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# NEST SITE SELECTION IN AN EXPANDING POPULATION OF HERRING GULLS

By Joanna Burger and Fred Lesser

## INTRODUCTION

During the 20th century Herring Gulls (*Larus argentatus*) have extended their breeding range and increased their numbers both in Europe (Andersson, 1970; Davis and Dunn, 1976) and North America (Kadlec and Drury, 1968; Drury and Kadlec, 1974). This expansion and increase has been attributed to the presence of garbage dumps which provide a dependable food supply at all times of the year (Drury, 1965; Harris, 1970; Kihlman and Larsson, 1974). Such a constant food supply increases the reproductive rate and decreases mortality during the winter months (Drury and Smith, 1968).

Herring Gulls nest in a wide variety of habitats including rocky cliffs, gravel and sand islands, sand dunes, and grassy meadows (Kadlec and Drury, 1968; Harris, 1970; Cramp et al. 1974). In their expansion southward into New Jersey they have started to nest in *Spartina* salt marshes (Burger, 1977). These marshes occur all along the Atlantic coast, suggesting no habitat barriers to their eventual movement farther south.

The expansion of Herring Gulls into new geographical areas and new habitats provides an opportunity to study habitat selection. The presence of suitable, unused habitats might suggest further increases in nesting numbers in New Jersey, if food is not limiting. Presumably gulls use optimum habitats first, and then move into sub-optimal habitats. Their choice of colony sites may be influenced by the presence of other colonial birds. The present study examines the colony and nest site selection of Herring Gulls in New Jersey where populations are still increasing. We censused 90 km of coastline, examining all islands, and the adjacent barrier islands and mainland. We predicted that Herring Gulls would select nesting islands which differed from the unused islands with respect to size, shape, and location, and to the vegetation on the island.

## METHODS AND STUDY AREA

We surveyed the barrier islands, salt marsh islands, and mainland marshes in Barnegat Bay from Holgate to Normandy Beach, NJ from early April until mid-July 1977. Every gull colony was censused one to four times ($\bar{x} = 2.5$) during the last 15 days of incubation. During each census we recorded the number and location of other nesting species. Data taken at every gull nest in small colonies and at 100 nests in larger colonies included: vegetation species present within 1 m of the nest, percentage of cover within 1 m of the nest (bush and live grass cover), clutch size, species of nearest neighbor, distance to the nest of its nearest neighbor, and the distance to the nearest conspecific nest. In colonies of fewer than 100 nests we measured all eggs with a dial caliper. In

larger colonies we sampled nests and measured eggs from 20 randomly selected nests in each habitat type.

Using nautical maps, tax maps, and aerial surveys by helicopter, we collected the following data on all islands in Barnegat Bay: acreage, maximum length, maximum width, distance to the closest mainland, distance to the barrier beach, and the presence of mosquito ditching. We then compared the characteristics of the islands used by gulls to those of all other islands to determine the number of "suitable" islands that were not used for nesting by Herring Gulls. Unless otherwise stated, we present means ± one standard deviation.

## RESULTS

### *Colony Site Selection*

Herring Gulls nested on 28 salt marsh islands and two mainland salt marshes. The number of nesting pairs per island ranged from one to 900 ($\bar{x} = 82.6 \pm 204$). The 11 solitary areas accounted for only 2% of the 2,398 nests. The number of colonies as a function of the number of individuals in each colony was as follows: 2–24 nests (8 colonies), 25–49 nests (3 colonies), 50–99 nests (2 colonies), 100–199 (4 colonies), and over 200 nests (2 colonies of 650 and 900 nests). Of the islands with nesting Herring Gulls, 10 had nesting Common Terns (*Sterna hirundo*: 4–87 pairs, $\bar{x} = 45 \pm 29$), 5 had nesting Black Skimmers (*Rynchops niger*: 4–35 pairs, $\bar{x} = 14 \pm 14$), 8 had nesting Laughing Gulls (*L. atricilla*: 8–5,000 pairs, $\bar{x} = 769 \pm 1{,}193$), 6 had nesting Great Black-backed Gulls (*L. marinus*: 1–12 pairs, $\bar{x} = 4 \pm 4$), and 5 had heronries. Terns and skimmers nested at some distance from the Herring Gulls, Laughing Gulls and heron species nested adjacent to Herring Gulls, and Great Black-backed Gulls nested among them. Laughing Gulls nested among Herring Gulls on only one island.

