi*; Harris 1979) also did not find a relationship between mate retention and previous reproductive success. These studies and my data on Caspian

Terns show that, as a single factor, previous reproductive success did not have a strong influence on mate retention in at least three species. Therefore, caution should be exercised in assuming that the relationship between mate retention and previous reproductive success holds for all species of colonial seabirds.

Because mate retention is high in a number of species and appears to be related to reproductive success, it is important to consider why Caspian Terns and perhaps other seabird species do not fit this pattern. To date, most studies on mate retention in seabirds have examined species that nest in stable habitats, often with individuals returning to occupy the same burrow or cliff ledge as the previous year. In fact, several authors have pointed out the problem of measuring mate retention in populations that breed at stable sites. Nelson (1978) stated that Northern Gannets (*Sula bassana*) nesting in the North Atlantic are faithful to both mate and site and that it is difficult to study these two factors independently. Morse and Buchheister (1979) found that site fidelity far exceeded mate fidelity in Leach's Storm-Petrel and suggested that re-mating is a function of burrow fidelity. Recently Morse and Kress (1984) demonstrated experimentally that retention of the same mate by Leach's Storm-Petrel during successive breeding seasons is largely or totally dependent on site tenacity. Data for three species of terns which nest in a range of habitats suggest that mate retention is high in stable habitats (White Tern, Dorward 1963), medium in habitats of mixed stability (Common Tern, Austin 1947), and low in unpredictable environments (Caspian Tern, this study). The relationship between mate retention and habitat stability may be similar to that proposed by McNicholl (1975) between habitat stability and nest and colony site tenacity: the more predictable the environment, the higher the degree of mate retention.

Additional studies on species that use habitats of different degrees of stability are needed to clarify the relationship between site tenacity and mate retention. I would expect mate retention to be lower in the marsh- and riverbed-nesting tern species (e.g., Forster's Tern, [*Sterna forsteri*], McNicholl 1982; Black-bellied Tern [*S. acuticauda*], Ali and Ripley 1969) than in populations that occupy stable sites such as rock crevices or ledges (Brown Noddy [*Anous stolidus*], Dorward and Ashmole 1963). It also would be interesting to examine mate retention in the other sub-populations of Caspian Terns breeding in the Great Lakes. The colony sites in northeastern Lake Michigan are on small islands that are less protected from storm damage than some of the sites where these

terns breed in northwestern Lake Michigan (Gravelly Island) and in northern Lake Huron (North Channel and Georgian Bay).

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