Differential Use of Coastal Marsh Habitats by Nonbreeding Wading Birds

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Abstract.—We conducted weekly aerial surveys of wading birds of several species from a fixed-wing aircraft along the coastal salt marsh of Aransas and Matagorda Island National Wildlife Refuges on the Texas coast. Habitats used by wading birds were broadly classified as vegetation and open water habitats. Open water categories included, in order of increasing surface area, pools, ponds, lakes, and bays. Other open water habitats present included cuts and inlets. The five most common species observed included, Great Egret (*Casmerodius albus*, N = 720), Great Blue Heron (*Ardea herodias*, N = 561), Reddish Egret (*Egretta rufescens*, N = 121), Snowy Egret (*E. thula*, N = 60), and Tricolored Heron (*E. tricolor*, N = 37). The vast majority of individuals of all species were observed in open water habitats as opposed to vegetated areas. Lake was the most common habitat utilized by waders with >20% of individuals of all species observed in this habitat. Overall patterns of habitat use were significantly different ($\chi^2_{16} = 259.5$, $P < 0.001$) among species. Great Blue Heron, Great Egret, Reddish Egret, Snowy Egret, and Tricolored Heron all differed significantly ($P < 0.001$) in use of different open water habitat categories. Specific overlap indicies show Great Egret-Tricolored Heron to overlap completely (0.99) in habitat use patterns. High overlap occurred between the following species pairs: Reddish Egret-Great Egret (0.87), Reddish Egret-Tricolored Heron (0.86), and Great Blue Heron-Snowy Egret (0.87). Other species pairs showed little overlap in habitat use patterns. *Received 31 January 1995, accepted 2 June 1995.*

Key Words.—aerial surveys, Ciconiiformes, coastal salt marsh, habitat use, Great Egret, *Casmerodius albus*, Great Blue Heron, *Ardea herodias*, Reddish Egret, *Egretta rufescens*, Snowy Egret *Egretta thula*, Tricolored Heron, *Egretta tricolor*, Texas.

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In temperate regions of North America the study of wading birds has long centered on breeding individuals and populations (Kushlan 1992). Less is known regarding the winter distribution and patterns of habitat and food resource use by temperate breeding wading birds. Studies of sympatric wading birds during the nonbreeding season and winter period are rare (Heitmeyer 1986, Frederick and Bildstein 1992). Better knowledge of wintering areas and nonbreeding habitat requirements are essential and may help in the conservation of migratory wetland wading bird species (Kushlan 1992). In Europe, it has been shown that winter conditions can influence the size of breeding bird populations the following year (Dallinga and Schoenmakers 1987).

Wading birds have been shown to partition resources through a combination of characteristics, including habitat (Kushlan 1978). Sympatric species of herons and ibises may partition food resources by size, food, feeding location, and behavior (Kushlan 1981, Maccarone and Parsons 1994). Resources generally appear to be divided with a low degree of overlap among herons of different sizes (Willard 1977), while overlap in food and habitat among some similar-sized herons can be high (Jenni 1969, Willard 1977, Custer and Osborn 1978, Kent 1986). Seven species of sympatric ibises showed significant differences in the use of foraging habitats during the nonbreeding season in Venezuela (Frederick and Bildstein 1992).

Here we report on the relative abundances and use of open water habitat by five species of wading birds on Texas coastal marshes during the winter of 1992-1993.

METHODS

We studied wading bird habitat use on the salt marshes of Aransas National Wildlife Refuge (ANWR) and Matagorda Island National Wildlife Refuge (MINWR) located on the Texas Coastal Bend Region. Aransas NWR is located in Aransas and Refugio counties and is