In Barnegat Bay were 257 salt marsh islands. Herring Gulls nested on 28 islands that were longer ($\chi^2 = 58.3$, df = 6, $P < .001$) and wider ($\chi^2 = 38.6$, df = 6, $P < .001$) than the 229 unused islands. Although almost 60% of the available islands were smaller than one acre, Herring Gulls never nested on islands smaller than 5 acres. The number of nesting Herring Gulls was correlated with the acreage of the islands ($r = .35$, df = 17, $P < .05$). Herring Gulls nested on islands that were intermediate in distance from the mainland or barrier beaches when compared with the unused islands ($\chi^2 = 14.07$, df = 7, $P < .05$). They avoided nesting close or far from land. Six of the 28 nesting islands were closer to the mainland than the barrier beach. However, this was not significantly different from the unused islands. Herring Gulls usually nested in the center of islands (24 of 28 colonies). Eight of the 28 colonies (27%) were on islands ditched for mosquito control. Because only 10% of the available islands were ditched, Herring Gulls nested on a greater percentage of ditched islands than expected ($\chi^2 = 9.29$, df = 1, $P < .005$).

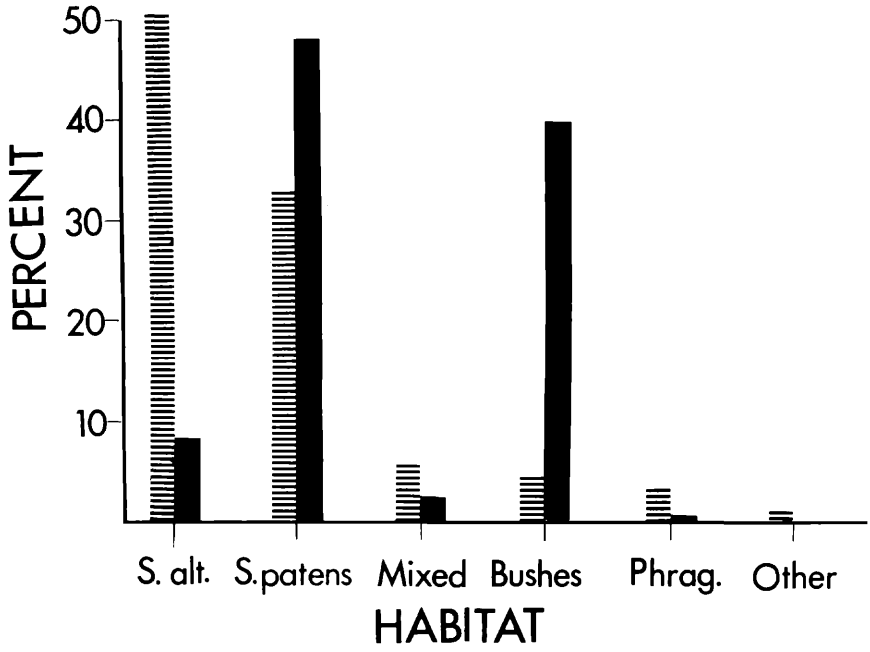


FIGURE 1. Vegetation at nest sites of Herring Gulls (solid bar) compared to vegetation available (hatched bar) on islands used for nesting.

Herring Gulls usually nested on islands covered with bushes (*Iva, Baccharis*). Over 68% of unused islands were devoid of bushes whereas only 21% of the islands with nesting Herring Gulls contained no bushes ($\chi^2 = 18.56$, df = 1, $P < .001$). All islands used by the gulls contained *Spartina alterniflora* and *S. patens,* but this was true of most of the available islands in Barnegat Bay. Islands selected contained 10 to 99% ($\bar{x} = 50 \pm 22$) *S. alterniflora,* 1 to 74% ($\bar{x} = 33 \pm 24$) *S. patens,* 0 to 30% ($\bar{x} = 2 \pm 6$) *Phragmites,* and 0 to 25% ($\bar{x} = 7 \pm 9$) standing pools or ponds. Generally the colony centers were in bushes on high *S. patens* locations.

We found no physical differences between mainland and island colonies, and between solitary and colonial Herring Gulls. Solitary nesting Herring Gulls were usually solitary with respect to other species as well. Only three of the 48 solitary nesting Herring Gulls nested near colonies of other species.

Ninety-two of the islands not used by Herring Gulls are within the size range (over 5 acres) selected by Herring Gulls. Some of these contain bushes, and all contain *Spartina.* Presumably, some of these islands will be used by Herring Gulls in the future, assuming food does not become limiting.

