

# American Avocet Nesting on Constructed Islands in North Dakota

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**ABSTRACT** -- We related American avocet (*Recurvirostra americana*) nesting on 30 earthen constructed islands in wetlands of the Prairie Pothole Region of North Dakota to characteristics of the islands and the surrounding landscape. We found 174 American avocet nests on 10 of the 30 islands; eight islands had four or more nests each. Most (85.9%) clutches contained four eggs. The majority of nests were found in upland graminoids (57.9%) or on unvegetated ground (31.6%). We found little evidence of nest predation or abandonment and concluded that most (84.5%) clutches hatched. Islands with beaches had a higher nest density (mean number of American avocet nests per kilometer of island shoreline) ( $76 \pm 56$  SD nests/km) than islands without beaches ( $4 \pm 17$  SD nests/km). Islands located in wetlands classified by Cowardin et al. (1979) as L2ABF had a higher nest density ( $88 \pm 92$  SD nests/km) than did the wetlands classified as L2ABG ( $15 \pm 30$  SD nests/km) or L2UBGh. Larger islands ( $\geq 0.3$  ha) had a higher nest density ( $46 \pm 56$  SD nests/km) than did smaller islands ( $< 0.3$  ha) ( $5 \pm 19$  SD nests/km). Islands in shallow water ( $\leq 1$  m) were almost twice as large ( $0.42 \pm 0.13$  SD ha) and had a higher nest density ( $48 \pm 58$  SD nests/km) than did islands constructed in deep

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water (> 1m) ( $5 \pm 19$  SD nests/km). Seven of the 11 islands in shallower water also had beaches, whereas none in deeper water did. In general, nesting American avocets appeared to favor islands that were large, islands with beaches, islands located in shallow water, and islands built in wetlands classified as L2ABF.

**Key words:** American avocet, constructed island, nest, North Dakota, *Recurvirostra americana*, shorebird.

Creation of earthen islands in wetlands for nesting waterfowl is an established management practice in the Prairie Pothole Region (Lokemoen et al. 1984, Willms and Crawford 1989). Constructed islands provide excellent waterfowl nesting habitat if they are predator-free (Lokemoen and Woodward 1992) and provide appropriate nesting cover (Giroux 1981). The Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), gadwall (*A. strepera*), and blue-winged teal (*A. discors*) are the most common waterfowl species that nest on constructed islands in North Dakota (Dahl et al. 1999). However, other species of birds, mainly the American avocet (*Recurvirostra americana*), also use these islands for nesting (Lokemoen and Messmer 1994). American avocets commonly breed on the Missouri Coteau but are uncommon breeders on the Drift Plain of North Dakota (Stewart 1975). American avocet pairs usually are found on ponds and lakes with exposed shorelines or mudflats next to shallow water. They typically nest on mudflats, spits, wide beaches, or sand bars that have become small islands (Stewart 1975, Lokemoen and Messmer 1994). Some of these features naturally occur in alkali and subsaline ponds and lakes. See Dechant et al. (2002) for a comprehensive overview of the natural history of the American avocet. Our objective was to relate number of American avocet nests to characteristics of islands, wetlands containing the islands, and the landscapes surrounding the wetlands.

## STUDY SITES

We examined 30 constructed islands in 22 wetlands in 1997 in the Prairie Pothole Region of North Dakota. The islands were constructed by Ducks Unlimited, Inc. and the U.S. Bureau of Reclamation between 1985 and 1995 to create nesting habitat for waterfowl. Islands were earthen; most were rectangular, but some were dumbbell-, teardrop-, or kidney-shaped. Most islands were seeded with a dense nesting cover mixture of alfalfa (*Medicago sativa*), sweet clovers (*Melilotus* spp.), and wheatgrasses (*Agropyron* spp. and *Thinopyrum* spp.).

The islands were built in lacustrine wetlands; 21 of the wetlands were classified as wetlands dominated by aquatic plants that grew on or below the surface of the water (Cowardin et al. 1979). Three of these wetlands were classified

as having a semipermanently flooded hydroperiod (wetland classification L2ABF), whereas the other 18 wetlands (L2ABG) had a slightly more permanent water regime. The remaining wetland also was of the latter hydroperiod but was characterized by sparse aquatic vegetation and was an impounded wetland (L2UBGh; Cowardin et al. 1979).

