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FORAGING HABITATS AND MOVEMENTS OF NESTING GREAT BLUE HERONS IN A PRAIRIE RIVER ECOSYSTEM, SOUTH DAKOTA

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Great Blue Herons (*Ardea herodias*) nest in at least 23 colonies in South Dakota with most colonies occurring in riparian woodlands; at least 8 colonies are located on the James River (Adolphson and Adolphson 1968), which represents the only remaining forested, north-south corridor completely traversing South Dakota. Potential channel modifications related to water development, along with forest degradation, may have severe impacts on several of the James River heron colonies. The major types of forest degradation affecting the riparian woodlands along the James include clearing for cropland, woodcutting, and cattle grazing; the latter is preventing regeneration of much of the existing woodland (Smith and Flake 1983).

Our objectives were (1) to categorize foraging habitats of nesting Great Blue Herons in a prairie river ecosystem, (2) to determine foraging site dispersion as a measure of potential area within which habitat alteration might influence birds from a particular colony, and (3) to determine the foraging range of individual herons and their fidelity to a single foraging site.

MATERIALS AND METHODS

The Great Blue Heron colony examined in this study was on the James River in Spink Co., South Dakota (Fig. 1). The colony had 66 active nests in 1980, all in green ash (*Fraxinus pennsylvanica*). This colony will henceforth be referred to as the Glendale colony. The nearest heronry to the Glendale colony was 22 km north, but it appeared to be inactive during our study.

To gain information on important feeding areas, departing herons were followed by automobile to their landing points or until the observers could no longer keep the birds in sight. Selection of departing herons was assumed to be random, since the first heron to leave the colony was followed, regardless of flight direction. Sources of bias were caused by difficulty in following herons traveling in directions with poor road access and difficulty in following herons feeding at distances in excess of 12 km from the study area. Birds feeding closer to the colony flew at lower altitudes and were easiest to track.

The outcome of each tracking effort was categorized as: (1) colony-to-landing, (2) colony-to-probable landing, (3) colony-to-disappearance, (4) a sighting (a nonrandom observation of a heron already at a feeding site), or (5) landing site observation (when a heron was followed to a feeding area, but tracking did not originate at the heronry). In addition to the

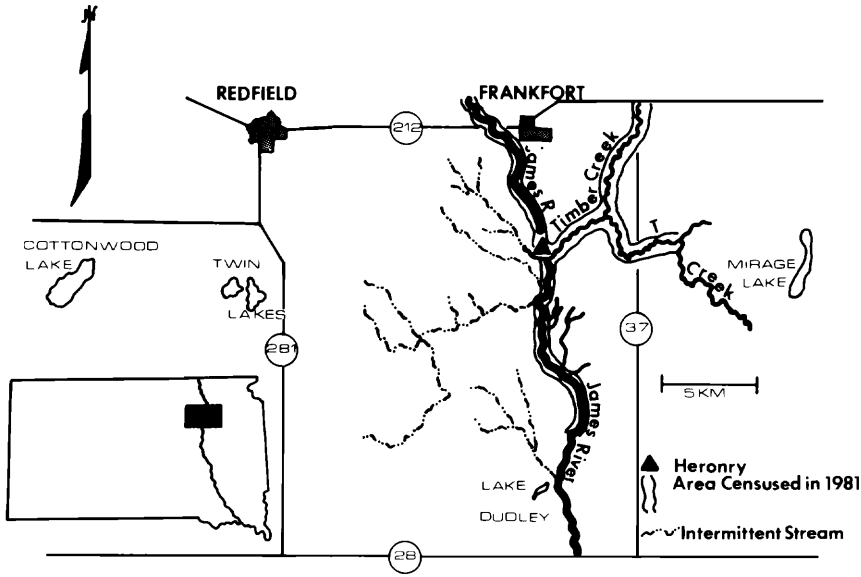

FIGURE 1. Location of the Glendale Great Blue Heron colony in Spink County, South Dakota.

observation category, each site was categorized as to habitat type and degree direction and distance from the heronry. Time of day and general weather conditions were recorded for each observation. Herons were followed in this manner for 2 consecutive breeding seasons. A small percentage of observations where tracking did not originate at the colony may have represented non-nesting herons or herons from other heronries.

