Condor, 82:251–258

COLONY AND NEST SITE SELECTION IN LAUGHING GULLS IN RESPONSE TO TIDAL FLOODING

JOANNA BURGER

AND

JOSEPH SHISLER

ABSTRACT.—We examined colony and nest site selection in Laughing Gulls (*Larus atricilla*) from 1976 to 1979 in Barnegat Bay, New Jersey. Laughing Gulls nested predominantly in *Spartina alterniflora* on low salt marsh islands. In 1978, the gulls shifted colony locations to higher islands that contained a higher percentage of *S. patens* and *Phragmites*. The gulls nested on spoil areas which were slightly higher in elevation. Differential nesting success occurred as a function of habitat because of high tides in early July which wiped out all nests in *S. alterniflora* and most of those in *S. patens*. Chick survival varied as a function of vegetation type. We propose that all larid species exhibit site tenacity because they return to former sites even if they eventually shift locations. Further, we suggest that each species chooses from a wide range of potential colony and nest sites depending upon local conditions and proximate environmental cues.

Many species of gulls and terns exhibit remarkable colony site tenacity in that they occupy the same places for decades or longer. This is particularly true of colonies situated in stable habitats such as rocky islands or cliffs: Black-legged Kittiwake (*Rissa tridactyla*) colonies use the same cliffs every year (Coulson and White 1956, 1958, 1960) and Glaucous Gulls (*Larus hyperboreus*) often nest on the same rocks in tundra lakes year after year (Snyder 1940). A colony of Black-headed Gulls (*L. ridibundus*) has remained at Ravenglass in England since the 1600's, nesting amid sand dunes and marram grass (Patterson 1965). Colony site tenacity has also been shown for the Herring Gull (*L. argentatus*; Tinbergen 1961, Ludwig 1963), Silver Gull (*L. novaehollandiae*; Murray and Carrick 1964), Glaucous-winged Gull (*L. glaucescens*; Vermeer 1963), Ring-billed Gull (*L. delawarensis*; Southern 1967), Black-headed Gull (*L. ridibundus*; Beer 1961), and Laughing Gull (*L. atricilla*; Stone 1937, Noble and Wurm 1943).

Species that nest in unstable habitats, on the other hand, shift colony locations when habitats become unsuitable. Notable examples of such species are the Black-billed Gull (*L. bulleri*, Beer 1966), Franklin's Gull (*L. pipixcan*, Burger 1974a) and Brown-hooded Gull (*L. maculipennis*, Burger 1974b). The first species nests on sand bars in the middle of rivers, and the latter two nest in marshes that suffer sporadic changes in water levels (Weller and Spatcher 1965). The apparent dichotomy between species nesting in stable habitats versus those in unstable habitats prompted McNicholl (1971, 1975) to postulate that colony tenacity relates to habitat stability.

Colony site tenacity may not differ among species, but may relate to the conditions that particular members of each species face. A colony of kittiwakes might shift quickly if their cliff suddenly fell into the sea. Similarly, Laughing Gulls, usually considered to show a high degree of colony site tenacity (Bongiorno 1970, Nisbet 1971), may abandon colony sites when these become temporarily unsuitable.

In this paper we report on colony and nest site selection in Laughing Gulls under normal tidal conditions (1976, 1977, 1979) and under unusually high tidal conditions (1978). At the beginning of the study, we did not know when flooding tides would occur, but planned to continue the study until we encountered these conditions. We wished to determine if Laughing Gulls would respond to exceptionally high tides by changing colony sites, changing nest sites, or both.

Laughing Gulls nest from the Gulf of Mexico and the Caribbean to the northern Atlantic, although few colonies exist farther north than New Jersey. Along the middle Atlantic coast they nest in tidal salt marshes (Burger and Beer 1975), while south of the Carolinas they nest on sandy islands (Stone 1937, Buckley and Buckley 1972, Dinsmore and Schreiber 1974).

STUDY AREA AND METHODS

We studied Laughing Gulls on the islands in Barnegat Bay, New Jersey from 1976 to 1979. Laughing Gulls nested on Clam (39°48′N, 74°08′W), High Bar (39°44′N, 74°08′W) and Long Point (39°36′N, 74°16′W) islands. In 1978, they also nested on North and East Vole Sedge (39°48′N, 74°08′W) and East Carvel (39°41′N, 74°10′W) islands. The vegetation on all islands consisted mainly of salt marsh cord grass (*Spartina alterniflora*) and salt meadow cord grass (*S. patens*), although higher areas of Clam and High Bar Islands contained *Iva frutescens* and *Baccharis halimifolia*. *S. alterniflora* generally grows in low habitats partially inundated by normal tides, whereas *S. patens* grows in higher areas inundated only by flood tides. East Carvel contained an area of *Phragmites communis*. None of these islands is a spoil island, one created by dumping material dredged from the intracoastal waterway in the bay, or by placing spoil material on already existing islands. Spoil refers to the dredged material, which tends to be sandy.

