

weeks old. On 26 June we last observed the young crane and adults in the meadow. Red-winged Blackbirds (*Agelaius phoeniceus*) were harassing the young bird, which struck and killed one, then walked out of view with the prey in its bill.—ROBERT C. FIELDS, ALAN K. TROUT, and DAROLD T. WALLS, *J. Clark Salyer National Wildlife Refuge, Bureau of Sport Fisheries and Wildlife, Upham, North Dakota 58789. Accepted 3 April 1974.*

Observations on the terrestrial wing displays of breeding Willets.—Willetts (*Catoptrophorus semipalmatus*) are large tringine sandpipers with unusually prominent white wing stripes bordered with dark brown and black. They are monogamous breeders with each pair maintaining a nesting territory (Vogt, Proc. Linnean Soc. N. Y., 49:8–42, 1938) and sometimes a separate feeding territory (Tomkins, Wilson Bull., 77:151–167, 1965). Both authors attributed territory advertisement almost exclusively to males, which perform aerial displays and engage in partly ritualized border standoffs with neighboring males. Loud vocalizations are used in both situations. Both authors also commented on the conspicuousness of the wing pattern during precopulatory wing vibration and aerial hovering displays, the latter likened in function to passerine song by Vogt. They both believed that the contrasting pattern provided stimulation to the female during courtship. Other functions, such as species recognition and distraction, were postulated by Tomkins (op. cit.). No references were made to terrestrial wing displays other than precopulatory wing vibration. For this reason I report here observations I made on behavior of Willets near Corpus Christi, Texas, in March and April, 1973. These observations provide evidence of additional contexts in which terrestrial wing displays regularly occur.

The Willets in my study area rarely fed in the nesting territory, which was set off from Gulf waters by man-made dikes, but instead utilized nearby tidal marsh for that purpose. One member of each of four different pairs was color-marked. Two of these were determined to be males, on the basis of position in copulation and relative size and color pattern (males are smaller and more strongly marked than females). The sexes of the other two marked birds were not determined. One pair, of which the male was marked, maintained fidelity to the same feeding territory throughout the two-month period, while two other pairs showed only intermittent attachment to particular feeding sites. I monitored two pairs with adjacent, well-defined territories in the nesting area, and the males of both pairs were marked.

Terrestrial wing displays were observed in four contexts:

1. Prior to copulation males were observed to approach females from behind, extend the wings vertically, vibrate them and give a rapid, prolonged, staccato *kip-kip-kip*. . . call. This behavior has been described by Vogt (op. cit.) and Tomkins (op. cit.).

2. Males landing in either the nesting or feeding territory nearly always held both wings vertically for two to three seconds after alighting and gave the loud *pill-will-willet* call several times. As known females were not marked, it was not determined whether females perform the same display when landing alone in their territories. However, when both members of a pair landed together, the display was given by both simultaneously.

3. When conspecifics flew over or near a male Willet on its nesting or feeding territory, the latter usually responded by giving the *pill-will-willet* call, often accompanied by the partial or complete raising of both wings. I observed this response over 100 times and found that it could be reliably predicted when a flying bird was seen approaching. It was my impression that wing display occurring in this context was a direct function

of the proximity of the flying bird. I recorded only one such response by a female, which was alone on the nesting territory at the time. Occasionally the wing display was given without vocalization.

4. During encounters of two birds near a territorial boundary, each was observed to assume an upright posture with the tail spread and tilted toward the other bird as described by Vogt (op. cit.). The *kip-kip* call was usually given at a slow or irregular tempo and attack often followed. Although this display was commonly performed with the wings in normal position, I recorded several instances in which the wings were extended vertically.

Contexts 2 to 4 appeared to be directly related to advertisement or defense of territory, although an epigamic function could not be ruled out in 2. In 2 and 3 the message of territory occupancy is potentially communicated over long distances by virtue of the loudness of the *pill-will-willet* call. In 4 the call is more subdued and the target bird is nearby. As the great majority of wing displays occurred in conjunction with *pill-will-willet* calls (contexts 2 and 3), I believe that a main function of exposing the wing pattern is to reveal to distant conspecifics a bird's precise position after vocalization has attracted attention to a general area. In certain situations (context 2) the pattern helps attract the attention of any conspecifics in the area to a bird's arrival. In others (contexts 3 and 4) the displays are directed at specific targets. My own ability to locate calling birds was greatly enhanced if the wing pattern was exposed.

I was impressed with the high incidence and visibility of terrestrial wing displays in the Willet. Except for precopulatory wing displays, which are clearly epigamic, the literature provides only scanty evidence of territory-related wing displays in other tringines. *Limosa limosa* (Lind, Studies on the behaviour of the Black-tailed Godwit *Limosa limosa* L., Munksgaard, Copenhagen, 1961), *Tringa totanus* (Grosskopf, J. F. Ornith., 99: 1-17, 1959), and *T. solitaria* (Oring, Wilson Bull., 80:395-420, 1968) occasionally raise both wings during courtship or territorial defense. *Actitis macularia* uses a variety of wing-up displays in aggressive interactions (pers. obs.).

