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NEST SITE SELECTION BY LAUGHING GULLS: COMPARISON OF TROPICAL COLONIES (CULEBRA, PUERTO RICO) WITH TEMPERATE COLONIES (NEW JERSEY)

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ABSTRACT.—We examined nest site selection in Laughing Gulls (*Larus atricilla*) nesting on three islands in the Culebra National Wildlife Refuge, Puerto Rico, to determine if gull nest sites showed consistent characteristics differing from most of the available habitat, to compare nest site characteristics on islands with different vegetative cover, and to contrast nest site choices on these tropical island colonies with colonies that we have studied on the northern Atlantic coast of mainland United States. At Culebra, Laughing Gulls nested with Royal, Sandwich, and Bridled terns (*Sterna maxima, S. sandvicensis, S. anaethetus*), Brown Noddies (*Anous stolidus*), and Brown Boobies (*Sula leucogaster*), but their nearest neighbors were usually conspecifics. The gulls' nest sites generally differed from random points with respect to percent cover, vegetation height, visibility, and distance from clearings. Compared to the random points, gull nests were under denser vegetation of intermediate height with high visibility from their nests and with less cover around their nests. Their choice of nest sites provided protection and cover from predators and the sun. Dense and tall vegetation would hinder gulls from flying directly from their nests, and many nests were thus near rocks or clearings, which allowed the gulls to exit quickly. Laughing Gulls nesting on the Culebran cays generally nested in taller, denser vegetation than those nesting farther north along the Atlantic coast, which partially reflects temperature differences between the localities.

The process of nest site selection involves choosing one site from those available within a bird's territory. Choice of site may be influenced by the proximity of aggressive neighbors, by a bird's previous nest site, and by physiognomic aspects of the habitat. Ground-nesting birds may strongly prefer a specific substrate, plant species, or growth form, and may have a restricted range of acceptable slope, visibility, and cover. Alternatively, they may be extremely tolerant and scarcely prefer one spot over another. Thus, demonstration that nest site selection involves choices must contrast the actual nest sites with other sites that would be available.

Larus gulls are largely temperate-zone species, and many species nest exclusively in north temperate and low arctic regions. The breeding range of a few species includes both temperate and tropical regions. Presumably, breeding adaptations, particularly those relating to nest site selection, vary in response to climatic variables. The need for protection against the heat of the noonday sun might cause gulls to choose sites in dense cover. On the other hand, potential predation in temperate as well as tropical zones should cause nests to be placed either so that adults can watch for predators and easily escape, or so that eggs and young are inconspicuous.

Laughing Gulls (*Larus atricilla*) nest along the Atlantic coast of North America from Massachusetts to Florida, along the Gulf coast of Texas, and on some Caribbean islands (AOU 1983). They nest on sandy beaches or islands (Bent 1921, Nisbet 1971), as well as on *Spartina* salt marshes in New Jersey and New York (Bongiorno 1970, Burger and Shisler 1978, Buckley et al. 1978).

Although nest and colony site selection by Laughing Gulls have been examined in salt marshes in New Jersey (Bongiorno 1970, Montevecchi 1978), few quantitative data exist from dry land colonies of Laughing Gulls. Physiognomically, *Spartina* salt marshes are relatively homogeneous, with little variation in the height and density of the grass. Laughing Gulls, however, use dry land habitats that vary from open sandy beaches with little grass to more densely vegetated habitats (Nisbet 1971, Dinsmore and Schreiber 1974). Variations in vegetation on the sites selected may relate to either predation pressures or to weather constraints (see papers in Cody, in press).

We examined nest site selection in Laughing Gulls on three small cays off Culebra, Puerto

TABLE 1. Colony composition in 1983 on three islands at Culebra, Puerto Rico. The estimated number of nests for each species are given.

	Matojo	Lobito	Geniqui	
			North	South
Laughing Gull	91	450	120	4
Royal Tern	152	—	—	—
Sandwich Tern	140	—	—	—
Bridled Tern	—	40	8	40
Brown Noddy	—	—	45	25
Brown Booby	—	—	60	60

Rico, and compared their choices with those of birds nesting in more northern, temperate colonies. We studied Laughing Gulls because they have a wide breeding distribution, ranging from northern United States to tropical Caribbean islands, and worked on Culebra because this area is easily accessible and is near the southern limit of this gull's breeding range. We examined nest site selection to (1) determine if gulls select particular sites on each island, (2) compare nest site selection on three islands with different vegetation types (physiognomically) to determine if the gulls selected similar nest sites with respect to cover and visibility, and (3) compare nest site selection in the Puerto Rican dry land colonies with that in more northern salt marshes. We asked what environmental attributes the gulls prefer and whether these attributes are similar among colonies and regions. We selected variables that have been found to be important in other studies (Burger 1977, Burger and Lesser 1978), recognizing that other physical, social, and historical factors may influence nest site selection. Thus, we predicted that Laughing Gulls may select sites with some optimum percent cover or visibility, regardless of vegetation structure.