From 15 April until 15 July each year we surveyed the islands every 7–14 days by helicopter and boat. We walked all areas occupied by Laughing Gulls, and recorded the kind of vegetation in which the colonies were located. From aerial surveys and maps we computed the percentage of each vegetation type on all study islands.

The flood tides in early and mid-April 1978 caused gulls to move from traditional colony areas. In 1978, we examined nest site placement in the two large colonies on High Bar and Vole Sedge islands. These were the only islands whose colonies increased in numbers in 1978 compared to previous years. Both islands had been ditched for mosquito control. Ditching results in the deposition of piles of spoil on the marsh beside the ditch. *S. patens* grew on the spoil, as well as on the adjacent areas. High Bar was ditched in 1977, whereas Vole Sedge was ditched in 1972.

We examined one area on each island for nest site placement. The plot on Vole Sedge was 130 × 80 m and contained 100 nests; that on High Bar was 240 × 200 m and contained 200 nests. Each area contained ditches and was located in the physical center of the colony. In each study plot we took the following data on all gull nests: clutch size, nest height, vegetation around the nest, distance to the spoil, and number of nests within 5 m. Using a table of random numbers to generate coordinates, we then measured the same physical characteristics for an equal number of random points in the study area. Mean nest height was measured from the ground to the top of the nest rim.

From April through August of 1976–1978, Burger was on Clam Island for 4 to 6 days a week studying Laughing Gulls and Herring Gulls. Burger was on Clam Island from 3 to 7 May 1978, observing the Laughing Gulls during the high tide. From 7–10 May 1978, we surveyed all islands in the bay area to determine where the gulls moved, and to observe their behavior.

RESULTS

COLONY SITE SELECTION

The number of nests on each island varied from year to year (Table 1). Laughing Gulls have nested on Clam Island and Long Point Island for many years. As Herring Gulls moved onto Clam Island, and nested in the high marsh once used by Laughing Gulls, some of the latter moved to nearby High Bar Island (Burger and Shisler 1978).

TABLE 1. Pairs of Laughing Gulls nesting on colonies in Barnegat Bay, New Jersey.

	1976	1977	1978	1979
Clam Island	5,000	4,200	300	3,500
High Bar Island	500	800	2,700	2,000
Long Point Island	1,000	1,000	1,000	500
Carvel Island	0	0	300	400
Vole Sedge Island	0	0	1,600	300
Total	6,500	6,000	5,900	6,700

In 1978, the Laughing Gulls shifted almost entirely from Clam Island to High Bar, Vole Sedge and Carvel islands during the high tides on 5–6 May (Table 1). These islands contained equal percentages of *S. patens* and brush areas. In 1976, 1977, and 1979 the gulls on High Bar nested in *S. alterniflora*, but in 1978 they shifted to bushes and *S. patens*. Carvel Island is higher than Clam or Vole Sedge islands. In 1976 and 1977 the gulls nested on islands 75% covered by *S. alterniflora*, whereas in 1978 the islands where they nested had a mean of 45% *S. alterniflora*.

The nests numbered about the same in all years. Table 1 was computed by counting the number of gull nests. There are no major Laughing Gull colonies north of Barnegat Bay, and the next largest colony is at Brigantine, 15 km south. Since the Brigantine colony did not shift (C. Beer, pers. comm.) we conclude that the same birds nested in the bay area each year.

Laughing Gulls returned to the traditional colony sites in mid-April of 1978, and some began to establish territories. Unusually high tides of 5–6 May just prior to egg-laying covered 75% of Clam and High Bar islands, forcing the gulls to leave their nesting territories. Some birds stood on their territories until the water was 3–5 cm deep. Eventually the tides obliterated any sign of land, as the vegetation was completely covered, and the gulls left. When the water receded on 5 May the gulls returned to stand on their territories. However, during the next night the tide again forced them to leave, and fewer birds returned the following day. After three days of high tides the gulls abandoned Clam Island. For a time they stood in "clubs" in the center of the island, but most left Clam Island by 8 May. During this period the population on nearby High Bar Island increased, presumably from the birds displaced from Clam Island. These Laughing Gulls did not nest on Clam

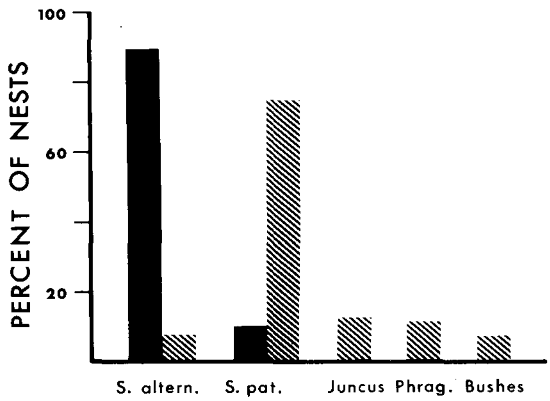

FIGURE 1. Location of Laughing Gull nests according to surrounding vegetation, for colonies in Barnegat Bay, New Jersey. Closed bar = 1976, 1977, and 1979; open bar = 1978.