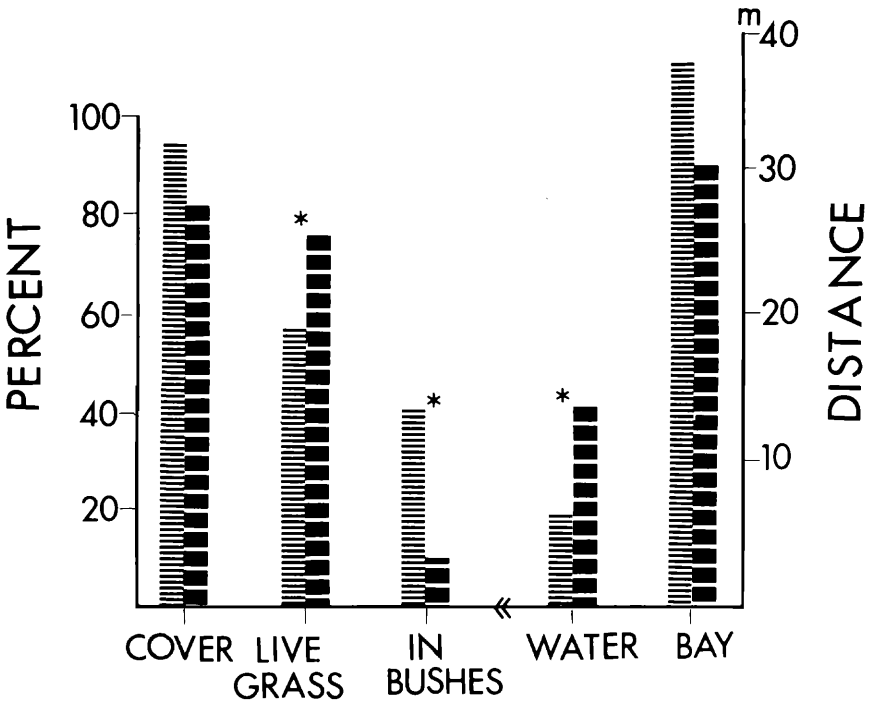


FIGURE 2. Comparison of characteristics of nests of solitary (thick bars) and colonial (thin bars) nesting Herring Gulls. Shown are percentage of all cover and of live grass, percentage of gulls nesting under bushes, and mean distance to bay and marsh water (pools, creeks). A star indicates significant difference.

*Nest Site Selection*

Herring Gulls nested primarily in *S. patens* and under bushes, although over 50% of the available vegetation on nesting colonies was *S. alterniflora* ($\chi^2 = 6930$, df = 2, $P < .001$, Fig. 1). Although bushes accounted for only 5% of the vegetation cover, 39% of the Herring Gulls nested under bushes.

In colonies the mean percentage of cover in the 1-m radius surrounding nests was 96%, the mean percentage of live grass cover was 58%, and the mean percentage of bushes was 9%. The low bush cover reflects the high percentage (60%) of gulls nesting in the open without bushes. The number of birds nesting on an island positively correlated with the percentage of bush cover ($r = .68$, df = 17, $P < .05$).

In comparing nest site characteristics of colonial with solitary Herring Gulls, we found no differences with respect to the percentage of cover, or in the distance to the bay (Fig. 2). However, solitary birds nested in the open rather than under bushes ($\chi^2 = 27.3$, df = 1, $P < .001$). Soli-