STUDY AREAS AND METHODS

We studied Laughing Gulls nesting on three small islands—Cayos Lobito, Matojo, and Geniqui—off Culebra Island, a national wildlife refuge, off the east coast of Puerto Rico. The gulls nested on only three of the several islands around Culebra (see map in Kepler and Kepler 1978). Lobito (6.1 ha, maximum elevation = 25 m) has low cliffs and is dome-shaped, covered with dense, low vegetation, predominantly *Capparis flexuosa*. Large, scattered boulders rise 20–160 cm ($\bar{x} = 46 \pm 34$ cm) above the ground. Matojo (0.8 ha, maximum elevation = 10 m) also has low cliffs and a plateau covered with small shrubs and vines, dominated by the vine, *Canavalia maritima*. Geniqui consists of two islands joined by a narrow rock bridge that is exposed only at low tide. Laughing Gulls nested mainly on the north island. North Geniqui (4.4 ha, maximum elevation = 20 m) has cliffs and a plateau with sedges (*Cyperus planifolius*). The islands thus offered three physiognomic types of vegetation: (1) tall, spikelike (Geniqui), (2) low, ground cover (Matojo), and (3) vine-shrub (Lobito). Our count of the number of nesting birds (22–25 June 1983) on the three islands is shown in Table 1. Further descriptions of these islands can be found in Kepler and Kepler (1978). All three cays are rock, covered with a thin soil layer, although bare rock is exposed in some places.

To minimize disturbance to the birds, we made our observations in the last two weeks of June, 1983, just before hatching began. We had determined the time of our visit after extensive correspondence with resident biologists. On these tropical islands, the vegetation changes only slightly during the nesting season. Thus, the vegetation in June was similar to that when the birds had selected their nest sites in May (S. Furniss, pers. comm.). A much earlier or later visit would have yielded similar results at greater risk to the birds. We spent 4–8 h on each island.

We studied all 91 Laughing Gull nests on Matojo, and 50 randomly selected nests each on Lobito and Geniqui. We selected nests by using a table of random numbers to generate coordinates, and used nests closest to these coordinates. It is necessary to compare the characteristics of nest sites with those of random points to determine if gulls select sites for certain attributes, distribute their nests randomly with respect to physical characteristics, or are influenced primarily by social factors.

On Lobito and Geniqui, we took the same measurements for 50 randomly selected points to determine if the gulls were selecting sites with particular attributes. We selected random points by generating X and Y coordinates from a table of random numbers. A starting point for the X and Y coordinates was established at the southwest corner of each colony, and the random points were plotted on the resultant grid. We did not take similar data on Matojo because the vegetation was more uniform and because we wished to minimize disturbance to the recently hatched Royal (*Sterna maxima*) and Sandwich tern chicks (*S. sandivicensis*), which are particularly vulnerable to human disturbance.

We recorded nest contents, species of nearest neighbor, distance to nearest neighbor, slope of the ground at the nest, substrate, size and height of the rock (where applicable), species of closest vegetation, percentage vegetation cover over the nest, and height of vegetation over the nest. We estimated rock size by mul-

