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ROOST SITES USED BY SANDHILL CRANE STAGING ALONG THE PLATTE RIVER, NEBRASKA

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ABSTRACT.—We assessed the influence of water depth, extent of unobstructed view, and human disturbance features on use of roost sites by Sandhill Cranes along the Platte River, Nebraska, during spring migratory stopover. Aerial photos taken near dawn were used to determine areas of flock use and habitat availability in four sample reaches, and measurements were made on the ground at flock roost areas. In general, depths of 1–13 cm were used by sandhill cranes in greater proportion than those available. Exposed sandbars and depths >20 cm were avoided, while depths of 14–19 cm were used in proportion to their availability. Sites 11–50 m from the nearest visual obstruction were used significantly greater than their availability, while sites 0–4 and >50 m from visual obstructions were avoided. Sandhill Cranes avoided sites near paved roads, gravel roads, single dwellings, and bridges when selecting roost sites; however, they did not appear to be disturbed by private roads, groups of residential buildings, gravel pits, railroads, or electrical transmission lines.

Key words: Sandhill Crane, Grus canadensis, *river roosts, habitat selection, water depth, disturbance, sandbars, Platte River.*

The impact of water resource development on the Platte River is well described (Kroonemeyer 1978, Williams 1978, Eschner et al. 1981, Kircher and Karlinger 1981, U.S. Fish and Wildlife Service 1981, Krapu 1987, Sidle et al. 1989). The major impact has come from irrigation projects along the North Platte River (Krapu et al. 1982), which remove approximately 70% of the annual flow of the Platte River before reaching south central Nebraska (Kroonemeyer 1978). Concomitant with channel shrinkage, woody vegetation has encroached on thousands of hectares of former channel area, contributing to further changes in channel features and altering habitat for numerous species of migratory birds in the Big Bend Reach of the Platte River in Nebraska (U.S. Fish and Wildlife Service 1981). The Big Bend Reach of the Platte River in Nebraska is an area of importance to numerous species of migratory birds of the Central Flyway (U.S. Fish and Wildlife Service 1981).

This area is an important stopover area for most of the midcontinent population of Sandhill Cranes (*Grus canadensis*) (400,000–600,000 birds), which roost in the river and feed in nearby corn fields (Krapu et al. 1981, Krapu 1987). The endangered Whooping Crane (*G. americana*) also uses the area during migration, and the threatened Bald Eagle (*Haliaeetus leucocephalus*) is a common winter resident (U.S. Fish and Wildlife Service 1981). The area is also important habitat for the endangered interior population of Least Tern (*Sterna antillarum*) and the threatened Piping Plover (*Charadrius melodus*), both of which nest along the Platte River (U.S. Fish and Wildlife Service 1981, Sidle et al. 1989).

Considerable attention has been given to the impact of changing channel conditions on the midcontinent population of Sandhill Cranes (*Grus canadensis*) that congregate along the river from early March to mid-April during their annual spring migration (Lewis 1977, Krapu 1978, U.S. Fish and Wildlife Service 1981). During this time approximately 400,000 Sandhill Cranes use this area while enroute to their breeding grounds in Canada, Alaska, and eastern Siberia (U.S. Fish and Wildlife Service 1981).

In Nebraska various facets of Sandhill Crane roosting habitat requirements have been studied (Frith 1974, Lewis 1974, U.S. Fish and Wildlife Service 1981, Krapu et al. 1982, 1984). However, these studies have not considered the influence of habitat availability in relation to habitat use. The purpose of this study was to