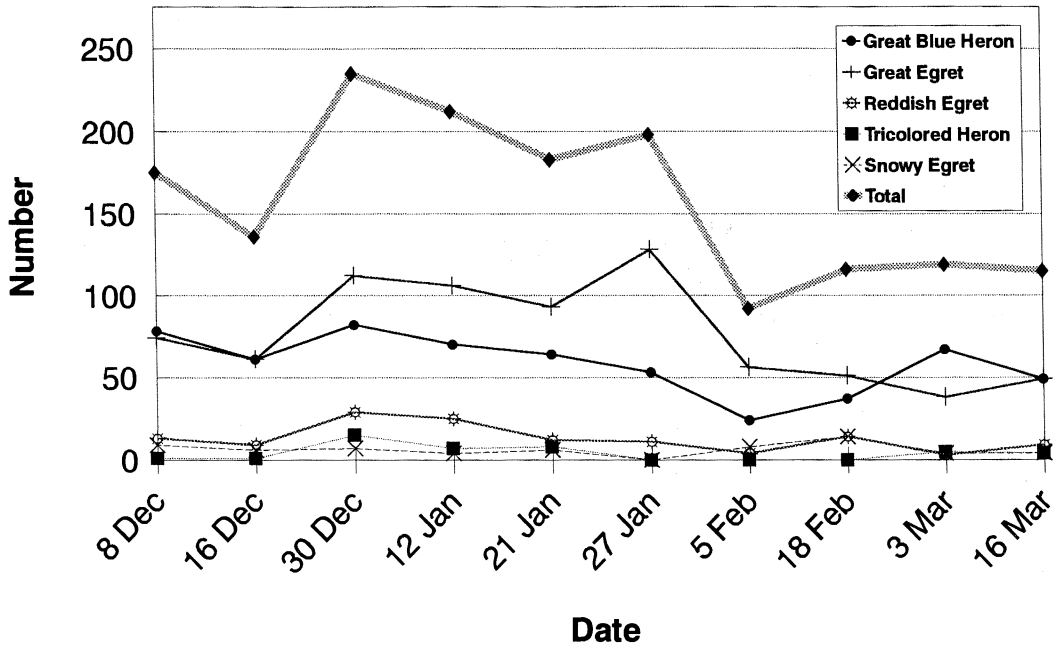

Figure 1. Numbers of wading birds observed during aerial surveys on salt marshes of Aransas and Matagorda Island National Wildlife Refuges, during fall and winter 1992-93.

part of the mainland. Matagorda Island NWR is a barrier island, 62 km long and varies from 1.2 to 7.3 km wide, and is located in Calhoun County. The salt marsh areas are located along the eastern coast of ANWR and on the west side of MINWR. Ground vegetation surveys at the two salt marsh areas showed them to be similar. Salt marsh habitats consist of vegetated flats dominated by glasswort (*Salicornia virginiana*), saltwort (*Batis maritima*), sea-oxeye daisy (*Borrichia frutescens*), wolfberry (*Lycium carolinianum*), saltgrass (*Distichlis spicata*), and smooth cordgrass (*Spartina alterniflora*), and wind tidal flats dominated by mudflat grass (*Eleocharis parvula*), saltgrass, and cordgrasses. Interspersed among vegetated areas are bodies of open-water of varying sizes.

For the purpose of this study we classified open-water habitats based on areal extent from smallest to largest as pool (< 4 m^2), pond (4 - 100 m^2), lake (> 100 m^2), and bay (shallow open-water area adjacent to the coastline). Other water habitats included inlets and cuts. Cuts are, narrow, straight or winding, open-water areas connecting two or more bodies of water except bays. Inlets are similar to cuts, except that they connect at one end to a bay.

Between 8 December 1992 and 16 March 1993 observations of wading bird habitat use were made as part of almost weekly aerial surveys conducted from a fixed-wing aircraft to locate Whooping Cranes (*Grus americana*) on the salt marsh of ANWR and MINWR. According to surveys conducted by Aransas National Wildlife Refuge personnel (Stehn, pers. comm.), Great Blue Herons, (*Ardea herodias*) are the first of wading birds to initiate breeding activity in mid to late March in the area where the aerial surveys were conducted. During each survey, transects were flown parallel to the coast line at an altitude between 30 and 50 m. A linear distance of approximately 285 km was covered on each survey for both refuges combined (110 km in ANWR, 175 km in MINWR). The first transect was flown along the coastline, with successive transects approximately 0.5 km inland from each previous one. All wading birds observed within 25 m perpendicular to the flight line on the observer's side of the aircraft were identified and habitat type in which the bird was located recorded. Birds not identified to species were eliminated from analysis of habitat use. Individual observations of habitats that could not be confidently classified (e.g., pool vs. pond) were not used in habitat use analysis, but individuals were tallied to obtain a total bird count for each survey.