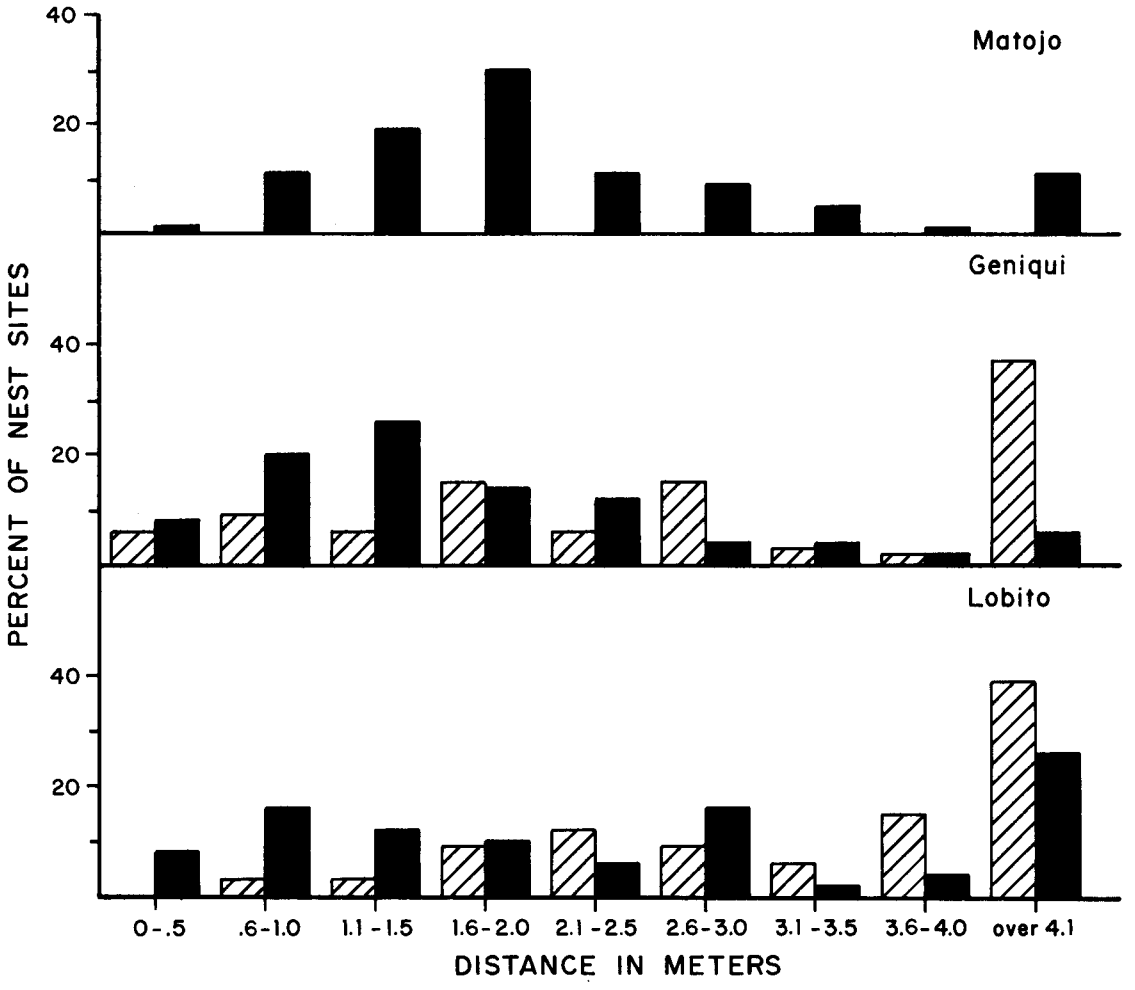

FIGURE 1. Distance to nearest nest for Laughing Gull nests (solid bar) and random points (hatched bar) on three Culebran islands. Sample sizes are Matojo (91 nests), Geniqui (50 nests), Lobito (50 nests), and 50 random points on each island.

tiplying the mean length × mean width of the rock. We selected these characteristics because they have been shown to affect nest site selection in some gull colonies (Veen 1977, Burger 1977, Montevecchi 1978). Further, they are measures of cover and protection from sun and predators.

We used a fisheye lens (Nikon 6 mm) affording a 220° view, to take photographs from the gull nests and random points on Lobito and Geniqui, as a measure of visibility at those sites (Burger 1977). This is a standardized method for recording the field of view from any point (Burger 1972). The back of the camera was placed on the nest aiming skyward and a spirit level used to assure accuracy of the levelling. One picture was taken at each nest and each random point. We placed a grid on each photograph to determine a visibility index (the number of open grid sections) for each nest and random point (see Burger 1972 for methodology). A score of 120 would equal 100% cover or no visibility. We also visually estimated (in 5% increments) the amount of the nest that was visible from a height of 1.5 m above the nest (cover over the nest) and 1 m away from the nest (cover around nests).

We compared nest site characteristics of Laughing Gulls nesting in the Culebran islands with those of dry land colonies in Florida (data from Dinsmore and Schreiber 1974) and salt marsh colonies in New Jersey (data from Clam Island, Burger and Shisler 1978; High Bar and Vol Sedge Islands, J. Burger, unpubl.; and Little Beach, Montevecchi 1975, 1978).

We used a contingency table χ^2 test to determine differences between islands and between nests and random points on each island. For this test, data such as percentage estimates (e.g., cover, visibility) were divided into pentiles (0–20%, 21–40%, . . . , 81–100%). Slope was divided into three categories (0–9°, 10–18°, >18°), other variables were divided into five classes, except vegetation height (six

TABLE 2. Statistical values for comparisons of nest site selection in Laughing Gulls among and within islands.*

Characteristic	Comparison of nests among islands			Comparison of nests and random points					
				Geniqui			Lobito		
	χ^2	df	$P<$	χ^2	df	$P<$	χ^2	df	$P<$
Distance to nearest neighbor	53.8	16	0.001	15.6	4**	0.005	10.5	4**	0.05
Distance to rocks							18.2	2	0.001
Slope at nest site	0.62	3	NS	12.7	2	0.001	3.1	1	NS
Distance to clearing				16.8	3	0.001			
Vegetation height at nest	121.5	8	0.001	23.0	5**	0.001	12.0	2**	0.001
Nearest vegetation species***				7.6	1	0.01	3.4	1	NS
Percent cover over nests	30.7	9	0.001	25.2	4	0.001	4.4	2	NS
Percent cover 1 m around nest	131.9	18	0.001	23.4	4	0.001	4.4	2	NS
Visibility from 1 m****				23.8	4	0.001			
Visibility index	60.0	4	0.001	7.6	2	0.02	11.0	1	0.001
Substrate	23.8	2	0.001	8.6	1	0.01	19.6	1	0.001

* Not all characteristics were relevant on each island.
** Categories collapsed where cells contained fewer than five values.
*** = The most dominant vegetation species on the island, compared to all others.
**** = A measure of potential detectability by predators.
NS = Not significant.

classes), and nearest vegetation species (dominant vs. non-dominant). The contingency table provides a very conservative test, obviates the need for transformations or assumptions about normalcy, and is more tolerant of estimation errors than tests based on continuous variables. We confirmed our impressions by applying the Mann-Whitney test, which in all cases gave equal or higher P values for differences among islands or between nests and random points. Only the more conservative χ^2 results are given here. Throughout the paper, we give means ± 1 SD.