## METHODS

We selected islands (Dahl et al. 1999) that were located in large (at least 10 ha) wetlands and were at least 90 m from shore; these features are known to discourage mammalian predators (Hammond and Mann 1956, Giroux 1981, Lokemoen 1993). We selected islands from a pool of candidate sites to obtain a broad geographic distribution and islands that ranged from 0.1 to 0.6 ha in surface area above water. All our sites were located in the Drift Prairie or the Coteau (Missouri Coteau and Coteau Slope) regions of North Dakota (Bluemle 1991).

Four searches for nests were conducted on islands at three-week intervals in 1997 beginning in early May and ending in July. Observers walked along parallel transect lines about 2 m apart and searched the entire island. Up to four individuals searched each island and attempted to locate all American avocet nests (scrape or bowl containing one or more eggs). Each nest was marked with a 1.5-m willow (*Salix* sp.) sapling stick placed 4 m north of the nest, and nest-site vegetation and number of eggs were recorded. Nests were revisited on subsequent searches until the clutch was hatched, destroyed, or abandoned. Observers examined nests for eggshell chips and, if found, considered that an indication of hatching (Mabee 1997).

Island vegetation was evaluated in May at points spaced 8 to 15 m apart along three parallel transects running the length of each island. Transects began and ended at least 4 m from the water's edge. At each point along the transect, observers placed 30-cm diameter circular plots and categorized each plot as being unvegetated or vegetated. Water depth of the wetland was measured at three equidistant points between the wetland shore and the nearest island shore during the first (in May) and fourth (in July) visits, and the mean water depth was categorized as being above or equal to/below 1 m. Islands were evaluated for the presence or absence of a beach, which was defined as a distinct unvegetated sandy or gravelly area at least 2 m wide along the island shore.

We used data collected with a Global Positioning System to determine several island and landscape features. These included island location (easting and northing), shape, area, island shoreline length, and distance from center of island to nearest mainland shore. We determined the composition of upland habitat within 1.6 km of the center of each island, which resulted in a circular area of about 810 ha, by examining U.S. Department of Agriculture, Farm Service Agency aerial

photographs and conducting ground and aerial surveys. Habitat was classified according to Cowardin et al. (1988) as grassland, grassland-wildlife, hayland, planted cover, cropland, woodland, shrubland, other habitats, right-of-way, and barren land. We later combined grassland, grassland-wildlife, hayland, planted cover, and right-of-way into a single habitat class that we called grass. Habitat classification data were digitized and imported into a geographical information system (GIS). Information on the area and location of wetlands in the study site was acquired from the U.S. Fish and Wildlife Service (USFWS), National Wetlands Inventory (NWI, St. Petersburg, Florida) and incorporated into the GIS. From these data, we determined the classification and area of the wetland containing each island. Road and railroad linear features (U.S. Geological Survey, Public Land Survey 1:24,000 Digital Line Graph data) were included in the GIS. From the completed GIS, we determined the areas of each habitat type present within each study site.

In May 1997, we acquired aerial videography of study sites while flying at about 4,200 m above ground level in a fixed-wing aircraft. We used Map and Image Processing System (Microlmages, Lincoln, Nebraska) software to determine from the videography the number and surface area of wetlands containing water for each study site. Only wet areas within NWI polygons were delineated.

American avocet nest density (i.e., mean number of nests per kilometer of island shoreline) was our response variable for model building. Explanatory variables were features of the islands, wetlands, and landscapes and are listed in Table 1. We constructed linear regression models to relate the American avocet nest density to the explanatory variables and their interactions by using PROC MIXED of SAS (SAS Institute 1999). We used Akaike's Information Criterion corrected for use with small sample sizes ( $AIC_c$ ; Hurvich and Tsai 1989, Akaike 1992, Burnham and Anderson 1998) to select the least biased and most parsimonious models from the candidate set of models.