Island in 1978. In 1979, however, substantial numbers of Laughing Gulls nested on Clam Island, occupying the areas used in 1976 and 1977.

NEST SITE SELECTION

Under normal tidal conditions, Laughing Gulls in New Jersey nest predominantly in *Spartina alterniflora*. Most gulls (89–92%) in 1976 and 1977 nested in *S. alterniflora*, whereas in 1978 they nested mainly in *S. patens* (Fig. 1). In 1976 and 1977, no Laughing Gulls nested in the high areas of *Juncus*, *Phragmites* or bushes. In 1978, these areas became centers for nesting. All early nests were built here while later ones were built in adjacent *S. patens* areas. We examined vegetation preferences and found that in areas of mixed *Spartina*, the gulls chose to nest in *S. patens* rather than *S. alterniflora* in 1978. On Vole Sedge Island, 100% of the gull nests were located in *S. patens*; 71% of the random points were in *S. patens* (χ^2 = 34, df =1, $P < 0.001$). In 1979, some gulls nested in *Juncus*, *Phragmites*, and bushes, but again most nested in *S. alterniflora*.

On Vole Sedge and High Bar islands, spoil areas were higher than the surrounding cord grass. On High Bar Island in 1978, 76% of the gull nests and 50% of random points were on spoil (χ^2 = 7.31, df = 1, $P <$ 0.001). On Vole Sedge Island in 1978, 38% of the gull nests and 19% of the random points were on spoil (χ^2 = 4.96, df = 1, $P <$ 0.05).

Spoil is always located next to ditches, which themselves may be attractive to the gulls. We therefore compared the distance to the ditches from nests on spoil, nests not on spoil, and the random points (Table 2). Although nests were significantly closer to ditches than were random points (ANOVA, F = 83.8, df = 2,419, $P < 0.001$), spoil and non-spoil nests did not differ significantly, with respect to the mean distance to ditches (*t*-tests).

Conceivably the gulls might have selected nest sites on the basis of vegetation height, as they did in Montevecchi's (1978) study. However, there were no significant differences (ANOVA) in mean vegetation height on 8–10 May 1978 as a function of island, island times nest site or nest sites (Table 2). The mean vegetation height varied from 21.6 ± 6 cm (random points on Vole Sedge) to 30.4 ± 6 cm (spoil nests on Vole Sedge). In general, the vegetation around nests was higher on spoil than on non-spoil sites.

We initially predicted that gulls nesting on the lower non-spoil areas would construct higher nests to compensate for their lower elevation. However there were no significant differences (ANOVA) with respect to nest height among islands, islands times nest sites, or nest sites (Table 2).

In 1976, 1977 and 1979, the gulls tended to nest in groups which were dispersed over the islands. In 1978 the gulls concentrated on higher elevations and were densely packed. We recorded two measures of nest density: nearest neighbor distance, and the number of nests within 5 m. With respect to

TABLE 2. Characteristics of Laughing Gull nests compared to random points for study islands in 1978.

Characteristic	Vole Sedge Island nests	Vole Sedge Island random points	High Bar Island nests	High Bar Island random points
Percent in *S. patens*	100	71*	98	76*
Percent on spoil	38	19*	76	50*
Distance to ditch (m)	9.8 ± 3	15.3 ± 5*	14.3 ± 5.4	41.5 ± 11*
Nest height (cm) spoil	9.2 ± 3.6	—	11.2 ± 1.5	—
non-spoil	9.3 ± 2.6	—	7.9 ± 2.6	—
Distance to nearest neighbor (m)	4.2 ± .9	10.6 ± 3*	3.3 ± 1.2	12 ± 6*
Nests within 5 m	6.4 ± 3	1.2 ± 8*	13.2 ± 4	1.1 ± .7*

* = Statistical differences at the .05 level.

TABLE 3. Percentage of Laughing Gull nests and chicks surviving the July 1978 storm as a function of the percentage of nests in each habitat on High Bar Island.

