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NEST-SITE SELECTION OF WILLETS IN A NEW JERSEY SALT MARSH

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Willets (*Catoptrophorus semipalmatus*) breed along the east and west coasts of North America (American Ornithologists' Union 1957); nesting in a variety of habitats including beaches, edge areas, and salt marshes. Willets gather on communal display areas over bare ground or marshes, and then scatter into the surrounding areas to nest (Palmer 1967). They defend nesting territories, and either feed within them or defend nearby feeding territories (Vogt 1938, Tomkins 1965). Tomkins (1965) mentioned the opposing tendencies for gregariousness and territorial spacing, which together should result in uneven distribution of nesting pairs in discrete flock groupings within the available habitat. However, the nesting pattern of Willets has not been documented despite their commonness along our coasts.

We studied nest-site selection of Willets in a salt marsh in southern New Jersey with particular emphasis on the environmental and social determinants of nest-site selection. Many of the marshes in this area contain mosquito ditches. We selected an area large enough to include ditched and unditched marsh to allow determination of the effect of ditching on nesting.

METHODS AND STUDY AREA

We examined a 20 ha salt marsh near Tuckerton, New Jersey (33°30′N, 74°21′W). *Spartina patens* and *S. alterniflora* dominated the marsh, although a few *Iva frutescens* and *Baccharis halimifolia* bushes grew on some higher areas (spoil piles). We distinguished the short form of *S. alterniflora* (< 50 cm) from the tall form (> 50 cm) since it is physiognomically distinct. The marsh contained approximately 1720 m of ditches constructed in 1970 by the Ocean County Mosquito Commission. They graded the spoil from the 0.65 m wide ditches over the marsh surface leaving the spoil only a few cm higher than the surrounding marsh. Spoil piles always occurred adjacent and parallel to the ditches. Spoil piles, the highest areas in the marsh, were never inundated by tidal water during this field season. During 2 storm tides water covered most of the rest of the marsh, although the higher *S. patens* areas remained dry under normal tidal conditions.

We mapped the vegetation in the study area from aerial photographs, aerial surveys by helicopter, and ground surveys, and monitored the area periodically to determine the peak of nesting activity. Four field observers surveyed the area and located 18 nests on 28 May 1976. We mapped the location of each nest (Fig. 1), and recorded the following data: clutch size, egg size, dead grass cover, mean height of live and dead grass, and distance to the nearest bush, ecotone, water, spoil pile, and Willet nest. We collected similar data from 20 points located in the study area selected from a table of random numbers.