## RESULTS

We found 174 American avocet nests on 10 of the 30 islands we studied; almost all of the nests were located along the islands' shores. The mean number of nests per island was  $5.8 \pm 11.8$  (SD) with a maximum of 51 nests on one island. Single nests were observed on two islands whereas eight islands had four or more nests each. Among islands having American avocet nests, the mean number of nests per island was  $17.4 \pm 15.0$  (SD). Most (85.9%) American avocet clutches contained four eggs; the remainder contained three (9.0%), two (3.2%), five (1.3%), or one (0.6%) egg. Although most (57.9%) nests were located in upland graminoids, 31.6% were located on unvegetated ground and 10.5% were located in upland forbs. Rates of predation (4% of nests) and abandonment (9.8%) were low,

**Table 1.** Explanatory variables used in model building to relate American avocet nest density to characteristics of the islands, wetlands containing the islands, and surrounding landscapes.

Variable	Description
<b>Features of Islands</b>	
AGE	Number of years since island construction
AREA	Area (ha) of island
ANSDUCKS	Apparent nest success of duck nests found on islands during concurrent study (Johnson and Shaffer 1990)
UNVEG	Percentage of island that was unvegetated
BEACH	Presence or absence of beach
SHAPE	Shape of island
<b>Features of Wetlands</b>	
WETLAREA	Area (ha) of the wetland
WETLCLASS	National Wetland Inventory classification of wetland
DISTSHORE	Distance (m) from the center of the island to the nearest mainland shore
DEPTH	Mean water depth classified as over or equal to/under 1 m
<b>Features of Landscapes</b>	
WETPONDS	Number of wetlands with water within 1.6 km of the island (from aerial videography)
GRASS	Percentage of the upland habitat within 1.6 km of the island that was composed of grassland, grassland-wildlife, hayland, planted cover, and right-of-way
WETAREA	Total area (ha) of water within 1.6 km of the island (from aerial videography)
EASTING	Location along an east/west gradient
LOCATION	Location of the island within the Coteau or Drift Prairie of North Dakota

so we concluded that most clutches (84.5%) hatched. We also found twelve piping plover (*Charadrius melodus*), seven spotted sandpiper (*Actitis macularia*), one Wilson's phalarope (*Phalaropus tricolor*), one marbled godwit (*Limosa fedoa*), and two killdeer (*Charadrius vociferus*) nests on the islands.

We examined more than 50 linear regression models and report the five models with the lowest AIC<sub>c</sub> in Table 2. The model with the lowest AIC<sub>c</sub> included BEACH, WETLCLASS, and their interaction. The next best model included the variables BEACH, WETLCLASS, DEPTH, and AREA, as well as AREA x DEPTH and BEACH x WETLCLASS interactions.

Islands with beaches had higher densities of American avocet nests than did islands which lacked beaches (Table 3). All seven of the islands with beaches had at least one American avocet nest, whereas 20 of the 23 islands without beaches had no American avocet nests. Of the three wetland classes included in our study, islands in class L2ABF had a higher density of nests than did the islands in the other two wetland classes. Smaller islands (< 3 ha) had lower American avocet nest densities than did larger islands (≥ 3 ha) (Table 3). Compared to island in deep water, islands in shallow water were almost twice as large ( $\bar{x} = 0.42 \pm 0.13$  SD ha) and had higher nests densities (Table 3). Seven of the 11 islands in shallower water also had beaches, whereas none of the islands in deeper water had beaches.

## DISCUSSION

Evidence of the American avocet nesting on islands in North Dakota dates from as early as 1905 (Bennett 1926). The American avocet commonly nests on islands in North Dakota (Sidle and Arnold 1982) and elsewhere (Kondla and Pinel 1978). This species often nests semicolonially in open areas along the edges of brackish wetlands (Sidle and Arnold 1982, Baicich and Harrison 1997, Dechant et al. 2002). We found that most American avocet nests on islands were either located near the water's edge in sparse grasses or forbs, as found by Sidle and Arnold (1982) or in the open on bare mud or sand as noted by several authors (Bent 1962, Hamilton 1975, Baicich and Harrison 1997).

In our study, nesting American avocets seemed to prefer islands with beaches; these beaches gradually sloped into the water and usually indicated shallow feeding areas around the island, thus allowing American avocets quick and easy access to food. The beaches in our study were largely unvegetated, which also would allow American avocets a clear view of each other as well as potential predators during feeding and nesting (Giroux 1985). Additionally, beach material might serve as camouflage for nests and eggs. Nests, although often in the open, are not easy to locate because the stick nests and mottled eggs blend with their surroundings (Bent 1962).