Vegetation	Percentage of nests in each area	Percentage of nests surviving	Percent chick survival
Spartina alterniflora	8	0	0
S. patens	72	48	45
Juncus	8	72	65
Bushes	12	96	83
Total number	500	300	500

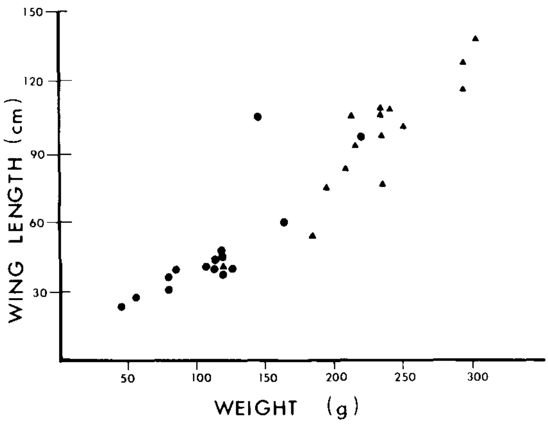

FIGURE 2. Relationship between wing length and weight for Laughing Gull chicks on High Bar Island after the 5–7 July 1978 storm. Circles = dead chicks; triangles = live chicks.

the distance to the nearest neighbor, there were significant effects of island times nest site and of nest site (F = 12.66, df = 2,594, $P < 0.01$: F = 150.4, df = 2,592, $P < 0.001$). Spoil and non-spoil nests did not differ on High Bar, but on Vole Sedge the non-spoil nests were farther apart than the spoil nests (Table 2, ANOVA), reflecting the gulls' tendency to prefer nesting on spoil. Birds that did not nest on spoil dispersed in the non-spoil area.

Examining the number of nests within 5 m, we found significant differences in island times nest site (F = 48.7, df = 1, $P < 0.001$) and nest site (F = 176.5, df = 1, $P < 0.001$). Densities were lower on Vole Sedge Island than on High Bar Island in each site type (Table 2). On High Bar Island, gulls were packed into the highest elevations, whereas Vole Sedge Island was higher overall and the birds were more spread out.

NESTING SUCCESS

The mean clutch size did not differ significantly (ANOVA) as a function of islands, island times nest sites, or nest sites for the five colonies in 1978. In early July, 1978, three days of heavy rain coincided with strong winds and high tides to inundate most salt marsh islands in Barnegat Bay. The percentage of chicks surviving varied by habitat on High Bar Island (Table 3). The vegetation had grown sufficiently to trap the dead gull chicks, so although they drowned or died of exposure, they were not carried by the water to other areas of the marsh. We were in the marshes during and immediately following the high tides. The survival figures were similar for the other islands in comparable habitats. As was expected, more chicks survived in the higher habitats. The almost total destruction in the lowest areas of *S. patens* strongly indicates that if any nests had been constructed in *S. alterniflora* they would have been washed out. Indeed, all nests on Clam Island were in *S. alterniflora*, and none survived the storm.

More small chicks died than larger ones (Fig. 2). Wing length tells the age of gull chicks, whereas we believe that weight indicates how well they are being fed. Our figure shows only chicks from high habitats in order to avoid confounding the results; all of these chicks were exposed to the same flooding conditions. All older chicks (large wing lengths) survived, all young chicks died and all middle-aged chicks lived if they were heavy.

DISCUSSION

COLONY SELECTION

Colony site selection is often discussed in papers dealing with habitat selection in gulls (cf. Bongiorno 1970, Burger 1974a, Southern 1977). Yet these papers merely describe colony location, which neither shows that species selected particular locations from a range of possibilities, nor that there were significant differences between all available locations and the birds' choice for a colony.

Burger and Lesser (1978) surveyed the available habitat along almost 100 km of New Jersey coastline to determine colony site selection in Common Terns (*Sterna hirundo*). They found that occupied islands differed from unused islands. In the present study, Laughing Gulls nested on islands with *Spartina alterniflora* and some *S. patens*, and not on the lower islands that contained only *S. alterniflora*. During high tide conditions in 1978, Laughing Gulls shifted within or among islands, colonizing the highest available parts of these islands.

Their overall choice of salt marsh islands is not surprising since there are no undisturbed dry, sandy barrier beach islands that are free from marinas, houses and recreational beaches in southern New Jersey. In most years, Laughing Gull colonies are on islands in the center of the bay rather than on islands adjoining barrier beaches. On High Bar Island, the gulls usually nest at the end of the island far from the boat channel. Under 1978 flood conditions, they abandoned the remote part of the island in favor of higher areas closer to humans. Similarly, the two Vole Sedge Islands used in 1978 were located near human activities beside the intercoastal waterway. Human disturbance, both recreational and scientific, creates problems for gull colonies (Robert and Ralph 1978, Gillett et al. 1978). In this study we compared behavior among years using similar procedures. We usually spent only one hour in any given colony on any day. Birds settled and incubated while we were watching. Thus, our disturbance was uniform and did not affect the results.