During the 1981 breeding season, heron censuses were conducted on 24.5 km of the James River and on approximately 14.0 km of a tributary, Timber Creek, to further evaluate the importance of these areas to foraging herons. These censuses were conducted weekly for 3 weeks from the end of June until the middle of July; nestlings were in the 6–10 week stage at this time (Dowd and Flake 1984). The river was traversed by canoe and the location of each heron sighting recorded. Herons sighted on the river immediately adjacent to the heronry were not recorded, as these birds were presumed to be fledglings. This presumption was based on observations made during the preceding breeding season. Adult herons were rarely observed feeding on the river in the immediate vicinity of the heronry; normally they used this area only for drinking and gathering nest materials. However, fledglings were often observed feeding at the river in this vicinity. Timber Creek was searched by 3 people walking different sections of the stream.

In an effort to gain more detailed information on the habitat use of individual herons, 5 adult herons were captured and fitted with radio

transmitters during the 1981 breeding season; we were unable to accurately sex these herons. Capture methods closely paralleled those of Parris (1977) in Ohio. Black bullheads (*Ictalurus melas*), yellow bullheads (*I. natalis*), and carp (*Cyprinus carpio*) were placed daily into wire enclosures located in shallow water at locations where herons had been observed feeding, primarily in Timber Creek. After several days of baiting, a cannon net was set at the bait site and fired when a heron was in range. A new bait site was established after each capture.

Herons were fitted with lithium-powered transmitters (Wildlife Materials, Inc., Carbondale, IL) weighing from 60–70 g. Transmitters were placed on the backs of herons and harnessed under the wings. A car-mounted null-peak antenna system, a yagi hand-held antenna, and a 20-channel receiver (Model RT-20A, Telemetry Systems, Mequon, WI) were used in tracking radio-tagged birds. Locations were determined by triangulation. One set of locations was obtained by aircraft, using methods similar to those reported by Gilmer et al. (1981). Attempts were made to locate each radio-tagged heron at least once daily.

Chi-square analysis was used to test differences between 1980 and 1981 for (1) distances flown by birds observed from colony to landing, (2) distances flown by birds in all 5 observation categories, (3) habitats used by birds tracked from the colony and observed landing (colony-to-landing), and (4) habitats used by birds in all categories except colony-to-disappearance. Chi-square analysis was also used to compare habitats used by birds tracked from the colony and observed landing versus habitats used by birds in all categories except disappearances for both 1980 and 1981.

Wetland habitats in our study were categorized as the James River and its inlets, streams, intermittent streams, dugouts, and stock dams. The James River is generally less than 30 m in channel width and is a shallow, meandering river with a flow of less than 0.5 m/s (Schneider 1978). The James River lacked emergent vegetation except in some inlets and backwater areas and appeared moderately to highly turbid during the study.

Tributary streams, such as Timber Creek, that contained continuous flow or extensive pools over most of their length in 1980 and 1981 are hereafter referred to as streams; those that were dry except for isolated pools for much of the study period are defined as intermittent streams. Streams and intermittent streams generally had more emergent vegetation and lower turbidity than the James River, although quantitative measurements of these variables were not made. Streams and intermittent streams seldom exceeded 5 m in width. Stock dams are defined as man-made ponds developed behind a dam on a natural drainage and often featured extensive shallow areas, irregular shorelines, and some emergents. Dugouts are ponds developed by excavating a depression without the use of a dam and generally have a rectangular shape, steep shoreline gradient, minimal shallow area, and few emergents. Turbidity on stock dams and dugouts appeared lower than on the James River.

Using the Cowardin et al. (1979) classification system, the James River is primarily a Riverine Lower Perennial Wetland with an unconsolidated bottom; our stream category also falls partially within this classification. Portions of our stream and intermittent stream categories would be classified as Palustrine Emergent Wetland.

Our test nettings indicated that black bullheads and small carp were particularly abundant in the James River and Timber Creek. Some dugouts that were connected to intermittent streams and periodically to the James River were accessible to fishes during flooding. Fish were observed in both stock dams in the study area, but no test nettings were made. Fishes of the James River are described by Tol (1976). Tiger salamanders (*Ambystoma tigrinum*), leopard frogs (*Rana pipiens*), and chorus frogs (*Pseudacris triseriata*) were other potential prey species common in the study area.