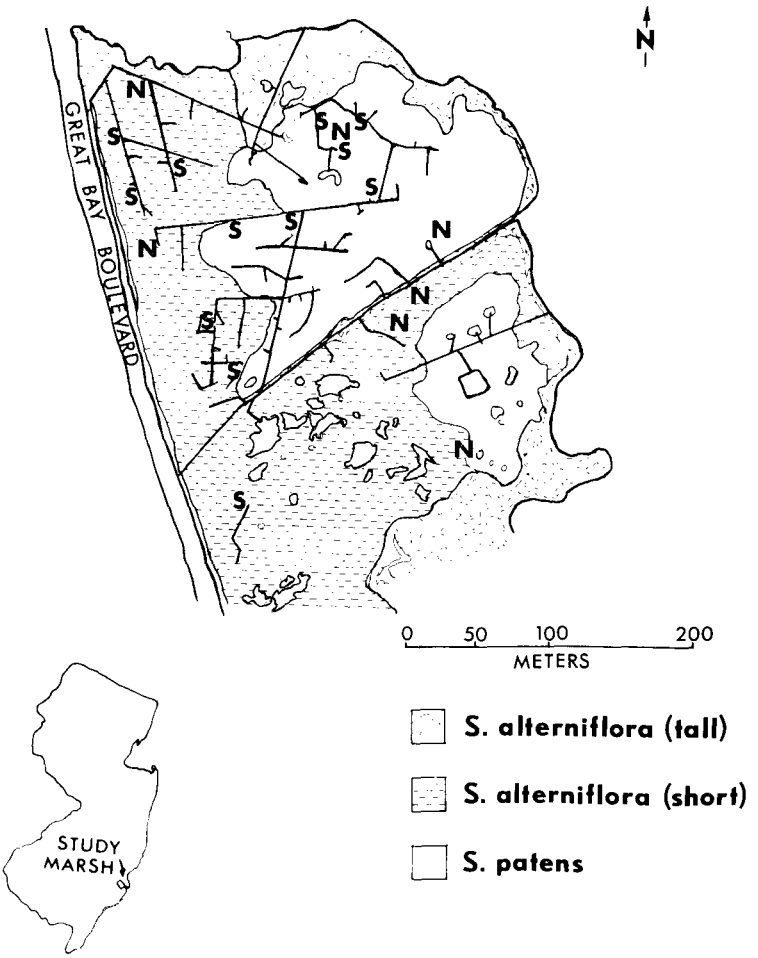

FIG. 1. Map of study marsh near Tuckerton, New Jersey, showing vegetation and nest locations. N = natural nest, S = spoil pile nest.

RESULTS

Environmental determinants of nest-site selection.—In the study area, most Willets nested in the northern section containing the most ditches. Few Willet nests occurred in an equivalent sized area completely devoid of ditches but otherwise similar in vegetation.

Half of the nests occurred in *S. patens* and half occurred in *S. alterniflora*

($\chi^2 = 4.5$, d.f. = 2, N.S.). Since ditches dominated much of the marsh where they nested, we wondered if Willets required ditches near nest sites. Therefore, we compared the percentage of ditching with the number of nests in each vegetation area but found no significant association ($\chi^2 = 2.26$, d.f. = 2, N.S.).

Twelve of the 18 Willets built nests on spoil piles, 5 nested within 20 m and 1 pair nested 50 m from a spoil pile. The nests were significantly closer to spoil piles than were the random points ($\chi^2 = 153.5$, d.f. = 4, $p < 0.001$). Secondly, the number of Willet nests actually on spoil piles differed significantly from the random points ($\chi^2 = 288$, d.f. = 1, $p < 0.001$). Thus, Willets tended to nest on or near spoil piles.

Since spoil piles always occur next to ditches, Willets may be selecting nest sites close to water rather than on the spoil piles. If water were the salient feature, then some Willets should nest near natural water areas. Several small pools dotted the area but Willets did not nest next to these. Secondly, if they preferred water and not the spoil piles, then some birds should have nested just off the piles near the water. This, however, did not occur.

All bushes on the study area grew on the spoil piles, suggesting that Willets may be selecting nest sites close to bushes. Willets on spoil piles, however, did not nest close to bushes ($\bar{x}$ distance = 6.1, S.E. = ±1.6 m). The mean distance to bushes of all Willet nests (8.1 ± 2.74 m) did not differ significantly from that of the random points ($\bar{x} = 6.8 \pm 0.68$ m, $t = 1.21$, d.f. = 35, N.S.).

We then compared vegetational characteristics of the Willet nests with those of the random points. The means for Willet nests did not differ significantly (t values less than 1.3) from the random points with respect to percentage of live vegetation (53% vs 54%), percentage of dead vegetation (46% vs 48%), height of live vegetation (31 vs 30 cm) and height of dead vegetation (22 vs 14 cm). Thus, Willets nest randomly with respect to vegetational characteristics, species of vegetation, distance to bushes, and distance to water. They preferred to nest on the spoil piles regardless of the surrounding vegetation.