Overall differences in use of habitat categories among all species were evaluated with a Chi-square test (Conover 1980). Differences in the use of habitat categories by individual species were evaluated with a Chi-square goodness-of-fit test (Conover 1980). To evaluate degree of overlap in patterns of habitat use among wading bird species, a specific overlap index was calculated for each species pair (Ludwig and Reynolds 1988). Specific overlap is based on a comparison of the resource utilization curves of two species, with values ranging from 0-1 (1 = complete overlap, while 0 = no overlap).

RESULTS

The five most common species observed on surveys were Great Egrets (*Casmerodius albus*) (N = 720), Great Blue Herons (N = 561), Reddish Egrets (*Egretta rufescens*) (N = 121), Snowy Egrets (*E. thula*) (N = 60), and Tricolored Herons (*E. tricolor*) (N = 37). Other spe-

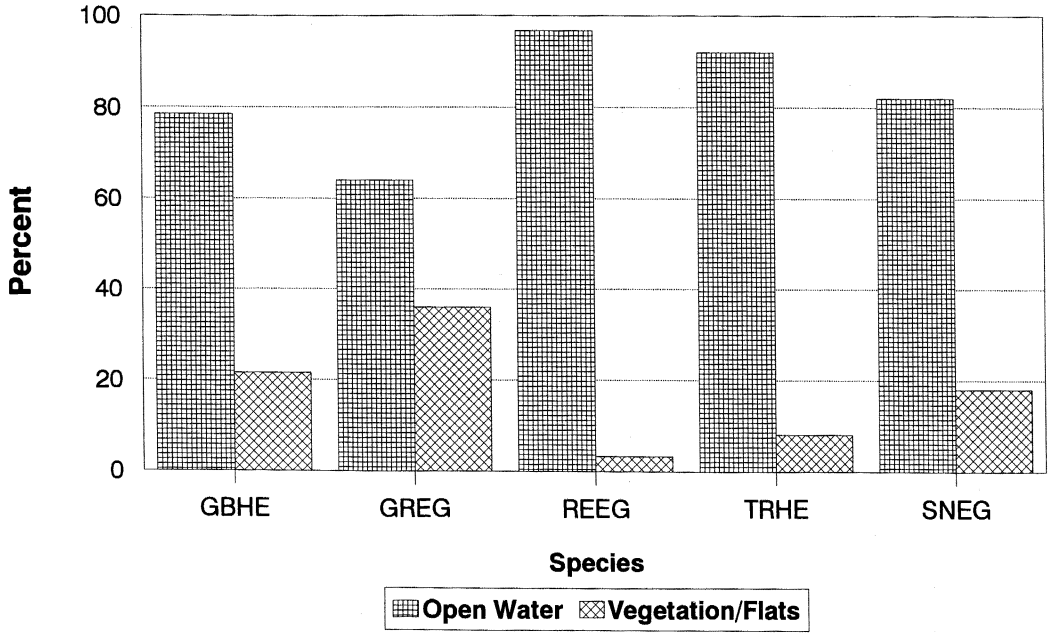

Figure 2. Percent birds observed in all open-water and vegetation habitats during aerial surveys on Aransas and Matagorda Island National Wildlife Refuges, during fall and winter 1992-93. GBHE = Great Blue Heron, GREG = Great Egret, REEG = Reddish Egret, TRHE = Tricolored Heron, SNEG = Snowy Egret.

cies observed, but rarely recorded on surveys included Little Blue Heron (*E. caerulaea*), Roseate Spoonbills (*Ajaia ajaja*), White Ibises (*Eudocimus albus*), and Black-crowned Night-Heron (*Nycticorax nycticorax*). Individuals of the latter four species were rarely recorded within the survey area and, when present, were regularly flushed, likely due to the low altitude at which the aircraft was flown. The five species assessed in this study were not flushed as the airplane approached.