RESULTS AND DISCUSSION

Feeding habitats.—Great Blue Herons that were tracked from the colony until they landed showed no significant differences in habitat categories selected between 1980 and 1981, so results were combined ($\chi^2 = 1.97$, df = 4, $P > 0.05$). The greatest percentage of such observations was on streams, the James River and inlets, and intermittent streams (Fig. 2). When habitat categories for colony-to-landings were combined with colony-to-probable landings, sightings, and landing sites, there was a significant difference among habitats used during 1980 and 1981 ($\chi^2 = 35.35$, df = 8, $P \leq 0.005$). Listed in order of use, foraging habitats for herons in these 4 observation categories combined in 1980 were streams, the James River and its inlets, pastures, and intermittent streams. In 1981, the order was intermittent streams, the James River and its inlets, streams, and pastures. Several times in 1981 we observed groups of up to 7 herons feeding together on fishes stranded in isolated pools of intermittent streams; this may have been associated with lack of precipitation in 1981 and a reduction in available pools on intermittent streams. These birds flew before we could determine if they were fledglings or adults.

Other studies of Great Blue Herons nesting in riparian systems have also indicated heavy use of rivers and tributary streams for feeding. Thompson (1978) reported that 86% of herons nesting in the Mississippi River floodplain also foraged in the floodplains. Warren (1979) found that herons nesting along a river in Idaho foraged primarily along tributaries. Parris (1979) followed the movements of herons nesting on Lake Erie and found that important foraging areas were shallow waters of marshes and rivers.

The use of terrestrial habitats by Great Blue Herons as foraging and resting areas has also been reported by several authors (Bent 1926, Palmer 1962, Peifer 1979, Warren 1979). Considering the colony-to-landing category only, 19% of the herons in our study were observed in the terrestrial habitats of pastures and small grain cropland. When the 4 categories were combined, 25% and 17% of the birds were observed in

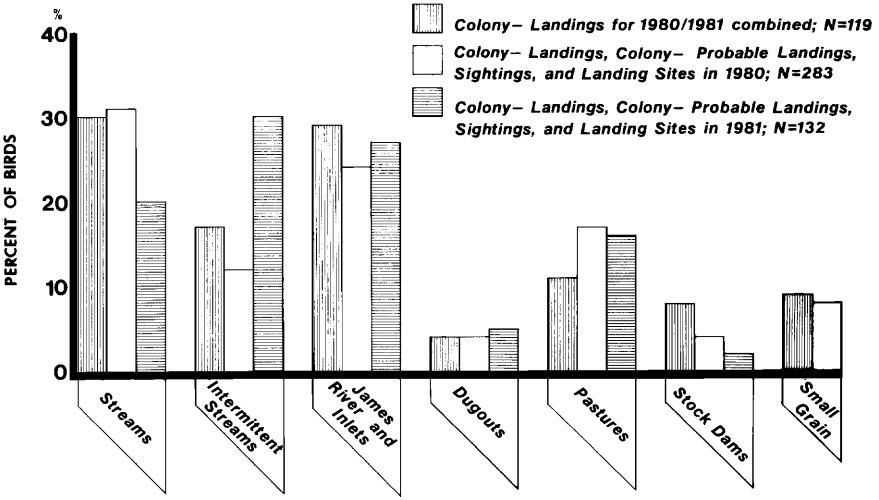

FIGURE 2. Number of Great Blue Herons from the Glendale heronry using various habitats in 1980 and 1981. Colony-landings and colony-probable landings data resulted from following herons from the heronry by automobile to a landing or probable landing site. Sightings represent non-random observations of herons at feeding sites. Landing sites resulted from following herons to feeding sites where tracking did not originate at the heronry. Colony-landings in 1980 and 1981 were combined due to similar results for the 2 years ($\chi^2 = 1.97$, df = 4).

terrestrial habitats in 1980 and 1981, respectively. Since we did not routinely observe the feeding patterns of the herons that we followed, it is possible that some terrestrial areas were used for resting, rather than feeding, as Warren (1979) observed in Idaho. However, 6 herons were observed preying on thirteen-lined ground squirrels (*Spermophilus tridecemlineatus*) during our study. Peifer (1979) reported that 2 radio-tagged Great Blue Herons in Minnesota had a mixed diet of fishes and terrestrial mammals. Parris (1979) in Ohio and Thompson (1978) in Wisconsin determined that herons did not use upland areas for feeding in their studies.