The literature contains much information on the wing displays of calidridine sandpipers, describing one-wing as well as two-wing displays in sexual and aggressive contexts. *Calidris alpina* (Holmes, Condor, 68:3-46, 1966), *C. melanotos* (Hamilton, Condor, 61:161-179, 1959), *C. maritima* (Bengtson, Ornis Scandinavica, 1:17-25, 1970), *C. mauri* (Brown, Ibis, 104:1-12, 1962), and *C. boirdii* and *C. fuscicollis* (Drury, Auk, 78:176-219, 1961) use vertical extensions of one wing during territorial encounters, usually with the underwing held facing the opponent. *C. temmincki* uses a two-wings up display, in combination with a trill, during courtship (Southern and Lewis, Brit. Birds, 31:314-321, 1938). *Tryngites subruficollis* exhibits a complicated repertoire of one- and two-wing displays in social gatherings (Oring, Auk, 81:83-86, 1964). Most species of sandpipers that use wing displays have the underwings white or show contrasting, light-dark wing patterns which accentuate the conspicuousness of the extended wing.

As the natural habitat of Willets lacks the elevated, conspicuous perches often used by many other species in the tringine group, selection may have favored the evolution of a more complex repertoire of wing displays and a more striking wing pattern as mechanisms for enhancing visibility. The same factor may account for what appears to be a greater diversity of wing displays (i.e., both one-wing and two-wing) among calidridines, most of which nest in open habitats; however, much more comparative information is needed to test this correlation.

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from the Penrose Fund of the American Philosophical Society. I would like to thank Alfred L. Gardner for critically reading an earlier draft of this manuscript and providing helpful comments and suggestions.—MARSHALL A. HOWE, *National Fish and Wildlife Laboratory, National Museum of Natural History, Washington, D.C. 20560. Accepted 1 March 1974.*

Breeding success relative to nest location and density in Ring-billed Gull colonies.—The role of nest location and density in determining breeding success in Ring-billed Gulls (*Larus delawarensis*), to our knowledge, has not been studied previously. In breeding colonies some nests will be located centrally while others are peripheral. Two factors that could affect breeding success of individual pairs within a colony are nest density and the relative location of each nest. Several workers have investigated nest location and its influence on breeding success of colonial breeding birds. Studies of the Black-headed Gull, *L. ridibundus* (Patterson, *Ibis*, 107:433–459, 1965), Adeline Penguin, *Pygoscellis adeliae* (Tenaza, *Condor*, 73:81–91, 1971), and the Black-legged Kittiwake, *Rissa tridactyla* (Coulson, *Nature*, 217:478–479, 1968), have shown that birds nesting solitarily, or on the edge of colonies, tend to have lower reproductive success than those nesting in the colony center.

We studied two Ring-billed Gull colonies in Lake Huron from 16 May to 4 July 1972. The Calcite Colony is located on a man-made peninsula near Roger City, Presque Isle County, Michigan. The other colony is on Bird Island in Thunder Bay near Ossineke, Alpena County, Michigan. The Calcite Colony contained about 3,000 pairs of nesting Ring-billed Gulls and is situated along the south shore of the proximal portion of the peninsula, about 2 m above water level. The ground is generally level and in summer it is partially covered with low-growing (1 m high) herbaceous vegetation, mostly grasses and a few burdock (*Arctium* sp.).

During highs in the Great Lake water cycle, such as when our study was conducted (see monthly and yearly mean water levels, Chart No. 207, Department of the Environment, Ottawa, Ontario), Bird Island is actually three small low-lying islands. We conducted our observations on the middle islet, which had approximately 500 nesting pairs of Ring-billed Gulls. Dense brush (1 to 7 m high) covered the islet except for portions of the south and east sides, which were essentially without vegetation and had the most gull nests. The most abundant plant species were red-osier dogwood (*Cornus stolonifera*), green ash (*Fraxinus pennsylvanica*), arbor vitae (*Thuja occidentalis*), and 2 m high nettle (*Urtica gracilis*).

For our study we used 184 nests in the Calcite Colony and 315 nests in the Bird Island Colony. Only those nests that formed the interface between the colony and its surrounding environment were considered as constituting the fringe sample. Nests proximate to the geometric center of each colony were selected as representative of the center. Nest density was measured by counting all contemporary nests within a radius of 1 m of each nest cup.

We visited the study sites at least every other day and recorded the number of eggs and young present, any mortality in each nest, and weather conditions. Data were collected on chicks from the time of hatching until they were 21-days-old or dead, whichever might have come first. The term "breeding success" is used here as a combination of hatching success and chick survival through 21 days.

Two statistical tests were applied to the data. For examining the effects of nest loca-