American avocets nested in higher densities on islands located in wetlands

**Table 2.** Model selection with various landscape and island features and their relationship to American avocet nest density on constructed islands in North Dakota during 1997. Models were selected based on  $AIC_c$  values.

Variables in model						$\Delta AIC_c$
BEACH	WETLCLASS	BEACH * WETLCLASS				0
BEACH	WETLCLASS	AREA	DEPTH	AREA * DEPTH	BEACH * WETLCLASS	2.4
BEACH	WETLCLASS	AREA	DEPTH	AREA * DEPTH		4.1
BEACH	WETLCLASS					4.2
BEACH	WETLCLASS	AREA				5.4
BEACH	WETLCLASS					8.7

**Table 3.** Mean and standard deviation of American avocet nest density (nests/km) by classes of BEACH, WETLCLASS, DEPTH, and AREA for 30 constructed islands in North Dakota during 1997.

Variable	Class	# of islands	Mean	SD
BEACH	absent	23	4	17
	present	7	76	56
WETLCLASS	L2ABF	3	88	92
	L2ABG	25	15	30
	L2UBGh	2	0	0
DEPTH	≤ 1 m	11	48	58
	> 1 m	19	5	19
AREA	< 0.3 ha	18	5	19
	≥ 0.3 ha	12	46	56

classified as L2ABF. However, it is not clear why wetland classification was related to nest density. Wetland classification L2UBGh (Cowardin et al. 1979) was represented by one wetland with two islands, neither of which contained American avocet nests. These two islands, regardless of wetland classification, evidently lacked suitable habitat; they had no beach, were very eroded, and had abrupt edges that were about 1 m above the water surface. Wetland classification L2ABF was represented by three wetlands with one island in each; two of these islands supported 18 and 51 American avocet nests respectively. The island with 51 nests was 3 years old, had a beach, and was located in shallow water. The remaining island had no American avocet nests, perhaps due to its tall and dense vegetation (Dahl et al. 1999). Most of the wetlands in our study were classified as L2ABG; only about a third of these wetlands had islands that supported American avocet nests. This latter difference might be more a result of island characteristics than wetland classification; most of the islands with American avocet nests in L2ABG wetlands were 3 years or under in age, had beaches, and were vegetated sparsely. Our results suggested that islands located in wetland classification L2ABF have a higher nest density on average than do islands in other wetland classifications. Variation due to wetland class was likely an artifact because islands with characteristics favored by American avocets happened to occur in certain wetland classes.

Islands in shallower wetlands probably had a greater nest density than those in deeper water because American avocets prefer to forage in shallow water and

tend to nest adjacent to these feeding areas (Hamilton 1975, Sidle and Arnold 1982). Also, Hamilton (1975) noted that American avocets feeding in shallow water often went to shore to defecate and then returned to the water to resume feeding. He determined that the average distance to land from the feeding area was only 2 m, which suggested that American avocets were willing to expend energy to defecate outside of their feeding area, but that the area must be located nearby. Therefore, having feeding and nesting areas adjacent to each other would be energetically efficient for American avocets.

American avocets had a higher nest density on larger-sized islands. However, like wetland class, it is not clear how island size alone influenced nest density due to other confounding factors. In general, large islands in our study had beaches and were constructed in shallow wetlands, many of which were very alkaline wetlands, all features that attract American avocets, as discussed earlier.

We were not able to determine confidently nest success due to the infrequency of our visits to the islands. Although eggshell evidence can be used to determine accurately nest fate of shorebirds, we suggest that some of the evidence could have been removed by winds during the 3-week interval between visits (Mabee 1997). However, we did not observe any signs of extensive depredation on American avocet nests, and waterfowl nests on the same islands had high nest success (Dahl et al. 1999). Therefore, we assumed that most American avocet nests were successful.

In summary, island-nesting American avocets in our study selected islands with beaches rather than beachless islands and large islands over smaller islands. American avocets had more nests on islands in shallow wetlands and in wetlands classified as L2ABF. We suggest it is likely that several of these factors combined to make an island more attractive for nesting than other islands.