Rodgers and Nesbitt (1979) theorized that natural selection has favored distant feeding by adult wading birds to prevent depletion of local food resources. The authors discussed the Great Blue Heron as an exception to this theory, since the adult birds select larger prey items than younger birds and can therefore feed near the colony without hampering the foraging success of fledglings.

The distance that herons travel to foraging sites will obviously vary depending on the distance of the colony from suitable feeding areas. The average distance flown by Glendale colony herons in the 5 observation categories was 3.1 km, with a maximum distance flown of 24.4 km. Since 15.4% of these birds were lost from sight, these figures underestimate the actual average and maximum distances flown. Thompson (1978) found

that Great Blue Herons breeding on the upper Mississippi River flew an average of 6.5 km before landing and a maximum distance of 20.4 km. Considering the colony-to-landing category alone, most herons (85.0%) in our study landed within 4.0 km of the heronry. When distances herons traveled to forage were divided into 4 subperiods, there were no apparent differences or trends to indicate foraging distance of adults changed with nestling age. In our study area, wetland drainage or wetland alterations such as channelization within 4–5 km of the heron nesting colony could cause appreciable losses of foraging habitat.

Data from heron censusing of Timber Creek and areas of the James River close to the colony further demonstrated the importance of proximate feeding sites to Glendale colony herons. Of the 96 herons seen on 14.0 km of Timber Creek, 44 (45.8%) occurred within 4.0 km of the heronry. Approximately 12.0 km of the James River was sampled in each direction, north and south, from the colony; 143 of a total of 253 (56.5%) were observed within 4.0 km of river channel, north or south, from the colony. Herons sighted on Timber Creek during censusing periods occurred at a mean density of 2.3 birds/km of the stream containing water. At the time of censusing, Timber Creek consisted of extensive and often nearly continuous pools with little or no flow; dry areas of the stream were excluded in this calculation. Mean density of birds sighted on the James River was 3.6 birds/km.

Locations of radio-tagged herons.—Capture sites and subsequent locations of 4 of 5 radio-tagged herons are presented in Figure 3. Herons numbered 8 and 17 were each located only 3 times after capture. These radios may have malfunctioned or become dislodged from the birds.

Although heron #5 was captured and radio-tagged on Timber Creek, it was not found in this area again. Bird #5 restricted its movements to an area of the river approximately 3.0 km north of the colony. The maximum straight-line distance between feeding sites after capture was 2.0 km. One of the 24 radio locations was in a pasture.

Heron #18 was captured and radio-tagged on an intermittent stream close to the colony, where it continued to feed until the stream became dry in July 1982. The bird also foraged on the James River north and south of the colony, within a 2.5 km range. Two of 20 radio locations were in terrestrial habitats.

Heron #3 was captured on Timber Creek and was thereafter, with one exception, located on the river approximately 15.0 km south of the heronry; this heron is not included in Figure 3 due to the foraging site distances. While feeding in this area, the bird had a maximum linear range of 4.1 km. None of the 13 radio locations of bird #3 was in terrestrial habitats or on Lake Dudley. There were no other active heronries near the rather distant foraging sites being used by #3.

Many authors have discussed the use of foraging territories by Great Blue Herons. Peifer (1979) reported that 4 radio-tagged Great Blue Herons in central Minnesota actively defended an average of 1.0 km of shoreline. The defended areas in his study ranged from 0.7–1.4 km.