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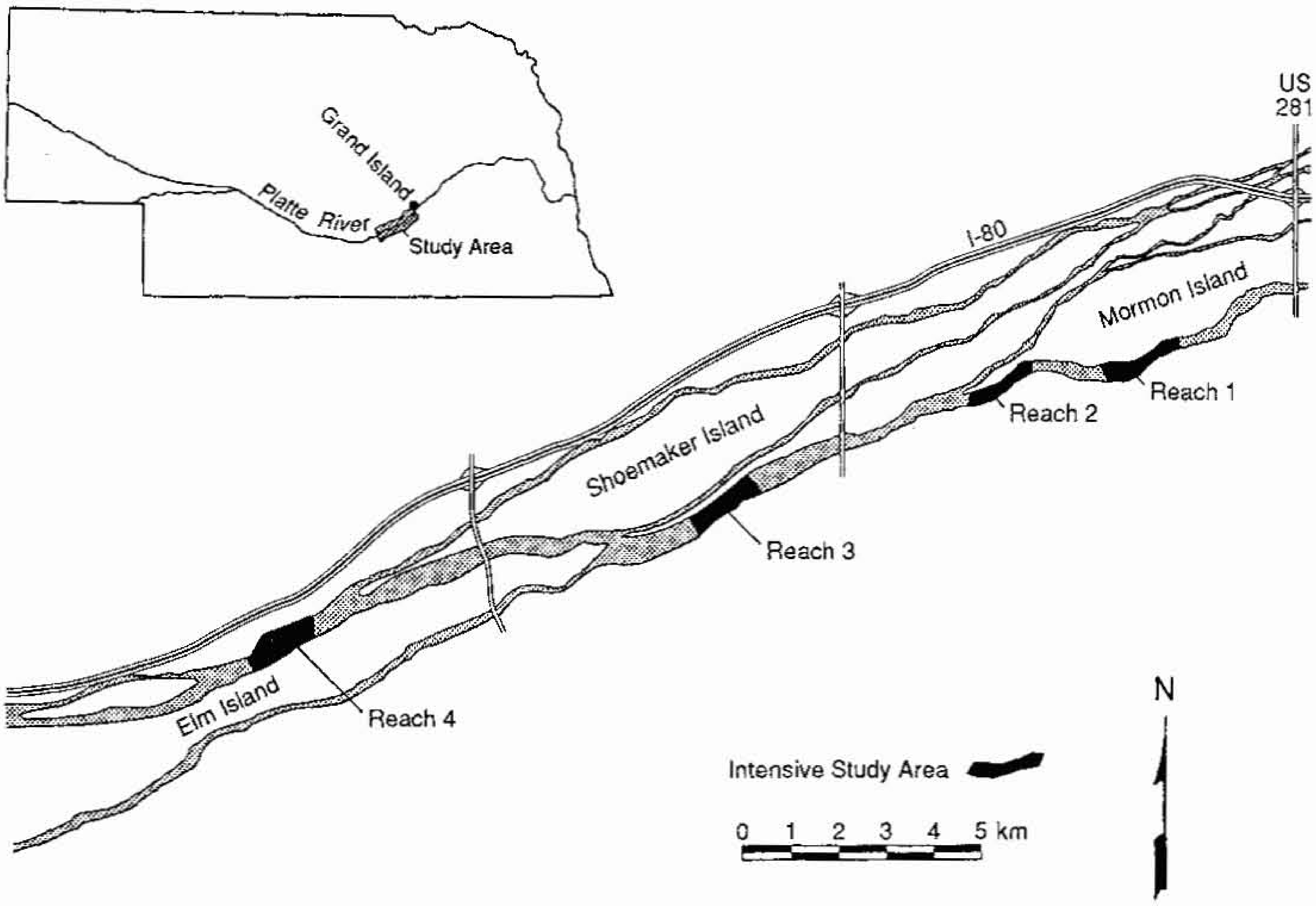

Fig. 1. Study sites in the Platte River, Nebraska.

determine the influence of habitat availability, as well as habitat use, on the selection of roost sites by Sandhill Cranes.

This study was designed to assess the influence of three types of habitat features on roost sites used by Sandhill Cranes: (1) water depth, (2) magnitude of unobstructed view, and (3) disturbance features.

STUDY AREA

The study area is located in south central Nebraska in Hall and Buffalo counties in the eastern half of the Big Bend Reach of the Platte River. It encompasses a 36-km stretch of the Platte River beginning 4 km west of Shelton to Grand Island (Fig. 1). All field measurements were in four 1.6-km reaches along the main channel of the Platte River.