Total wading birds observed per survey varied between 138-235, from 8 December through 27 January (Fig. 1). However, numbers declined slightly and leveled off at approximately 110 (range 96-110) thereafter. The total number of wading birds observed appears to reflect the pattern of occurrence of Great Egrets more than any other species. Relatively small percentages of each species were observed on vegetative areas and exposed sand and mudflats (Fig. 2).

Patterns of wading bird use of open-water habitat (Fig. 3, Table 1) were significantly different ($\chi^2_{16} = 259.5$, $P < 0.001$) among species. Because of small samples sizes, inlets and cuts were combined into a single category for statistical analysis, but use of these habitats is presented in Fig. 3. All species showed differences in their use of specific habitats. Great Blue Herons used bays and lakes significantly more than expected ($\chi^2_4 = 227.8$, $P < 0.001$), while using pools and ponds significantly less than expected. Great Egrets were found primarily in pools and, to a lesser extent, in lakes which they utilized more than expected, while ponds and bays were used less than expected ($\chi^2_4 = 233.7$, $P < 0.001$). Reddish Egrets preferred lakes ($\chi^2_4 = 85.8$, $P < 0.001$) and used pools and lakes more than expected, with ponds and bays used significantly less than expected. Snowy Egrets were most common in bays which were used more than expected ($\chi^2_4 = 38.7$, $P < 0.001$). Lakes and ponds were used as expected, and ponds were used less than expected. Tricolored Herons used pools greater than expected and bays less than expected ($\chi^2_4 = 19.7$, $P < 0.001$), while using lakes and ponds as expected.

We found two distinct groups in habitat use patterns based on the specific overlap index, with Great Egret-Tricolored Heron-

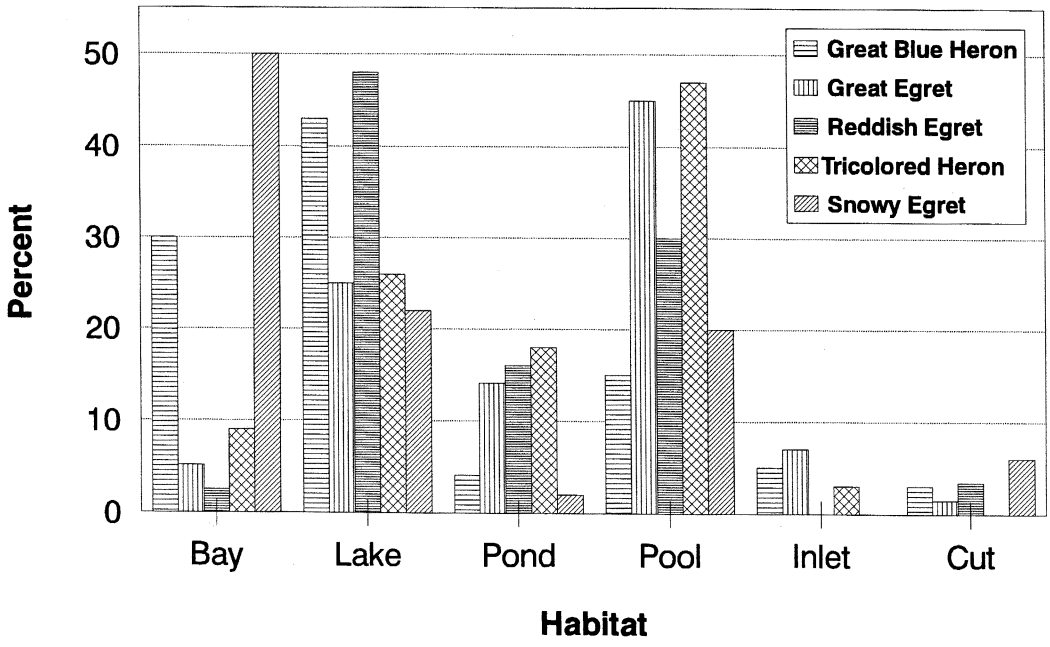

Figure 3. Patterns of open-water habitat use by wading birds in salt marsh areas of Aransas and Matagorda Island National Wildlife Refuges, during 1992-93 fall and winter.