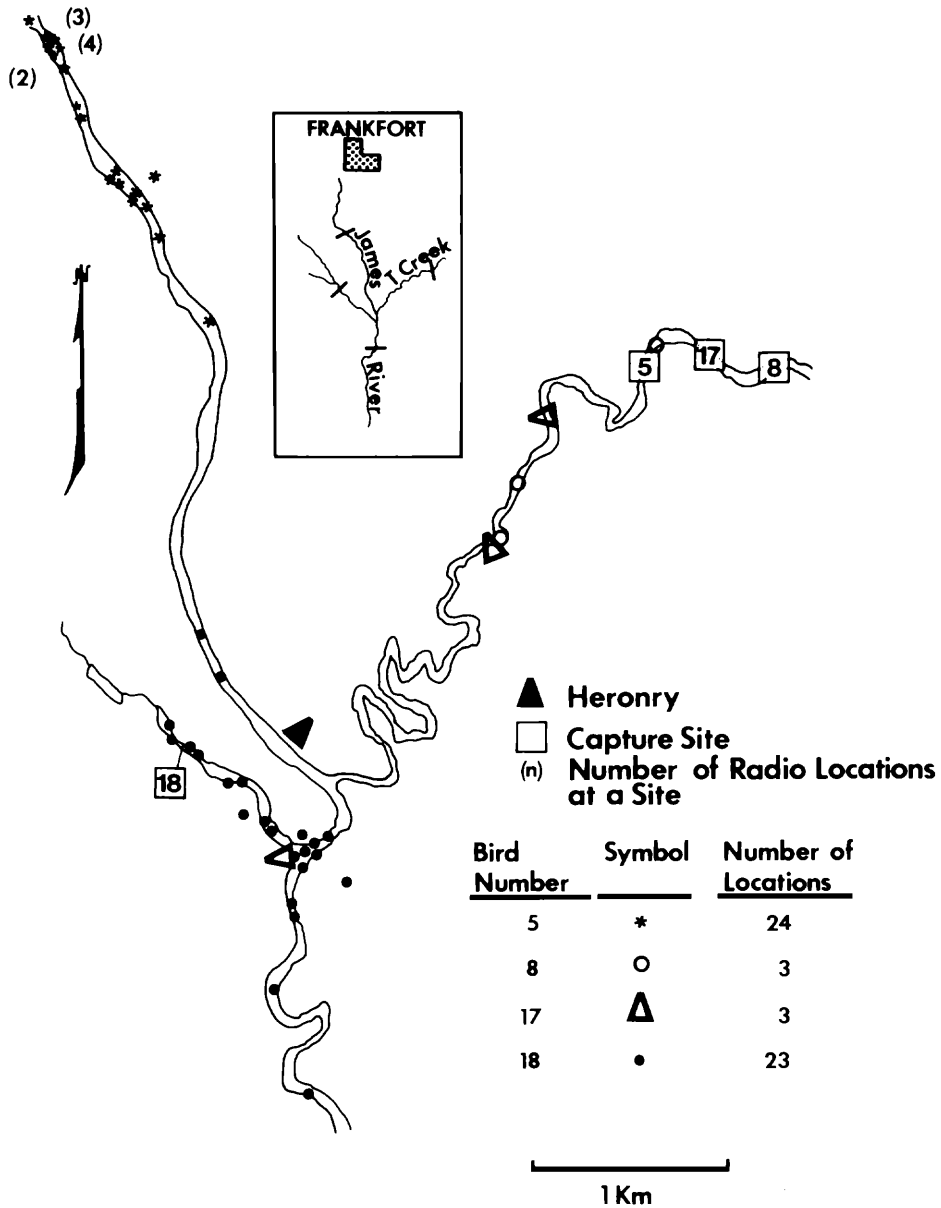

FIGURE 3. Capture sites and radio locations of radio-tagged Great Blue Herons numbered 5, 8, 17, and 18 from the Glendale heronry, 1981.

Kushlan (1978) stated that the degree of dispersion of the food resource may determine territoriality in Great Blue Herons. In the event of concentrated food patches, Great Blue Herons tend to forage non-territorially in groups. If food is widely dispersed, herons are more likely to defend a larger territory.

We would categorize the James River as an area with a widely dispersed food supply. Linear foraging ranges of from 2.0–4.1 km in the radio-tagged herons suggested opportunistic foraging and a lack of strict fidelity to a particular foraging site. Herons did tend to return to the same general areas of the river, but other herons also used these areas. Adult herons were rarely seen feeding within sight of each other on the James River or Timber Creek, although fledglings were often seen in foraging groups. As noted previously, groups of herons of unknown age were observed feeding on stranded fishes in isolated pools of intermittent streams. Unmarked adult herons were observed defending foraging areas from other herons.

SUMMARY

Major feeding habitats of adult Great Blue Herons included the James River and its inlets, streams, intermittent streams, and pastures. Unmarked herons that were followed from the colony until they landed or were lost from sight traveled average and maximum distances of 3.2 and 24.4 km, respectively. Five radio-tagged birds foraged in areas from 2.0 to 4.1 km in linear range, but no strict fidelity to a particular foraging site was found. Forty-eight of 65 radio locations occurred on the James River and its inlets.

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