Spring precipitation in Nebraska contributes to the Platte River Basin flow, but most of the flow is derived from spring runoff that originates as snowmelt in the Rocky Mountains (Eschner et al. 1981). Spring runoff flows into both the North and South Platte rivers, which flow northeast and southeast, respectively, across the Great Plains to their confluence near North Platte, Nebraska.

The study area is characterized by numerous braided channels interspersed with unvegetated sandbars that frequently shift. Most of the land within and adjacent to the study area is in private ownership. Land use in the area is predominantly agriculture and includes approximately 60% cropland (mostly corn), 5% tame pasture, 20% native grassland, and 15% riparian woodland (Reinecke and Krapu 1979).

The riparian woodland comprises eastern cottonwood (*Populus deltoides*) forests with dominant understory species of red cedar (*Juniperus virginiana*) and rough-leaf dogwood (*Cornus drummondii*). On low islands and vegetated sandbars, peach-leaf willow (*Salix amygdaloides*), coyote willow (*S. exigual*), and indigo bush (*Amorpha fruticosa*) are the dominant species (U.S. Fish and Wildlife Service 1981, Currier 1982).

METHODS

Aerial photography was used to determine flock locations and delineate flock boundaries of roosting Sandhill Cranes along a 36-km stretch of the Platte River. Photography was restricted to mornings with less than 10% cloud cover and ceilings above 975 m. Flights were begun 30 minutes before sunrise because of the need to photograph Sandhill Cranes before they leave the roost in early morning. Light was adequate to permit photography 10–15 minutes before sunrise.

A Hasselblad 500 EL, 70-mm camera was used to photograph the study area. The camera was mounted in a standard camera hatch in a Cessna 172 fixed-wing aircraft and was equipped with an 80-mm focal length Zeiss lens. Exposures were made at 1/60 and 1/125 second at f2.8 using Kodak Tri-X 640 AFS Aerographic film. The camera was equipped with a 70 exposure back loaded with 5.5 m of film allowing 80 exposures.

The aircraft was flown at approximately 140 km/hr at an initial altitude of 790 m above ground level for the first two flights. During the last two flights the altitude was increased to 910 m above ground level. These altitudes provided a 0.48-km^2 and 0.64-km^2 coverage on each frame, respectively. Frame rate was controlled by an intervalometer, calibrated for 30% overlap, to provide continuous photographic coverage of the study area.

Shortly after each flight the film was custom processed by hand agitation in a single solution tank, varying time and developer temperature to obtain optimum development. Approximately 150 frames were exposed from each flight. Frames were examined under 8X magnification to identify crane flocks and were enlarged to 41 × 51 cm (16 × 20 in) and printed on Kodak Poly contract RC paper. Processed photographs were stored for later analysis of visual obstructions and disturbance features.

Each of the four 1.6-km reaches was marked on both sides of the river bank with 16, 1-m^2 markers made of white cloth. The markers, placed 100 m apart at the edge of the river bank, were positioned in such a way that markers on the opposite sides of the channel were parallel to the channel. The markers enabled accurate scale measurements to be taken from photos and provided position reference for transects across the channel when sampling water depths. Aerial photographs covering each reach were used to determine the position of transects through flocks. Transects were positioned so that each flock studied on a photo was divided into general areas of equal size with two to five transects depending upon flock size. A flock was defined as a continuous distribution of birds or an aggregation of birds spatially independent of other birds separated by a distance >20 m. Flocks usually occurred in configurations that appeared distinct from other flocks in the vicinity.

After transects were located on photographs, they were measured and laid out on the ground in relation to marker locations using vinyl flagging placed on each side of the channel. Water depths were measured to the nearest 3 cm at 3-m intervals and plotted on acetate overlaid on aerial photographs with delineated flock boundaries. Width and depth data were combined to give mean estimates for each of the four reaches.

Each 1.6-km reach was sampled as soon as possible after each flight, always within three days. Staff gauges were placed in each area to measure any changes in water level between the time each reach was photographed and the time it was sampled. Detectable changes in water level were recorded and used to correct depth distributions.

Discharge was measured on each flight day in close proximity to the study areas following the technique of Buchanan and Somers (1969).