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#### LITERATURE CITED

- Akaike, H. 1992. Information theory and an extension of the maximum likelihood principle. Pp. 610-624 *in* Breakthroughs in statistics, Volume 1 (S. Kotz and N. L. Johnson, editors). Springer, London, England.
- Baicich, P. J., and C. J. O. Harrison. 1997. Nests, eggs, and nestlings of North American birds. Second edition. Academic Press, San Diego, California.
- Bennett, W. W. 1926. White pelicans and other birds of Chase Lake, North Dakota. *Wilson Bulletin* 38:65-79.
- Bent, A. C. 1962. Life histories of North American shore birds. Volume I. Dover Publications, New York, New York.
- Bluemle, J. P. 1991. The face of North Dakota, revised edition, North Dakota Geological Survey, Educational Series 21, Bismarck, North Dakota.
- Burnham, K. P., and D. R. Anderson. 1998. Model selection and inference: a practical information-theoretic approach. Springer, New York, New York.
- Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.
- Cowardin, L. M., D. H. Johnson, T. L. Shaffer, and D. W. Sparling. 1988. Applications of a simulation model to decisions in mallard management. U.S. Fish and Wildlife Service, Report 17.
- Dahl, A. L., K. L. Baer, T. L. Shaffer, G. A. Sargeant, M. A. Johnson, and R. E. Reynolds. 1999. The relation of mallard nest numbers on constructed islands to upland habitat and mallard breeding pairs in North Dakota. Unpublished Report, North Dakota Game and Fish Department, Bismarck, North Dakota.
- Dechant, J. A., A. L. Zimmerman, D. H. Johnson, C. M. Goldade, B. E. Jamison, and B. R. Euliss. 2002. Effects of management practices on wetland birds: American avocet. Unpublished Report, Northern Prairie Wildlife Research Center, Jamestown, North Dakota, <http://www.npwr.usgs.gov/resource/literatr/wetbird/amav/amav.htm>.
- Giroux, J. -F. 1985. Nest sites and superclutches of American avocets on artificial islands. *Canadian Journal of Zoology* 63:1302-1305.
- Giroux, J. -F. 1981. Use of artificial islands by nesting waterfowl in southeastern Alberta. *Journal of Wildlife Management* 45:669-679.

- Hamilton, R. B. 1975. Comparative behavior of the American avocet and the black-necked stilt (*Recurvirostridae*). Ornithological Monograph 17:1-97.
- Hammond, M. C., and G. E. Mann. 1956. Waterfowl nesting islands. Journal of Wildlife Management 20: 345-352.
- Hurvich, C. M., and Tsai, C. -L. 1989. Regression and time series model selection in small samples. Biometrika 76:297-307.
- Johnson, D. H., and T. L. Shaffer. 1990. Estimating nest success: when Mayfield wins. Auk 107:595-600.
- Kondla, N. G., and H. W. Pinel. 1978. Clutch size of the American avocet in the prairie provinces. Blue Jay 36:150-153.
- Lokemoen, J. T. 1993. Increasing waterfowl nesting success on islands and peninsulas. U.S. Fish and Wildlife Service Fish and Wildlife Leaflet 13.2.11.
- Lokemoen, J. T., H. F. Duebbert, and D. E. Sharp. 1984. Nest spacing, habitat selection, and behavior of waterfowl on Miller Lake Island, North Dakota. Journal of Wildlife Management 48:309-321.
- Lokemoen, J. T., and T. A. Messmer. 1994. Locating, constructing, and managing islands for nesting waterfowl. The Berryman Institute, Utah State University, Logan, Utah.
- Lokemoen, J. T., and R. O. Woodward. 1992. Nesting waterfowl and water birds on natural islands in the Dakotas and Montana. Wildlife Society Bulletin 20:163-171.
- Mabee, T. J. 1997. Using eggshell evidence to determine nest fate of shorebirds. Wilson Bulletin 109:307-313.
- SAS Institute. 1999. SAS/Stat user's guide. Version 8.0. SAS Institute, Cary, North Carolina.
- Sidle, J. G., and P. M. Arnold. 1982. Nesting of the American avocet in North Dakota. Prairie Naturalist 14:73-80.
- Stewart, R. E. 1975. Breeding birds of North Dakota. Tri-College Center for Environmental Studies, Fargo, North Dakota.
- Willms, M. A., and R. D. Crawford. 1989. Use of earthen islands by nesting ducks in North Dakota. Journal of Wildlife Management 53:411-417.

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