Laughing Gulls undoubtedly use islands rather than salt marshes attached to the mainland because of the absence of mammalian predators. While surveying by helicopter, we often saw dogs, raccoons, cats and children wandering over the mainland salt marshes. Several authors (Cullen 1960, Tinbergen 1961, Kruuk 1964) have suggested that larids select inaccessible colony sites as an antipredator mechanism. Kruuk (1964) and Patterson (1965) discussed the inability of Black-headed Gulls to defend nests adequately from mammalian predators. Southern and his colleagues (Patton and Southern 1977, Southern and Southern 1979) investigated the effects of gull antipredator behavior on mammals. They found that Ring-billed Gulls (*L. delawarensis*) could not successfully deter mammalian predators. In New Jersey, islands away from barrier beaches or the mainland have no mammalian predators. Winter storms and high tides wash over the islands, and mammalian populations do not become established.

At present, the usual location of Laughing Gull colonies does not seem to be affected by the presence of Herring Gulls. Both species have nested on Clam Island for over 25 years (Burger and Shisler 1978). However, reproductive success in Laughing Gulls has declined in areas where they nest close together, and the number of Laughing Gulls nesting on Clam Island is decreasing. The major threat comes during high tides, when Laughing Gulls usually move to the higher areas of the marsh to nest. Herring Gulls, however, now nest in many high bush areas of the salt marsh islands (Burger 1977). Since they arrive on the islands two months prior to the Laughing Gulls, and they are three times as large, they win territorial encounters against the Laughing Gulls (Burger, unpubl. data). Thus, when flooded by tides, the Laughing Gulls cannot simply move to higher parts because Herring Gulls already nest there. The 15 colonies of Herring Gulls in Barnegat Bay seem to be increasing annually (Burger and Lesser, unpubl. data). The Herring Gulls are eliminating the potentially safe nesting areas of Laughing Gulls.

During tidal threats, Laughing Gulls can shift colony sites if suitable areas are available nearby. The proximity of such alternative sites is critical. For example, in 1978, the Clam Island gulls moved to islands within two or three km of their traditional colony sites. However, farther south, a large Laughing Gull colony at Brigantine National Wildlife Refuge located in primarily *S. alterniflora* marsh did not relocate in response to flood tides, and suffered an 80% washout of nests (C. Beer, pers. comm.). This colony, studied by Montevecchi (1975) and others, has existed for many years in the same location, and no nearby islands are suitable for colonization. Laughing Gulls seem reluctant to move too great a distance.

NEST SITE SELECTION

Nest site selection refers to the precise location of nests within a colony. Laughing Gulls on Clam Island and in nearby areas normally nested in the highest areas of *S. alterniflora* (this study, Burger and Shisler 1978). Their choice of nest sites in Barnegat Bay was similar to that at Brigantine (Montevecchi 1975, 1978) and Stone Harbor, New Jersey (Bongiorno 1970). Montevecchi (1978) and Bongiorno (1970) found, however, that Laughing Gulls also selected piles of debris (windrow) strewn on the marsh by high tides. Bongiorno manipulated these piles and influenced the choice of nesting sites. Barnegat Bay has a relatively low tidal amplitude, and debris is left only at the leading edge of the high tide line. These are not good nesting areas, and the gulls do not use them.

Montevecchi (1978) found that Laughing Gulls at Brigantine nested in low areas with tall grass, wheréas we found that the gulls nested in the highest area of the marshes. Although these results seem contradictory, they are not, since the entire study area at Brigantine was higher than Clam Island. Thus, gulls on Clam Island who select the highest areas of the marsh may be choosing locations equivalent to those used by gulls at Brigantine. Furthermore, due to the low tidal flow at Clam Island, there is little variation in grass height. At Brigantine, low areas have the tallest grass, which stabilizes nests during flood tides (Montevecchi 1978).

In this study the Laughing Gulls changed their nest sites in relation to high tides. They shifted 1) from island to island, 2) from a low area of an island to a higher area, and 3) from *S. alterniflora* to *S. patens*. The birds nesting in *S. patens* nested on higher spoil piles whenever available.

This adaptability suggests that Laughing Gulls have a range of nest sites that they will use, and that the particular nest site selected depends upon external cues such as the presence of people and flood tides. Under different environmental conditions, the gulls select different nest sites (see Bongiorno 1970, Montevecchi 1975, Burger and Shisler 1978). The range of nest sites used shifts up or down on an elevation gradient depending on the amount and extent of marsh flood. On Clam Island, Laughing Gulls could not shift to higher locations because these areas contained nesting Herring Gulls.