Social behavior determinants of nest-site selection.—We compared the nearest neighbor distances of the Willet nests with those of the random points within the entire nesting area. The mean internest distance of Willets was much lower (41.2 ± 32 m) than that of the random points (58.7 ± 46 m) and they nested closer together than expected by chance ($\chi^2 = 17.2$, d.f. = 5, $p < 0.005$). Only 2 Willets (11%) nested farther than 50 m from a neighbor, compared to 6 (38%) of the random points. Thus, considering the entire nesting area, Willets clumped while nesting. Their clumping doesn't appear

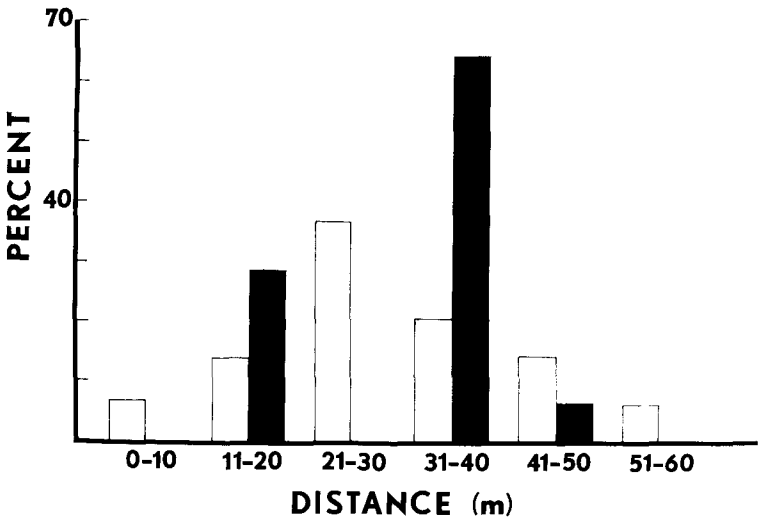

FIG. 2. Comparison of internest distances along mosquito ditches for Willet nests (solid bar) and random points (open bar) on northern ditched area.

to be a function of the clumped ditches since Willets did not nest on the outlying ditches (Fig. 1). Similarly, even within the area of extensive ditching, birds could have nested farther from one another than they did.

We next examined nest spacing in the north end of the study area. Eleven Willets nested along the ditches and 3 nested elsewhere. Using a table of random numbers, we located 3 points in the area. Then we computed the total linear ditching distance (1522 m), and randomly plotted 11 points (equal to the number of nests) along the ditches. We then computed nearest neighbor distances for the random points and compared them to the Willet nests (Fig. 2). The Willets nested farther from each other than expected by chance ($\chi^2 = 21.9$, d.f. $= 5$, $p < 0.001$). With the exception of 1 group of 4 nests in *S. patens*, all Willets nested between 37 and 53 m apart. One of the Willets in this group did not nest on a spoil pile, thus its nest was slightly lower and may not have been as visible as the other 3 nests nearby. The side of the ditch used for nesting made no difference in the distance between neighbors. That is, nearest neighbor Willets nesting on opposite sides of a ditch did not nest significantly closer ($t = 0.56$, d.f. $= 11$, N.S.) than those on the same side of the ditch (28 ± 1.9 vs 33.6 ± 12 m). Since Willets rely heavily on aerial and wing displays (Tomkins 1965, Howe 1974), we did not expect ditches to act as visual barriers for nesting.