Contact prints were made from each roll of film. Individual frames were cut out and glued onto posterboard to form a mosaic, providing a continuous coverage of the river channel. Scale was determined by comparing bridge segments and transect locations on the contact prints with measurements of these locations made on the ground. Scale estimates were made along 2- to 3-km segments of river. Photograph scales ranged from 1:8,681 to 1:10,334 for the first two flights, and 1:10,595 to 1:11,857 for the last two flights.

A binocular zoom microscope (1–4X) was used to identify flocks and delineate flock boundaries on the contact prints covered with acetate. Flocks were delineated and subsequently numbered on the acetate overlays on contact photos. The distance from the edge of each flock to the nearest visual obstruction was measured to the nearest 0.5 mm on the photos (ground distance = 4–6 m) using a drafting caliper. Visual obstructions included vegetation, a river bank, or any other "visually solid" object >1 m in height.

Random points were plotted on contact photos to estimate the features of available habitat. Random points were determined by a series of random numbers identifying point coordinates on gridded overlay covering contact prints. Points outside the river channel were discarded. Only random points located in water were used because points on sandbars, islands, or the river bank were not considered potentially usable roosting habitat. A total of 339 random points within the river channel were identified on the contact prints. Grid squares were 1.25 mm^2 to ensure a representative sample of locations on the river. As with flock locations, the distance from each random point to the nearest visual obstruction was measured on the photos to the nearest 0.5 mm using a drafting caliper.

For analysis of human disturbance features, flock locations and random points along the entire 36-km study area were transferred from 70 mm contact prints to acetate overlays of color infrared aerial photographs (scale 1:25,595) using a zoom transfer scope. The photographs taken in April 1989 were obtained from the Bureau of Reclamation in Grand Island, Nebraska. Distances were measured from the edge of each flock and individual random points selected by placing a card over the photograph to the nearest human disturbance features. These features included paved roads, gravel roads, private roads, urban dwellings, single dwellings, railroads, commercial development, highways, and bridges. Distances were measured to the nearest 0.5 mm on photos (ground distance = 13 m) with a drafting caliper.

Data Analysis

Frequency histograms were plotted for measured distances from the edge of a flock and for random distances to the nearest visual obstruction and disturbance features. Frequency distributions were plotted for available and used selected water depths. Frequency distributions of available and used selected water depths for each 1.6-km reach were determined by combining flock data for each reach for a given flight. Available depths were defined as all depth measurements taken along a transect, and used depths were those depths where birds were present along a transect. Habitat selection was computed by dividing the proportion of habitat used within a depth interval by the proportion of depths available in that same interval (Bovee 1986). Depths used less than their availability were defined as being avoided, while those used more than their availability were defined as being selected. Habitat availability, use, and selection were summarized within reaches, across flight dates, and from data pooled across reaches and flight dates. Data were pooled to generalize the selection of depths over the course of the sampling period.

The chi-square of homogeneity (Marcum and Loftsgaarden 1980) was used to test whether differences existed between the distribution of random points and those locations used by Sandhill Cranes relative to visual obstructions and disturbance features. It was also used to determine if there were differences between the proportion of used and available water depths among and within reaches. Confidence intervals were calculated using the Bonferroni Z-statistic to test which intervals within the distributions were used more or less than expected (Byers et al. 1984). Differences between selection functions were tested with a Z-test. Analysis of variance (ANOVA) was used to determine if visual obstructions had an effect on the disturbance potential created by various types of disturbance features. Significance for all statistical inferences was $P \leq .05$.

RESULTS

A total of four sampling flights were made: one each on 21 and 31 March and 4 and 10 April 1989. A total of 285 flocks were identified during the four flights. Following the flights, 20 flock sites were selected and sampled and a total of 5109 depth measurements were recorded in the field.

SAMPLING AREAS.—Reaches I and II were the narrowest, with mean channel widths of 254 m (range = 225–319 m) and 249 m (range = 241–263 m), respectively, while reaches III and IV, located upstream, were wider. Reach III had a mean channel width of 413 m (range = 387–440 m), while reach IV had a mean channel width of 357 m (range = 296–445 m).