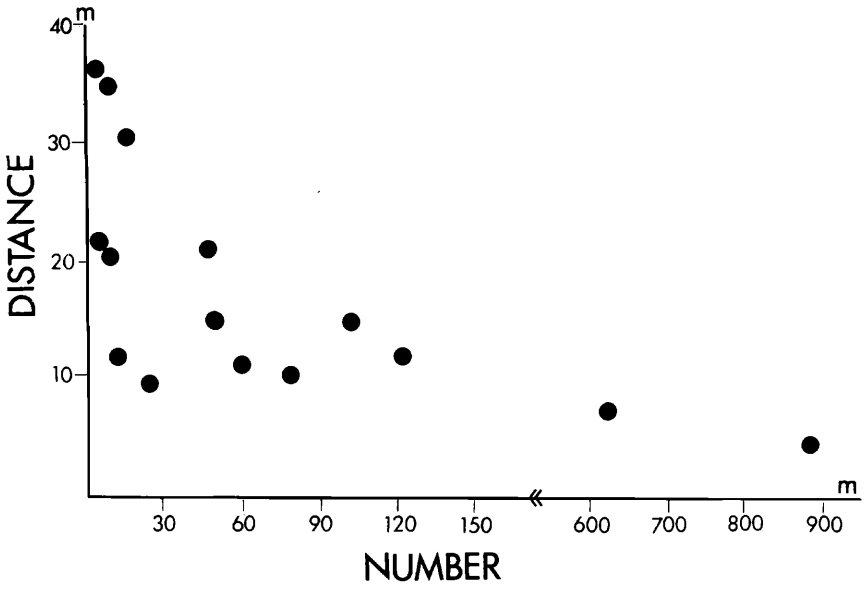


FIGURE 3. Mean nearest neighbor distance as a function of colony size for Herring Gulls.

tary birds had more live grass around their nests compared to colonial birds ($t = 2.21$, df = 28, $P < .05$, Fig. 2), and they nested farther from marsh water (pools, creeks) than colonial birds ($t = 1.98$, df = 28, $P < .05$).

The mean nearest neighbor distance for colonies ranged from 6.3 to 32.3 m ($\bar{x} = 17.3 \pm 5$), and was negatively correlated with the number of birds nesting in the colony ($r = -.52$, df = 13, $P < .05$, Fig. 3), positively correlated with the above ground cover ($r = .47$, df = 13, $P < .05$, Fig. 4), and negatively correlated with the total vegetation cover ($r = -.66$, df = 13, $P < .001$).

Because egg and clutch size are indicators of breeding age and experience (see discussion), we recorded clutch size and measured eggs. Clutch size did not correlate with the number of birds in each colony. However, the mean clutch size of solitary birds ($\bar{x} = 2.9 \pm 0.1$) was higher than for colonial birds ($\bar{x} = 2.5 \pm 0.2$, $t = 5.87$, df = 28, $P < .001$). Although no differences in egg length of colonial and solitary nesting Herring Gulls were found ($t = 1.21$), mean egg width correlated with the number of birds nesting on islands ($r = .76$, df = 13, $P < .001$, Fig. 5). The greatest variability in egg width occurred on islands with less than 20 pairs of nesting gulls. Furthermore, solitary birds laid significantly wider eggs ($\bar{x} = 58.2 \pm 1.3$ mm) than colonial birds ($\bar{x} = 49.1 \pm 1.5$ mm, $t = 5.67$, df = 24, $P < .001$).

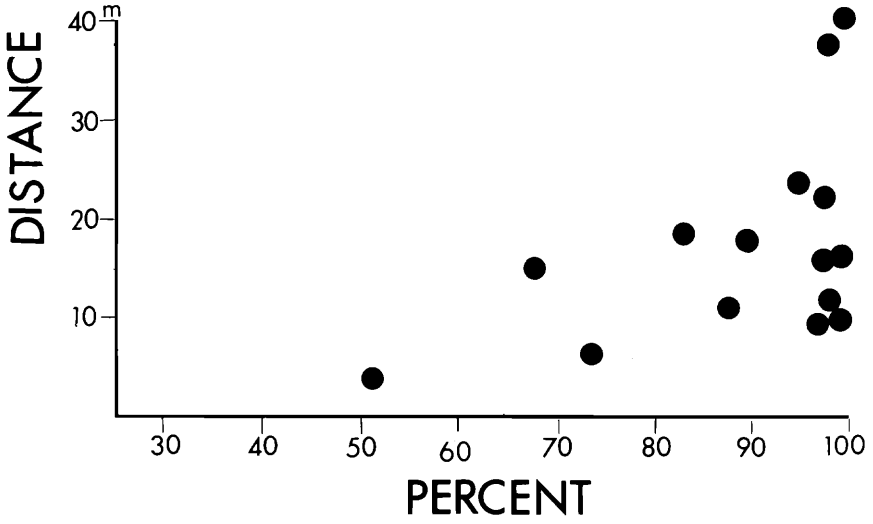


FIGURE 4. Mean nearest neighbor distance as a function of percent open areas above nests for Herring Gulls.

## DISCUSSION

### *Colony Site Selection*

Several studies on colony and nest site selection of larids exist (Patterson, 1965; Bongiorno, 1970; Burger, 1974a, 1974b, 1976; Montevecchi, 1975, 1978; Burger and Shisler, 1978). Yet, these studies merely describe colony sites and do not demonstrate selection by the gulls, which requires that the gulls nest in areas that are significantly different from unused areas.