Thus, in summary, Willets nested in clumps, spacing themselves with

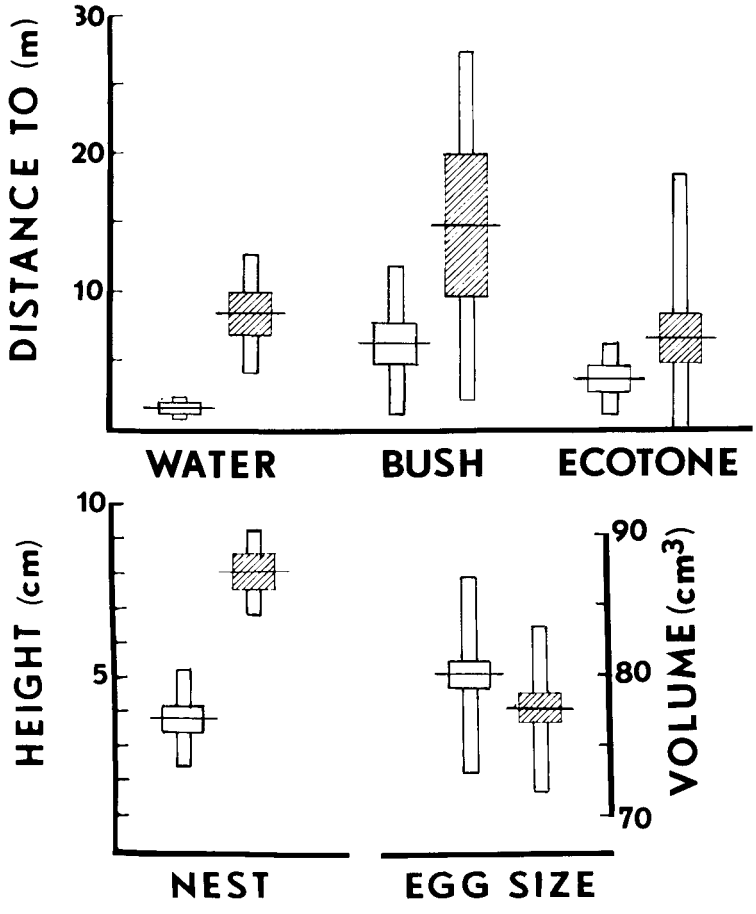

FIG. 3. Comparison of spoil nests (open rectangle) with natural nests (hatched rectangle) for nesting parameters. Means = horizontal line, standard error = vertical rectangle, and standard deviation = vertical bar.

respect to one another in the preferred nesting area. They preferred to nest on spoil piles and nested randomly with respect to vegetational species, vegetational characteristics, and water.

Spoil versus natural nests.—We compared the characteristics of Willet nests in natural areas with those on spoil piles (Fig. 3). Features characteristic of ditch construction (i.e. water and bushes) showed significant differences between spoil and natural nests ($F = 32$, d.f. $= 1$). No differences existed with respect to the distance to the ecotone (here meaning an area of change

in vegetation species). No significant differences existed between spoil and natural nests with respect to vegetational characteristics ($F < 1.23$).

Willets in this study constructed nests of only *S. patens* grass, concealing the nest by pulling some of the dead grass over the top to form a dome. We measured the depth of all nests. Willets nesting in natural situations built significantly deeper nests than those nesting on spoil piles ($F = 34.5$, d.f. $= 1$, 18, $p < 0.005$). We then computed egg size using the method of Grossfeld (1937) which takes into account the length and breadth. Willets nesting on spoil piles laid significantly larger eggs than those nesting in natural situations ($F = 5.93$, d.f. $= 1$, 46, $p < 0.05$).

DISCUSSION

Nest-site selection.—Despite the extensive recent work on shorebirds, little information exists either on general habitat preferences, or on specific nest-site preferences. Graul (1975) analyzed general habitat preferences as well as specific nest-site characteristics for the Mountain Plover, *Charadrius montanus*. He recorded differences with respect to vegetation species, slope of the ground, and proximity to manure piles. He noted that the spatial relationships of the plover nests suggested that nests were not placed randomly with respect to one another, but he did not test this hypothesis.

In this study we examined general habitat and specific nest-site preferences of Willets nesting in a salt marsh containing mosquito ditches. Willets selected nest sites on spoil piles and nested randomly with respect to vegetation characteristics and distance to bushes and water. Slight elevation differences in the marsh result in different species of vegetation. Tidal waters regularly inundate the low *S. alterniflora* areas. Presumably, Willet nests and eggs cannot withstand tidal inundations; hence the preference for spoil piles.

Although their absence from these low *S. alterniflora* areas was not significant, it would have been if we added the extensive marsh area that did not contain any Willets and which was adjacent to our study area.

Considering the entire nesting area, Willets nested closer to one another than expected by chance; but considering only the north end of the study area, the Willets nested farther apart than expected by chance. Thus they spaced out in a clump. This nesting pattern was not an artifact of the ditching pattern because sufficient ditching existed for the Willets to nest either farther or closer than they did. Our data, therefore, support the suggestion of Tomkins (1965) that Willets clump, spacing out within these clumps. Several authors described the social behavior responsible for this nesting pattern (e.g. Vogt 1938, Tomkins 1965, Howe 1974). More marsh area should be examined to confirm the clumping nature of their distribution.