REPRODUCTIVE SUCCESS

Evolutionarily, shifting colony and nest sites in response to tidal flooding is important if it results in differences in reproductive output. When no other high tides occur, shifting is adaptive only in a proximate sense. In this study, high tides later in the season provided a test of the effectiveness of the gulls' response.

In 1978, most gulls shifted from low areas on the same island (High Bar Island), or from low islands to higher islands. A few gulls remained in the low *S. alterniflora* areas on Clam Island. Reproductive success was directly related to nest location. All nests in this cord grass succumbed to the high tides, and chick survival was related directly to elevation. Spoil piles provided additional high areas. Methods of mosquito control including ditching have often been criticized for disturbing the marsh ecosystem (Bourn and Cottam 1939, 1950, Service 1971, Daiber 1974). Criticism centered around the changes in vegetation as a result of elevation differences. In the marshes we examined, which were managed to provide open marsh water, vegetation on the spoil piles resembled that in the surrounding area. The slightly higher elevation, however, provided a buffer against encroaching high tides and these ditched areas became the centers of the shifted colonies.

COLONY TENACITY RE-EXAMINED

Our results indicate that under normal tidal conditions Laughing Gulls show a high degree of colony site tenacity. McNicholl (1975), in a discussion of larid site tenacity and group adherence, proposed that 1) nest site tenacity is strong in highly stable habitats, 2) group adherence is enhanced in low stability habitat and 3) in intermediate habitats both attributes may be important. He defined the tendency to nest among the same neighbors as group adherence. We propose that most larids have strong colony site tenacity. They always return to the colony site, but when it is unsuitable for any reason they shift to a better site. For example, Laughing Gulls (this study), Black-billed Gulls (Beer 1961) and Franklin's Gulls (Burger 1974a) all returned first to previous colony sites. When the site is unsuitable, they may shift immediately, as in the case of Black-billed Gulls, or later, in the case of the other two species.

We view colony and nest site selection as resulting from a range of environmental and behavioral responses. The responses of a particular group may include only a part of those available to the species. The location of a colony can shift slightly as a result of proximate environmental conditions. Laughing Gulls nest on dry land with no vegetation (Burger and Beer 1975), on dry land between grass and bushes (Dinsmore and Schreiber 1974), in poison ivy (*Rhus toxicodendron*; Forbush 1925), and in tidal salt marshes. Black-headed Gulls nest on sand dunes (Patterson 1965) or in lakes and marshes (Gribble 1962, Burger 1976). Within any of these habitats, colony location no doubt moves with changes in the environment, be they tides or vegetation. We agree with McNicholl (1975) that gulls appear to differ in colony site tenacity, but suggest that the differences result from environmental conditions and not some lack of behavioral plasticity. We suggest that given stable environmental conditions, all gulls would show colony site tenacity; without such stability, the tenacity seems to disappear. Our hypothesis needs to be tested in other larids nesting in a variety of environmental conditions.

ACKNOWLEDGMENTS

We thank F. G. and P. A. Buckley, M. Gochfeld, and F. Lesser for helpful discussions during this research. Lesser and Gochfeld contributed valuable field time. J. Burger thanks E. O'Malley and G. Costa for letting her use the hunting cabin on Clam Island from 1975 to 1979. This research was funded by the Research Council of Rutgers University, the New Jersey State Mosquito Control Commission, and the Ocean County Mosquito Commission. Paper of the Journal Series, New Jersey Agricultural Experiment Station, New Brunswick, New Jersey 08903.

LITERATURE CITED

BEER, C. G. 1961. Incubation and nest building behaviour of Black-headed Gulls. I. Incubation behaviour in the incubation period. Behaviour 18:62–106.

BEER, C. G. 1966. Adaptations to nesting habitat in the reproductive behaviour of the Black-billed Gull *Larus bulleri*. Ibis 103:394–410.

BONGIORNO, S. F. 1970. Nest-site selection by adult Laughing Gulls (*Larus atricilla*). Anim. Behav. 18:434–444.

BOURN, W. S., AND C. COTTAM. 1939. The effect of lowering water levels on marsh wildlife. Trans. N. Am. Wildl. Conf. 4:343–350.

BOURN, W. S., AND C. COTTAM. 1950. Some biological effects of ditching tide water marshes. U.S. Fish Wildl. Serv. Res. Rep. 19.

BUCKLEY, F. G., AND P. A. BUCKLEY. 1972. The breeding ecology of Royal Terns *Sterna (Thalasseus) maxima maxima*. Ibis 114:344–359.

BURGER, J. 1974a. Breeding adaptations of Franklin's Gulls (*Larus pipixcan*) to a marsh habitat. Anim. Behav. 22:512–567.