We compared the colony sites used by nesting Herring Gulls with all other available salt marshes. Herring Gulls selected islands that were statistically different from the unused, available islands. They nested on larger salt marshes with more bushes and a higher percentage of *Spartina patens* compared to the unused islands. Their selection of islands reflects a compromise between minimizing predation and the dangers of washouts. Bushes and *S. patens* grow only in areas with little tidal inundation (Burger and Shisler, 1978). Thus, by selecting large islands with bushes, they are nesting on islands which are higher than many of the unused islands, and have less chance of being inundated by high tides. Nesting on higher islands, however, increases their chance of predation from mammals because the bushes on such islands provide refuges for rats, foxes, and other predators during very high tides. By choosing islands that are far from land they decrease the chance of mammalian predation because insufficient food is available for these

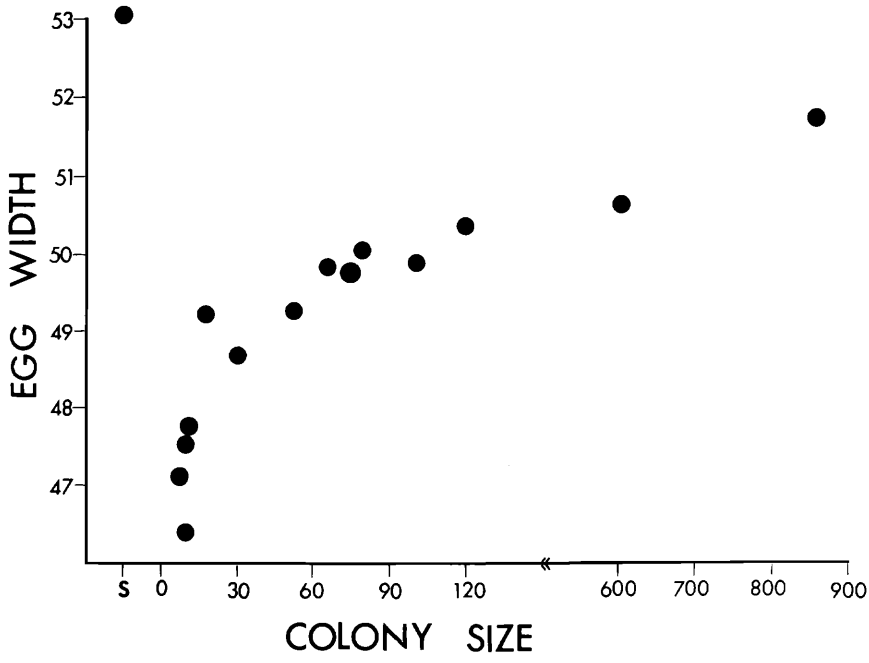


FIGURE 5. Mean egg width as a function of colony size in Herring Gulls.

mammals at other times of the year. Mammals return to the mainland or barrier beaches to find food during the winter, and the distance is too great for most small mammals to swim. Furthermore, intermediate elevation islands are often swept by ice during the winter, probably eliminating any remaining small mammals.

Herring Gulls nesting on the mainland selected locations similar in vegetation to those selected by island-nesting birds. They selected colony sites separated from the rest of the mainland by numerous small creeks, thus decreasing some of the predation pressure. Because a determined human can reach these outer areas, presumably a fox could also. On the two mainland marshes used for nesting, gulls primarily nested solitarily, thus providing some protection. By spacing out, a solitary gull is less obvious, the uncovered eggs are cryptic, and predators might not search in an area of low density of nests, especially if colonies are nearby. Göransson et al. (1975) found that predation rates positively correlated with nest density in experimental plots. Thus, he found that spacing out reduced predation rates.

Solitary gulls nested in the open from which points they could see approaching predators and flee if necessary. Although a gull nesting in grass is visible to avian predators, in New Jersey probably no avian predators can harm adults, or force an incubating bird from its eggs.

Solitary nesting Herring Gulls did not leave their nests as quickly as colonial birds when disturbed, but waited until we approached within 10 m before flying. Only when gulls leave their eggs exposed can avian predators pose a threat. A gull incubating in the grass is hidden from a mammalian predator, which must get close before seeing its prey. Because the gull is watching constantly, it will detect the predator before being seen. A gull nesting under bushes is unable to escape rapidly because it cannot fly directly from the bushes, whereas one nesting in open grass can fly immediately. In colonies, gulls nesting under bushes are warned by the cries of neighbor gulls long before the predator gets close. Solitary nesting gulls presumably need the time advantage of a rapid escape.