RESULTS

GENERAL NESTING PATTERN

Breeding chronology can affect nest site selection in mixed-species colonies if some species arrive and select nest sites before others. Most of the Laughing Gulls on the cays had selected nest sites before the arrival of the terns and noddies. On Geniqui, the boobies nested on bare rock above the cliffs and were incubating before the gulls arrived. The boobies did not use all the available bare area, but the Laughing Gulls avoided this substrate, nesting almost exclusively in nearby vegetation.

In all three colonies, Laughing Gulls nested with boobies and/or terns, although the nesting pattern differed among the islands. On Geniqui, noddies nested on the cliffs or in tall cactus, boobies nested on the top edge of the cliffs where they could easily take off into the winds, and Laughing Gulls nested in the sedges, mainly away from the island edges. On Lobito, the gulls nested throughout the shrub- and vine-covered top and windward (eastern) slope of the island. Bridled Terns (*Sterna anaethetus*) nested in rock crevices.

On Matojo, the Laughing Gulls nested throughout the island wherever vines grew. The Royal and Sandwich terns, in contrast, nested together only in the few sparsely vegetated areas, and were completely surrounded by gulls.

NEAREST NEIGHBORS

Although other species nested on all three islands, Laughing Gulls generally nested in monospecific groups. On Matojo, only 14% (n = 13) of the Laughing Gull nests were closer to Royal (n = 12) and Sandwich terns (n = 1) than to each other. Where the tern and gull nesting areas abutted, the gulls' nearest neighbors were terns, because the tolerance distance (distance a nesting bird will let another bird nest) is lower for the terns than it is for the gulls. In all cases, nearest neighbors of a different species were closer only on one side, while other Laughing Gulls were the nearest neighbors on the other sides. Thus, birds other than Laughing Gulls were nearest neighbors only at the edges of the gull colony. Nearest-neighbor distances for gulls on Matojo averaged 2.03 ± 1.09 m (Fig. 1). The few gulls with terns as nearest neighbors had lower mean nearest-neighbor distances (0.5 ± 0.2 m) than gulls with conspecific nearest neighbors (2.09 ± 1.03 m).

Although Brown Noddies (*Anous stolidus*), Brown Boobies (*Sula leucogaster*) and Bridled Terns nested around the edge of North Geniqui, all gull nearest neighbors were gulls. The mean distance between nests on North Geniqui was 1.81 ± 1.61 m. Nearest-neighbor distances for gull nests were less than the random point-to-nest distances (Fig. 1, Table 2).

The colony on Lobito contained mostly Laughing Gulls (Table 1), and all nearest neighbors were gulls. Again, the distances between nests were less than the random point-to-nest distances (Fig. 1).

TABLE 3. Substrates of Laughing Gull nests and random points on three cays near Culebra, Puerto Rico.

	Rock %	Ground* %	On top of vegetation %
Matojo (n = 91)			
Gull nests	22	74	4
Geniqui (n = 50)			
Gull nests	6	94	
Random points	28	72	
Lobito (n = 50)			
Gull nests	48	52	
Random points	8	92	

* Under vegetation.

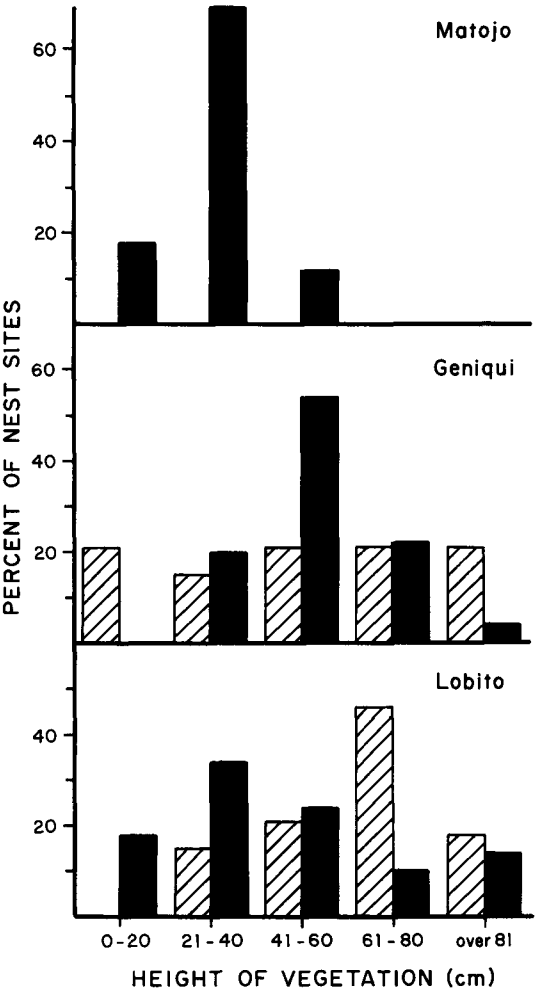

FIGURE 2. Height of vegetation at Laughing Gull nests (solid bar) and random points (hatched bar) on three Culebran islands. Sample sizes equivalent to those in Figure 1.