BURGER, J. 1974b. Breeding biology and ecology of the Brown-headed Gull in Argentina. Auk 91:601–613.

BURGER, J. 1976. Nest density of the Black-headed Gull in relation to vegetation. Bird Study 23:27–32.

BURGER, J. 1977. Nesting behavior of Herring Gulls: invasion into *Spartina* salt marsh areas of New Jersey. Condor 79:162–169.

BURGER, J., AND C. G. BEER. 1975. Territoriality in the Laughing Gull (*L. atricilla*). Behaviour 55:301–320.

BURGER, J., AND J. SHISLER. 1978. Nest site selection and competitive interactions of Herring and Laughing gulls in New Jersey. Auk 95:252–266.

BURGER, J., AND F. LESSER. 1978. Selection of colony sites and nest sites by Common Terns *Sterna hirundo* in Ocean County, New Jersey. Ibis 120:433–449.

COULSON, J. C., AND E. WHITE. 1956. A study of colonies of the Kittiwake. Ibis 98:63–79.

COULSON, J. C., AND E. WHITE. 1958. The effect of age on the breeding biology of the Kittiwake *Rissa tridactyla*. Ibis 100:40–51.

COULSON, J. C., AND E. WHITE. 1960. The effect of age of breeding birds on the time of breeding of the Kittiwake *Rissa tridactyla*. Ibis 102:71–86.

CULLEN, J. M. 1960. Some adaptations in the nesting behavior of terns. Proc. Int. Ornithol. Congr. (1958) 12:153–157.

DAIBER, R. C. 1974. Salt marsh plants and coastal salt marshes in relation to animals, p. 475–508. *In* R. J. Reimond and W. H. Queen [eds], Ecology of halophytes.

DINSMORE, J. J., AND R. W. SCHREIBER. 1974. Breeding and annual cycle of Laughing Gulls in Tampa Bay, Florida. Wilson Bull. 86:419–427.

FORBUSH, E. H. 1925. Birds of Massachusetts and other New England states. Vol. 1 Massachusetts Dept. of Agriculture, Boston.

GILLETT, W. H., J. L. HAYWARD, JR., AND J. F. STOUT. 1978. Effects of human activity on egg and chick mortality in a Glaucous-winged Gull colony. Condor 80:492–495.

GRIBBLE, F. C. 1962. Census of Black-headed Gull colonies in England and Wales. 1958. Bird Study 9:56–71.

KRUUK, H. 1964. Predators and anti-predator behaviour of the Black-headed Gull (*Larus ridibundus* L.). Behaviour Suppl. 11:1–30.

LUDWIG, J. P. 1963. Return of Herring Gulls to their natal colony. Bird-Banding 34:68–72.

MCNICHOLL, M. K. 1971. The breeding biology and ecology of Forster's Tern (*Sterna forsteri*) at Delta, Manitoba. M.S. thesis, University of Manitoba, Winnipeg.

MCNICHOLL, M. K. 1975. Larid site tenacity and group adherence in relation to habitat. Auk 95:98–104.

MONTEVECCHI, W. A. 1975. Behavioral and ecological factors influencing the reproductive success of a tidal salt marsh colony of Laughing Gulls (*Larus atricilla*). Ph.D. thesis, Rutgers University, Newark, New Jersey.

MONTEVECCHI, W. A. 1978. Nest site selection and its survival value among Laughing Gulls. Behav. Ecol. Sociobiol. 4:143–161.

MURRAY, M. D., AND R. CARRICK. 1964. Seasonal movements and habitats of the Silver Gull, *Larus novaehollandiae* Stephens, in southeastern Australia. C.S.I.R.O. Wildl. Res. 9:160–188.

NISBET, I. C. T. 1971. The Laughing Gull in the Northeast. Am. Birds 25:677–683.

NOBLE, G. K., AND W. WURM. 1943. The social behavior of the Laughing Gull. Ann. N.Y. Acad. Sci. 45:179–220.

PATTERSON, I. J. 1965. Timing and spacing of broods in the Black-headed Gull *Larus ridibundus*. Ibis 107:433–459.

PATTON, S. R., AND W. E. SOUTHERN. 1978. The effect of nocturnal red fox predation on the nesting success of colonial gulls, p. 91–101. *In* W. Southern [ed.], Proc. 1977 Conf. Colonial Waterbird Group. Northern Illinois Univ. Press, De Kalb.

ROBERT, H. C., AND C. J. RALPH. 1978. Effects of human disturbance on the breeding success of gulls. Condor 80:495–499.

SERVICE, M. W. 1971. Conservation and the control of biting flies in temperate regions. Biol. Conserv. 3:113–122.