*Nest Site Selection*

Nest site selection was similar in colonial and solitary-nesting Herring Gulls. They placed their nests in *S. patens* under bushes. Because bushes and *S. patens* grow only in the highest and driest areas of the marsh (Bourne and Cottam, 1950), their selection reduces the chances of washouts. Bushes also provide cover from avian predators when they do leave their eggs uncovered (Parsons, 1971; Haycock and Threlfall, 1975; Hunt and Hunt, 1975), and from adverse weather conditions such as rain or heat (Austin, 1933; Power, 1964; Nisbet, 1973; Gillett et al., 1975). In several gulls and terns that nest in vegetation, nesting success is highest in thick cover (Brown, 1967; Lemmetyinen, 1973).

*Colony Formation and Group Dynamics*

The degree of colony site tenacity in larids relates to habitat stability (see McNicholl, 1975 for a review). Gulls nesting in stable environments show a high degree of fidelity to colony sites, whereas species nesting in ephemeral habitats are not as faithful to traditional sites. Generally Herring Gulls have a high degree of colony site tenacity (Ludwig, 1962; Drury and Kadlec, 1974). Although salt marshes appear unstable because water levels constantly change, the nature of the change is predictable. A high tide occurs twice a day; the only unknown is the height of the tide, determined by the phase of the moon and the direction and strength of the wind. Islands free from high tides one year are apt to be free from tidal inundations in subsequent years. In Barnegat Bay, Herring Gull colonies have been in the same locations for many years (Burger and Lesser, unpubl. data). When a colony of more than five individuals formed, it grew or remained constant in numbers. Colonies have increased at phenomenal rates: the colony at Clam Island has doubled in numbers of nesting pairs every three or four years since 1964 (Burger and Shisler, 1978).

Solitary Herring Gulls had larger clutch and egg widths than colonial birds, and egg width positively correlated with the number of birds nesting in each colony. Older gulls and terns normally lay larger eggs and clutches (Coulson and White, 1960; Coulson, 1966, 1968; Greenhalgh, 1974; Ryder, 1975). We suggest that in Barnegat Bay (1) solitary

nesting Herring Gulls are older, more experienced birds, (2) small colonies contain a disproportionately large percentage of younger gulls, and (3) the larger the colony, the higher the percentage of older, experienced birds. Because gulls exhibit nest site fidelity (see Bongiorno, 1970, for a summary), and the locations of solitary nesting pairs in Barnegat Bay were occupied year after year, they are probably the same individuals. If they are older and experienced at that location, then solitary birds are good predictors of safe nesting conditions. A young gull hunting for a nest site might be attracted to a solitary nesting pair, and small colonies may contain one or a few older birds plus a large number of younger birds. Because younger birds are less able to compete for territories in the central area (Coulson, 1966), they space out, accounting for the larger nearest neighbor distances found in smaller colonies. Once established, the colonizers grow older, and the age distribution shifts toward a higher percentage of older birds. The egg and clutch size data from the colonies studied are consistent with the above hypothesis.

The suggestion that solitary birds are older, experienced birds rather than young birds is contrary to Patterson's (1965) finding that edge and solitary Black-headed Gulls (*L. ridibundus*) were younger, less successful birds which may have been forced to nest outside the main colony. His solitary birds, however, were not far from the main colony as were those in our study. Herring Gulls that nest far from other birds, as they do in New Jersey, may not be outcasts unable to compete, but may nest there by preference.

Thus, Herring Gulls in New Jersey select islands for nesting that are notably different from unused islands. Some of the unused islands are suitable for nesting according to their preferred characteristics suggesting further population increases in the future. Egg and clutch size data indicate that solitary pairs are older. We suggest that older birds may initially nest on a new site, young birds move in, and the colony gradually stabilizes to contain a high percentage of older birds.

## SUMMARY

Colony and nest site selection in Herring Gulls were studied along 90 km of coastline in New Jersey. Herring Gulls nested on the higher, drier islands containing bushes compared to the unused islands. They nested in *S. patens* and bushes even though more *S. alterniflora* areas existed. Some available habitats similar to those islands used by gulls still exist, suggesting further population increases. For colonies, egg size correlated positively with the number of birds in the colony. However, solitary birds had significantly wider eggs than any other gulls. Because egg size relates to age, solitary birds may have been older and more experienced. Small colonies appear to be formed by the addition of younger birds to the one or two older, solitary birds on the site. As colonies increase in numbers, the percentage of older birds again increases.

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