SUBSTRATE

Gulls could nest on elevated rocks, on the ground (flat rock with some soil), or on compacted vegetation. On Matojo, they nested primarily on the ground, although some nested on rocks (elevated less than 0.5 m above the ground) or on flattened vegetation (less than 0.25 m above ground). The low vine provided adequate support for nests.

Over 90% of the nests on Geniqui were on the ground, and the rest were on flat rock. Laughing Gulls preferred to nest on these rocks, a choice that differed significantly from the substrate at random points (Tables 2 and 3). The horizontal surface area of rocks available for gull nesting ranged from 400–33,800 cm^2 ($\bar{x}$ = 6,843 ± 10,650 cm^2). All rocks had at least one gull nest, and the largest rocks had two or three nests, located as far apart as possible. Not all gulls could nest on rocks because the number of rocks was limited. Gull nests on the ground were closer to rocks ($\bar{x}$ = 3.7 ± 1.11 m) than were the random points ($\bar{x}$ = 5.35 ± 3.17 m, Table 2). There were very few level spots on the islands, but the gull nests were on flatter sections than were the random points (Table 2). Gulls could compensate for sloped substrate by building up one side of their nest.

VEGETATION

Most gulls on all three islands nested close to the dominant vegetation, although on North Geniqui, fewer nests than random points were next to sedge compared to other vegetation (Table 2). On South Geniqui, where only four pairs nested, all were in the only clump of sedges (4 × 2 m) on the island.

Mean vegetation height was tallest on Geniqui, intermediate on Lobito, and shortest on Matojo (Fig. 2). Gulls nested in vegetation heights significantly different from random on both Geniqui and Lobito (Table 2). On Lobito, the gulls nested in lower vegetation than was generally available, whereas on Geniqui, they selected vegetation of intermediate height from a number of vegetation heights that were equally available (Fig. 2).

CLEARINGS

Vegetation can present an obstacle to the gulls, hindering them from flying directly to or from the nest. On Matojo, the gulls hopped from their nest to the low vine stems and flew from there; on Lobito, most gulls nested on or close to rocks where they had open areas for takeoff. On Geniqui, however, the vegetation (sedge) was vertical, and the gulls could not fly from dense areas. We therefore compared the distance to the nearest clear area for gull nests and random points. The nests were significantly closer to clearings ($\bar{x}$ = 1.36 ± 1.09 m) than were the random points ($\bar{x}$ = 4.78 ± 5.05 m, Table 2). All nests had open paths available that birds used to walk to a clearing from which