Reddish Egret in one and Great Blue Heron-Snowy Egret forming a second (Fig. 4). In group one, Great Egret and Tricolored Heron overlapped completely (0.99), while both overlapped with Reddish Egret (0.87 and 0.86 respectively). In the other group, overlap in habitat use occurred between Great Blue Heron and Snowy Egret (0.87).

DISCUSSION

In general, we found considerable overlap in habitat use patterns among herons and egrets. In coastal areas of New Jersey, Great Blue Herons overlapped little with other species present, while Great Egrets overlapped significantly with Snowy Egrets and Tricolored Herons (Willard 1977). Maccarone and Parsons (1994) found differential use of tidally-influenced habitat for foraging in Staten Island, New York by Great Egrets, Snowy Egrets, and Glossy Ibis (*Plegadis falcinellus*). In coastal areas of Florida Little Blue Herons, Snowy Egrets, and Tricolored Herons showed no difference in habitat use (Kent 1986). Heron species have shown differences in foraging sites by water

Table 1. Number of wading bird species observed, and expected, in different open-water habitats in Texas coastal salt marsh during winter of 1992-1993. Expected frequencies shown here are for Chi-square goodness-of-fit tests for each species separately, based on the assumption that all habitat categories were equally accessible.

Species	Bay	Lake	Pond	Pool	Other	N
Great Blue Heron	133	189	18	68	36	444
Expected	88.8					
Great Egret	24	116	65	209	48	462
Expected	92.4					
Reddish Egret	3	56	19	35	4	117
Expected	23.4					
Snowy Egret	24	11	1	10	3	43
Expected	8.6					
Tricolored Heron	3	9	6	16	1	35
Expected	7.0					

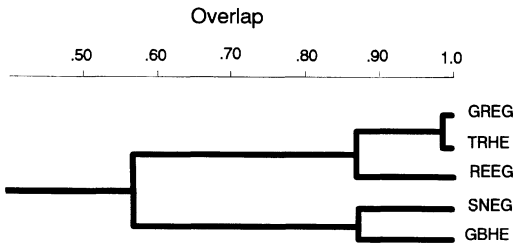

Figure 4. Dendrogram based on specific overlap indicies calculated on habitat use patterns of all species pairs.

depth, with longer-legged birds feeding in deeper water (Meyerriecks 1962, Kushlan 1976, Custer and Osborn 1978).

In areas where both saltwater and freshwater habitats have been compared, species have tended to differentially use these broader habitat categories. In our study area the influence of freshwater comes in the form of precipitation through a small reduction in salinity levels. Among five species of breeding herons in Yucatan, Mexico, two species groups were identified: an inland-water group consisting of Great Blue Herons, Great Egrets, and Snowy Egrets, and a coastal group consisting of Reddish Egrets and Tricolored Herons (Ramo and Busto 1993). In Venezuela, seven ibis species were separated by their use of habitats into groups along an aquatic-terrestrial gradient (Frederick and Bildstein 1992).

Our results do not support the hypothesis that similar-sized herons overlap in resource use (Willard 1977), while different sized herons differ in their use of similar resources (Jenni 1969, Willard 1977, Custer and Osborn 1978, Kushlan 1978). In our study, species that were most similar in size (Great Blue Heron-Great Egret and Snowy Egret-Tricolored Heron) showed the least overlap in patterns of habitat use. The medium-size species (Reddish Egret), with little size overlap with other species, used habitats in proportions similar to both a larger (Great Egret) and smaller (Tricolored Heron) species.

Differences between the results of our study and previous studies may reflect differences between breeding and nonbreeding habitat use. Most previous studies have been conducted during the breeding season when foraging site selection may be highly specialized because of nutritional or energetic needs. For example, Marabou Stork (*Leptoptilos crumeniferus*) chicks require calcium not present in adults primary food, carrion (Kahl 1966). White Ibis feed on saltwater prey; however, nestlings require freshwater prey in order to develop normally (Bildstein *et al.* 1990). Other species do not have specific food and habitat requirements during the breeding season. Willard's (1977) data, for example, suggest that prey sizes in Great Egret, Great Blue Heron, and Snowy Egret diets during high spring-summer food availability, were more diverse than during fall and winter. If Willard's hypothesis is true, we can expect to find the greatest overlap in resource use among wading birds during the breeding season compared with nonbreeding periods.