Presumably the clumping provides increased social stimulation for breeding, whereas the spacing relates to predation pressures. Nest density is generally assumed to be a compromise between nesting together for social stimulation and predator mobbing (Kruuk 1964) and nesting far apart for camouflage of the eggs and young (e.g. Tinbergen 1956, Cullen 1960). Evidence for the camouflaged pattern included roofed-over nests, cryptic eggs, cryptic young, and cryptic adults while incubating. Whereas Willets are not noted for mobbing predators, several times we have had 3 or 4 birds fly over our heads at one time.

Spoil versus non-spoil nests.—Considerable discussion surrounds salt marsh management practices. In the early 1900s mosquito control personnel constructed parallel ditches connected to the bays on many of our Atlantic coastal marshes (Smith 1907). Unfortunately, ditching occurred on many areas unnecessarily since mosquitoes do not breed in all salt marshes. Drainage of the marshes resulted in vegetational changes involving an increase in *Iva* and *Baccharis* bushes (Bourn and Cottam 1950). Subsequently, some observers reported on the detrimental effects of ditching (e.g. Service 1971, Daiber 1974), while others proclaimed the overall effect as beneficial (e.g. Bennett 1971, Rio 1971, Shisler 1973). The ditching on our study area, not parallel in construction, only connected mosquito breeding areas and did not markedly change the vegetation. Nevertheless, the spoil did create some slightly higher areas and Willets preferred these for nest sites.

Older gulls and terns lay larger eggs and clutches than do younger birds (e.g. Coulson 1966, 1968). The Willets nesting on the spoil piles had significantly larger eggs suggesting that they may be older, more experienced birds. This further suggests that younger birds may have been excluded from the spoil areas.

Nesting on spoil piles confers a number of advantages. Since they are the highest areas, they are drier and provide more visible areas for courtship and territorial displays. The piles provide grass cover for nest construction and concealment similar to that provided by the natural areas. Thus, spoil piles provide advantages that natural areas do not, while retaining the advantages of the natural areas.

SUMMARY

We examined the requirements for nesting in Willets in a salt marsh in southern New Jersey. Willets did not nest in an extensive area of tall *Spartina alterniflora* marsh, a few nested in an area of short *S. alterniflora*, and 18 nested in a *S. alterniflora* and *S. patens* marsh with mosquito ditching.

The nest sites chosen by the Willets did not differ from random points with respect to several vegetation characteristics including species of vegetation, % live cover, % dead cover, mean height of live and dead grass, and distance to ecotone. Willets selected nest

sites on high ground, in this case on spoil piles. The Willets nesting in the study marshes nested closer together than expected by chance. Upon examining the dense nesting area, however, Willets nested farther apart than expected by chance. Thus, Willets spaced themselves in a clump.

We discuss the advantages of nesting on spoil piles, and the advantages and disadvantages of the nesting pattern with respect to social factors.

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SYMPOSIUM ON BIRDS OF THE SEA AND SHORE

A 5-day symposium, consisting of 3 days of formal sessions and 2 days of excursions, will be held at the University of Cape Town, South Africa from 19–23 November 1979. The theme of the symposium will be "Birds of the sea and shore" and papers will be given on seabirds and waders, both inland and coastal. Excursions are planned for an offshore seabird breeding island, Langebaan Lagoon and a seawatching cruise.

Persons interested in attending the symposium should write to the Organizing Secretary, Mr. G. D. Underhill, 12 Roseberry Road, Mowbray 7700, South Africa for further information. Persons wishing to deliver a paper should also write to Mr. J. Cooper, Southern African Seabird Group, c/o FitzPatrick Institute, University of Cape Town, Rondebosch 7700, South Africa, giving details of their proposed paper.