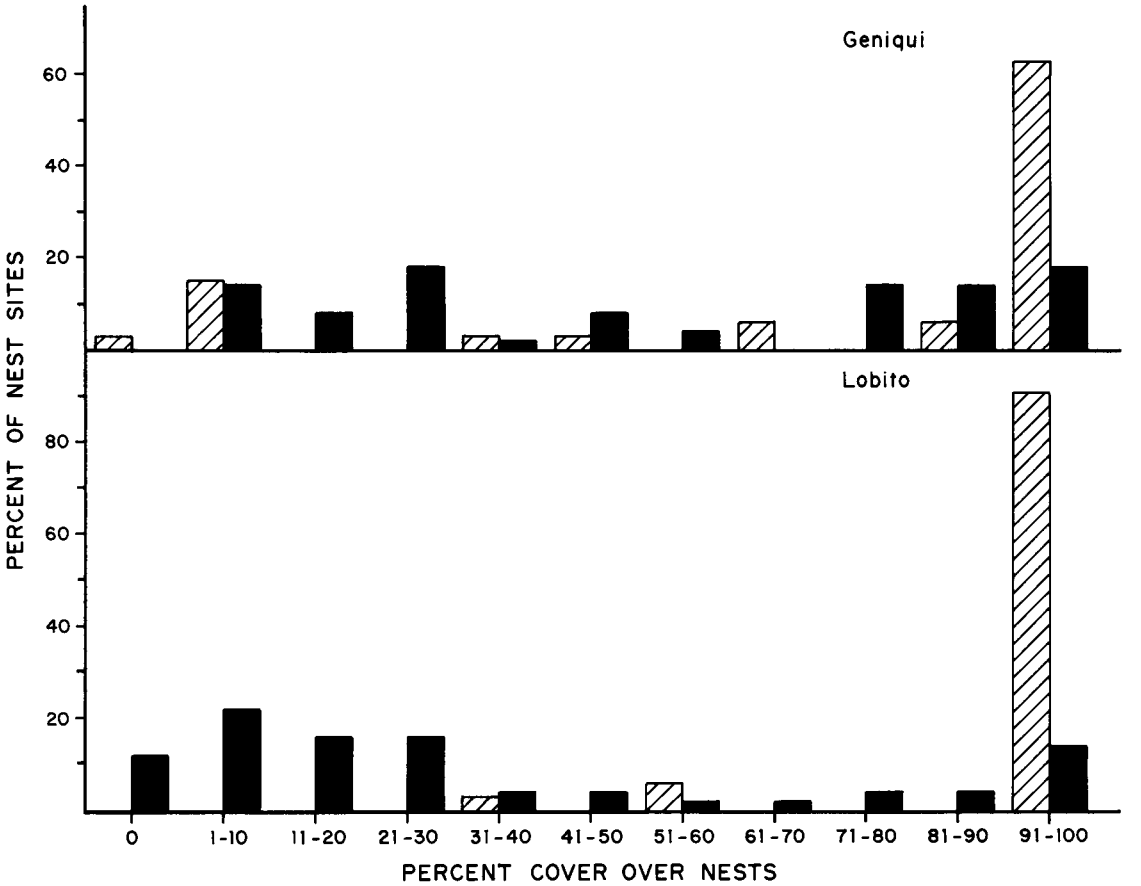

FIGURE 3. Percent of cover (either vegetation or rock) directly over Laughing Gull nests (solid bar) and random points (hatched bar) on two Culebran islands. Sample sizes are the same as those in Figure 1.

they could fly. This was also evident from the fisheye photographs: every nest had one direction that was open. In watching the birds from the edge of the colony, we noted that they did leave by the clearings.

COVER AND VISIBILITY

Cover directly over the nests varied from 1% for nests on some rocks on Lobito to 98% for some nests in sedges on Geniqui (Fig. 3). On Geniqui, cover directly over nests differed significantly from cover over the random points (Table 2). On both of these islands, the sites used by gulls were more open than were the random points. On all three islands, the percentage cover within 1 m of gull nests was higher than the percentage cover immediately over the nest itself, suggesting that gulls nest in open sites adjacent to spots with more cover (Fig. 4). Cover immediately around nests was generally over 60% on Lobito and Geniqui, although it ranged from 8–98% on Matojo (Fig. 4). Most areas on Matojo had ground cover ranging from 20–70%, but gulls nested in sections with greater cover (50–70%). Percentage cover within a 1-m radius differed significantly for nests versus the random points on Geniqui, but not on Lobito (Table 2, Fig. 4).

Visibility from the nest allows gulls to see approaching predators and, conversely, visibility of the nest is important for predators (Tinbergen 1960). On Geniqui, visibility from 1 m was significantly higher for the nests ($\bar{x}$ = 63 ± 34%) than for the random points ($\bar{x}$ = 30 ± 41%, Table 2); some of the random points were entirely in the open on rock, while others were in 100% cover.

The visibility index (from fisheye photographs) for gull nests was low on Geniqui and higher on Lobito (Table 4), although, on both islands, the indices for nests differed significantly from those for the random points (Table 2). On Geniqui, the gull nests had a higher mean visibility index than did the random points ($\bar{x}$ = 10 ± 4), because some of the random points were entirely in the open. On Lobito, the nests had a lower visibility index than did the random points ($\bar{x}$ = 90 ± 13), because most of the random points were entirely under cover. Thus, these gulls preferred sites with intermediate visibility.