Among sympatric species with similar morphologies, differences in resource use could result from differences in: 1) habitat, 2) diet, or 3) temporal activity patterns (Pianka 1994). Feeding sites are important factors determining both type and size of food taken by wading birds (Kushlan 1978). We did not evaluate diets of wading birds. However, habitat partitioning observed in our study site might be explained by similar use of food resources among similar-sized species (Jenni 1969, Willard 1977, Custer and Osborn 1978, Kent 1986, Ramo and Busto 1993). Among competing species high overlap in one resource gradient (e.g., food) generally results in low overlap in a second resource (e.g., habitat) (DuBowy 1988, Ramo and Busto 1993). Alternatively, the possibility exists that low overlap in food type taken by similar-sized birds, as observed by Busto and Ramo (1993) for Great Blue Heron and Great Egret, may predispose each species to select different habitats where preferred food may be found.

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LITERATURE CITED

Bildstein, K. L., W. Post, J. Johnston and P. Frederick. 1990. Freshwater wetlands, rainfall, and the breeding ecology of White Ibises in coastal South Carolina. Wilson Bulletin 102:84-98.

Conover, W. J. 1980. Practical nonparametric statistics. Wiley and Sons, New York.

Custer, T. W. and R. G. Osborn. 1978. Feeding habitat use by colonial-breeding herons, egrets, and ibises in North Carolina. Auk 95:733-743.

Dallinga, J. H. and S. Schoenmakers. 1987. Regional decrease in the numbers of White Storks (*Ciconia c. ciconia*) in relation to food resources. Colonial Waterbirds 10:167-177.

DuBowy, P. J. 1988. Waterfowl communities and seasonal environments: Temporal variability in interspecific competition. Ecology 69:1439-1453.

Frederick, P. C. and K. L. Bildstein. 1992. Foraging ecology of seven species of neotropical ibises (Threskiornithidae) during the dry season in the Llanos of Venezuela. Wilson Bulletin 104:1-21.

Heitmeyer, M. E. 1986. Postbreeding distribution and habitat use of wading birds in Oklahoma, USA. Colonial Waterbirds 9:163-170.

Jenni, D. A. 1969. A study of the ecology of four species of herons during the breeding season at Lake Alice, Alachua County, Florida. Ecological Monographs 39:245-270.

Kahl, M. P. 1966. Comparative ethology of the Ciconiidae Pt 1: The Marabou Stork, *Leptoptilos crumeniferus* (Lesson). Behavior 26:76-106.

Kent, D. M. 1986. Behavior, habitat use, and food of three egrets in a marine habitat. Colonial Waterbirds 9:25-30.

Kushlan, J. A. 1976. Wading bird predation in a seasonally-fluctuating pond. Auk 93:464-476.

Kushlan, J. A. 1978. Feeding ecology of wading birds. Pages 287-299 *in* Wading Birds (A. S. Sprunt, J. C. Ogden and S. Winckler, Eds.). National Audubon Society Research Report No. 7, New York.

Kushlan, J. A. 1981. Resource use strategies of wading birds. Wilson Bulletin 93:145-163.

Kushlan, J. A. 1992. Population biology and conservation of colonial wading birds. Colonial Waterbirds 15:1-7.

Ludwig, J. A. and J. F. Reynolds. 1988. Statistical ecology. Wiley and Sons, New York.

Maccarone, A. D. and K. C. Parsons. 1994. Factors affecting the use of freshwater and an estuarine foraging site by egrets and ibises during the breeding season in New York City. Colonial Waterbirds 17:60-68.

Meyerriecks, A. J. 1962. Diversity typifies heron feeding. Natural History 71:48-59.

Pianka, E. R. 1994. Evolutionary ecology. Harper Collins College Publishers, New York.

Ramo, C. and B. Busto. 1993. Resource use by herons in a Yucatan wetland during the breeding season. Wilson Bulletin 105:573-586.

Willard, D. E. 1977. The feeding ecology and behavior of five species of herons in southeastern New Jersey. Condor 79:462-470.