SNYDER, L. L. 1940. Laughing Gull breeding in Nova Scotia. Auk 57:568–569.

SOUTHERN, W. E. 1967. Colony selection, longevity, and Ring-billed Gull populations: preliminary discussions. Bird-Banding 38:52–60.

SOUTHERN, W. E. 1977. Colony selection and colony site tenacity in Ring-billed Gulls at a stable colony. Auk 94:469–478.

SOUTHERN, L. K., AND W. E. SOUTHERN. 1979. Absence of nocturnal predator defense mechanisms in breeding gulls, p. 157–162. *In* W. Southern [ed.], Proc. 1978 Conf. Colonial Waterbird Group, Northern Illinois University Press, De Kalb.

STONE, W. 1937. Bird studies at Old Cape May. Vol. 2. Acad. Nat. Sci., Philadelphia.

TINBERGEN, N. 1961. The Herring Gull's world. Revised ed. Basic Books, New York.

VERMEER, K. 1963. The breeding ecology of the Glau-

cous-winged Gull (*Larus glaucescens*) on Mandarte Island. Occas. Pap. B. C. Prov. Mus. 13.
WELLER, M. W., AND C. S. SPATCHER. 1965. Role of habitat in the distribution and abundance of marsh birds. Iowa Agric. Home Econ. Exp. Stn. Spec. Rep. 43.

Department of Biology, Livingston College, Rutgers University, New Brunswick, New Jersey 08903, and Mosquito Research and Control, New Jersey Agricultural Experiment Station, Cook College, Rutgers University, New Brunswick, New Jersey 08903. Accepted for publication 28 August 1979.

Condor, 82:258

RECENT PUBLICATIONS

Graphics Simplified: How to plan and prepare effective charts, graphs, illustrations, and other visual aids.—A. J. MacGregor. 1979. University of Toronto Press, Toronto. 64 p. Paper cover. The title says it all. This little manual concisely provides information "about when to use and how to design charts and graphs, how to achieve legibility, how to prepare graphics for specific media, and how to use various types of graphic aids to make the job easier." It is intended for those who must prepare their own illustrations whether for teaching or for publication. Prospective contributors to *The Condor* are urged to get themselves a copy. Copious illustrations, selected bibliography, index.

Voices of the Loon.—William Barklow. 1980. 33⅓ rpm phonograph record. NAS 1001. North American Loon Fund and the National Audubon Society. $9.00 plus postage. Source: North American Loon Fund, Main St., Humiston Bldg., Meredith, NH 03253 and National Audubon Society, 950 Third Ave., New York, NY 10022. The calling of loons is the quintessential sound of the north-country. Its scientific and evocative aspects are both captured in this phonodisc, produced from recordings made by Barklow in Maine. The first side presents the four basic calls, introduced by narrator Robert J. Lurtsema. The second side, eight bands without commentary, presents loons calling in different situations. The climax is a combined chorus of loons and coyotes at night (dubbed in, yet true to life). The quality of the recordings is generally excellent, especially considering that many of them were made in a canoe. Proceeds from the sales of this record will be used for research and management of the Common Loon. For additional information about the loon's tremolo call, see Barklow (1979. *Condor* 81:53–64).

Bird Student/An Autobiography.—George Miksch Sutton. 1980. University of Texas Press, Austin. 216 p. $15.95. In a modest and engaging manner, Sutton here recounts his memoirs, from his childhood until his early years at Cornell. He tells of his family and teachers, his associations with Louis Agassiz Fuertes, W. E. Clyde Todd, and J. B. Semple, and his trips to Labrador, Florida, and the arctic. It is virtually impossible to open the book anywhere without being immediately drawn into the story. Throughout are vivid recollections of birds—seeing them in life, preparing them as specimens, and learning to paint them. The book is illustrated with numerous field sketches and finished paintings in monochrome and color from various points in Sutton's career. Although certain episodes have been told before, it is good to have them set in place in this more complete history. Admirers of "Doc" Sutton and his paintings will relish this book.

A Naturalist on a Tropical Farm.—Alexander F. Skutch. 1980. University of California Press, Berkeley. 405 p. $16.95. Here is another volume of Skutch's experiences and observations of natural history in Costa Rica. In terms of his career, it follows his earlier books, *The Imperative Call* (1979. Noted in *Condor* 82:141) and *A Naturalist in Costa Rica* (1971). Most of the chapters focus on the plant and animal life surrounding the author's farm and the activities of the farm itself. The penultimate chapter describes a very different region in the northwestern part of the country. In closing, Skutch discusses his philosophy of life. The book is well designed and is handsomely illustrated with full-page scratchboard drawings by Dana Gardner. It will be enjoyed by those who have visited Central America and those who enjoy traveling vicariously.