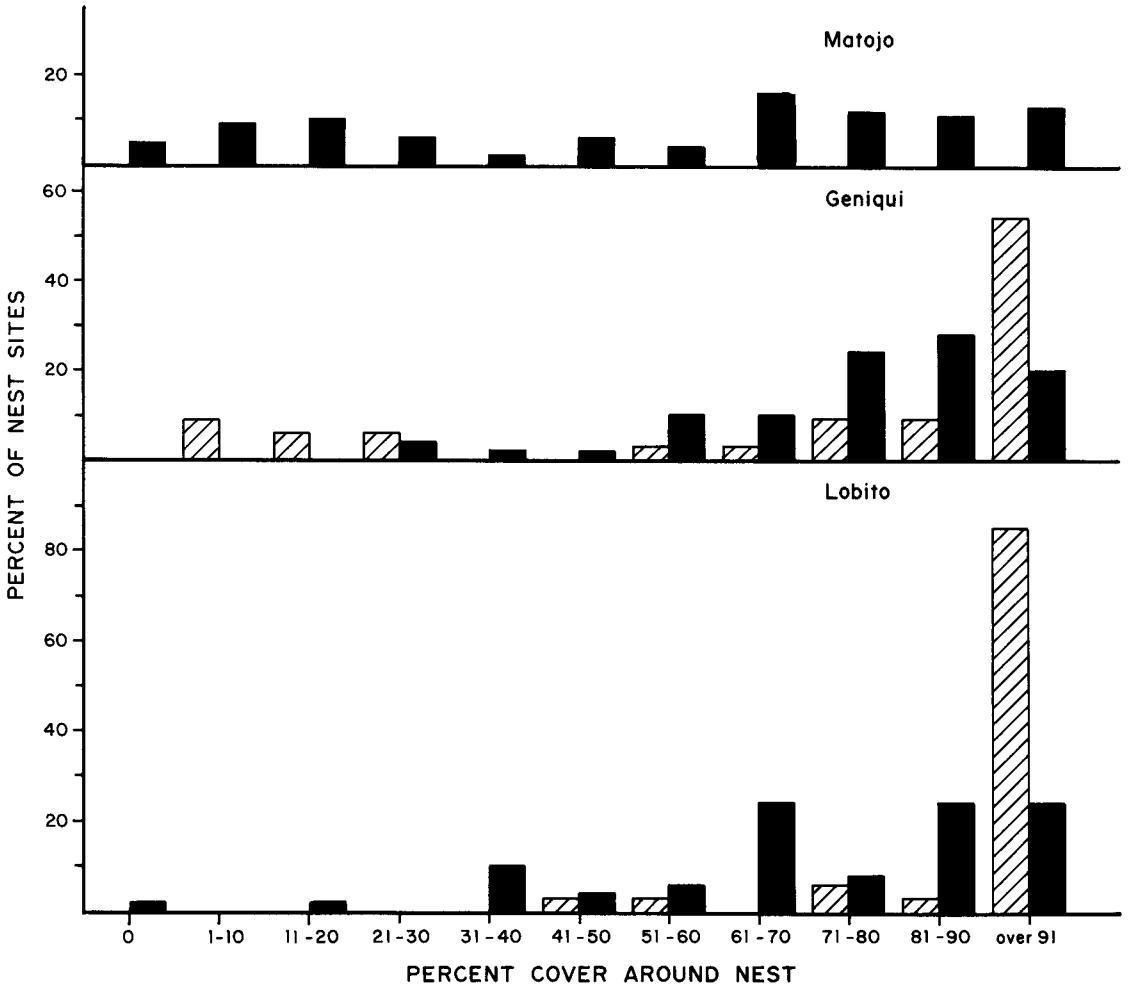

FIGURE 4. Percent cover (either vegetation or rock) within 1 m radius of Laughing Gull nests (solid bar) and random points (hatched bar). Sample sizes are the same as those in Figure 1.

DISCUSSION

SOCIAL FACTORS AFFECTING NEST SITE SELECTION

On Geniqui and Lobito, the gulls nested primarily in monospecific groups, whereas on Matojo, groups of terns nested among the gulls. The gulls might have nested in completely open areas on Matojo, but the terns occupied these entirely. The terns nest close together and can crowd out gulls (Veen 1977). Densely-nesting Arctic Terns (*Sterna paradisaea*) evict nesting Herring Gulls (*Larus argentatus*; Bianki 1967); and Sandwich Terns arriving later than Common Black-headed Gulls (*Larus ridibundus*) succeed in displacing gulls from the center of the colony (Taverner 1969).

Along the eastern Atlantic coast of the United States, Laughing Gulls frequently nest alone (Bongiorno 1970, Montevecchi 1978) or with other species, such as Black Skimmer (*Rynchops niger*), Least Tern (*Sterna antillarum*; Dinsmore and Schreiber 1974), and Herring Gull or Common Tern (*Sterna hirundo*; Burger and Lesser 1978).

Nearest-neighbor distances in the Puerto Rican islands were similar to those reported for the dry land colonies in Florida (Schreiber et al. 1979), but lower than those reported for the New Jersey salt marshes (Montevecchi 1975, 1978, Burger and Shisler 1978). In general, dry land colonies are more compact than the salt marsh colonies (Table 4). Most of the salt marsh colonies are on islands where space is not restricted, and the gulls have plenty of unused salt marsh areas. In contrast, space is limited at dry land colonies and islands, including those at Culebra.

EFFECTS OF VEGETATION ON NEST SITE SELECTION

Gulls on the three Puerto Rican islands nested under vines, low shrubs, and sedges. Although sedges resemble the *Spartina alterniflora* of

New Jersey salt marshes, the vines and shrubs are denser and provide more canopy cover than even the *Baccharis* bushes in some Florida colonies (Dinsmore and Schreiber 1974).

Vegetation was taller on Geniqui and Lobito islands than on Matojo or the New Jersey salt marsh islands. Owing to the height of the vegetation on Geniqui and Lobito, it was difficult for the gulls to fly directly from their nests, so they walked to clearings (Geniqui) or rocky areas (Lobito) to fly. We saw gulls attempt to fly from nests, and get caught in vegetation. In contrast, when Laughing Gulls in New Jersey construct their nests, the new *Spartina* growth is only a few centimeters high and the gulls pile nest material on it, preventing further growth. Nests may be as wide as 120 cm, providing a suitable platform for departure. In many cases, nests are on wide *Spartina* mats (Bongiorno 1970, Montevecchi 1978), enabling the gulls to fly from them. In contrast, the vegetation on the Puerto Rican islands is dense and tall, making exit difficult.

For all nesting colonies, average vegetation cover ranged from 42 to 75%, suggesting that moderate cover is important for nesting Laughing Gulls. In the New Jersey salt marshes, cover prevents losses to predators because eggs are less visible (Burger 1979) and provides protection from rain storms (Burger 1980) and high tides (Montevecchi 1978).

PREDATION

We observed Red-tailed Hawks (*Buteo jamaicensis*) and Magnificent Frigatebirds (*Fregata magnificens*) capturing young larids at Culebra. Additional predators include Cattle Egret (*Bubulcus ibis*), Black-crowned Night-Heron (*Nycticorax nycticorax*), Peregrine Falcon (*Falco peregrinus*), as well as rats and feral cats. Mammalian predators were not found on the cays. Perhaps the most important potential predators are the gulls themselves.

Vegetative cover near the nest offers chicks hiding places from predation, as well as shelter from climatic extremes. The opportunity for rapid adult departure is important because it contributes to maintaining a cryptic nest site by early departure rather than protection of self from predators, since the adults are at low risk of direct predation.

TEMPERATE-TROPICAL COMPARISONS

The vegetation around and over the nests in the Puerto Rican colonies was generally greater than in the New Jersey salt marsh colonies. Similarly, visibility or the amount of open area above the nest was lower in the nests in the tropical, compared to the temperate, colonies (Table 4). Furthermore, in tropical colonies

TABLE 4. Comparison of characteristics of dry land and salt marsh colonies.

	Southern dry land*			Northern salt marsh				
	Geniqui	Matojo	Lobito	Clam**	High bar**	Vol sedge**	Little Beach*** (center)	Little Beach*** (periphery)
Mean (±SD) nearest neighbor distance (cm)	181 ± 161	203 ± 109	263 ± 180	301 ± 126	314 ± 70	420 ± 50	502 ± 12	760 ± 25
Visibility Index	28 ± 3		43 ± 22	73 ± 10	78 ± 11	84 ± 9	67 ± 6	
Percent cover around the nest	74 ± 18	51 ± 35	72 ± 11	52 ± 16	34 ± 18	44 ± 27		
Mean (±SD) vegetation height at the nest (cm)	60 ± 32	32 ± 12	52 ± 33	28 ± 11		22 ± 9	42 ± 4	35 ± 5

* This study.
** Burger and Shisler 1980, and unpubl. data.
*** Montevecchi 1975, 1978.

with sparse vegetation (Matojo), gulls chose sites with the densest vegetation, and on colonies with dense vegetation (Lobito), they chose sites with less cover (see below). Thus, Laughing Gulls in the tropical colonies chose sites with an intermediate percent cover, and this value was higher than in the New Jersey colonies. Although the Puerto Rican colonies are located on islands free from mammalian predators (according to refuge personnel), avian predators, such as hawks and frigatebirds, are present and were seen taking chicks. In the Puerto Rican colonies (at 18°N latitude), cover provides some protection from predators, but, more importantly, it protects the chicks from the tropical sun. Temperatures on bare rocks unprotected by any cover were as high as 44°C, and ground temperatures (at nest height) in places without any cover were as high as 58°C. Although sand temperatures in New Jersey in mid-summer occasionally approach these levels, the substrate in salt marsh colonies rarely exceeds 42°C.

SUMMARY AND CONCLUSIONS

The choice of nest sites on the Puerto Rican islands was influenced by the presence of other species (densely-nesting terns), substrates, and vegetation. The gulls selected moderately dense vegetation of intermediate height that provided protection and cover from predators and the sun. Dense, tall vegetation apparently hindered gulls from flying easily from the nest, so they nested near or on rocks or at the edges of vegetation stands. Compared to temperate colonies along the mid-Atlantic coast, the tropical Puerto Rican gulls nested in taller, denser vegetation with less visibility. Nests in the Puerto Rican colonies were closer together than those in the New Jersey salt marsh colonies, and farther apart than in the Florida dry land colonies. Vegetation cover and vegetation density no doubt made it impossible for Laughing Gulls in Puerto Rico to nest as closely as those in Florida. The extent to which such behavioral differences are genetically determined is, of course, unknown, but we favor the speculation that the differences reflect behavioral plasticity allowing gulls to exploit a wide range of situations. That Laughing Gulls occupied only three of the cays off Culebra may reflect the lack of suitable habitat (e.g., as on forested Luis Pena), but also involves social and factors not examined in this study.

Our results from Puerto Rico indicate that Laughing Gulls are labile in their selection or acceptance of nest sites. They appear to choose their sites in response to available habitat and social conditions (see Partridge 1978). Their choice of nest sites apparently reflects compromises between nesting in dense cover for protection from predators and the sun, and being able to depart from the nest quickly.

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