Reaches I and II had similar discharge (17 m^3/s), while reaches III and IV had greater values (27 and 44 m^3/s) on 21 March (Table 1). Discharge in reach III was typically twice as high as reaches I and II. Reach IV had the highest discharge of the four reaches, often three times greater than in reaches I and II (Table 1). Reaches I, II, and III were located in a braided portion of the surface along the south channel and contained only partial river flow.

TABLE 1. Discharge in cubic meters per second (m^3) for sample reaches on different flight dates along the Platte River, Nebraska, during spring 1989.

Flight date	Reach I	Reach II	Reach III	Reach IV
21 March[a]	17.4	17.4	27.5	44.6
31 March	11.1	—	18.6	32.1
4 April	10.6	10.6	—	28.8
10 April	7.9	7.9	13.7	21.7

[a]Discharges for all reaches on 21 March were measured on 24 March. Thus, a three-day lag period existed between the time each reach was flown and the time each reach was measured for discharge.

Reach IV was located along the main channel and contained total river flow.

HABITAT AVAILABILITY.—The distribution of available water depths differed among reaches. On 21 March 1989, 82% of the available habitat in reaches I and II consisted of depths 0–25 cm. In contrast, 53% and 66% of the available habitat in reaches III and IV, respectively, consisted of depths 0–25 cm.

An increased frequency of shallow depths (0–19 cm) and a decreased frequency of deeper depths (>20 cm) occurred over the study period. This division is made because cranes seldom used depths greater than 20 cm. The increase in exposed sandbars (depth = 0 cm) was most pronounced in reaches I and II, which showed increases of 13% and 11%, respectively. Reaches II and III showed increases of 12% and 19%, respectively, in available depths of 1–4 cm between the first and last flight. Reaches III and IV showed decreases of 10% and 7%, respectively, in depths >38 cm for the same period. During the study period a progressive decrease in discharge occurred (Table 1), causing more shallow areas (0–19 cm).

HABITAT USE.—Frequency distributions of roosting habitat use by cranes indicated the highest proportions of used water depths were from the 1–4 and 5–7 cm increments. This range of water depth accounted for 65% of the measured depths. There was no discernible variation in the frequency of water depths used among the four reaches.

There was a small, but significant, difference in the distribution of depths used between the beginning and end of the study period ($P < .05$). Depths of 0 cm showed a significant decrease in use, while depths 20–22 cm showed a significant increase in use ($P < .05$). The data showed a significant difference between the distribution of used and available water depths for all four sampling periods ($P < .001$). Sandhill Cranes used progressively deeper water depths as the study season progressed. Depths >20 cm were used significantly less than expected during the first flight; but, by the last survey, only depths >29 cm were used less than expected ($P < .05$). Depths of 0 cm were generally avoided by Sandhill Cranes during the last two surveys and were used less than would be expected by chance ($P < .05$).

Habitat selection was assessed using both habitat use and availability data for specific water depths. The most frequently occurring depth intervals for which selection occurred were 5–7 cm, followed by 1–4, 8–10, 11–13, and 14–16 cm in decreasing order of preference.

VISUAL OBSTRUCTIONS.—There was a significant difference between the distribution of flock locations and random points relative to the distance from the nearest visual obstruction ($P < .001$). Proportional use of sites 0–50 m from the nearest visual obstruction was significantly greater than availability ($P < .05$), while sites >50 m from a visual obstruction were avoided ($P < .05$).

The 0–25 m interval was divided into six increments: 0, 1–4, 5–10, 11–15, 16–20, and 21–25 m. There was a significant difference between the distribution of flocks and random point distances ($P < .001$). Sites as close as 5–10 m from the nearest visual obstruction were used by Sandhill Cranes. Only sites 0–4 m from a visual obstruction were avoided ($P < .05$), while sites 11–25 m from a visual obstruction were used more than expected ($P < .05$).

Visual obstructions were divided into three categories: (1) unvegetated bank, (2) vegetated bank, and (3) vegetated island. There were no significant differences in the distribution of distances between an unvegetated and vegetated bank, but there were significant differences for the distribution of distances between vegetated banks and vegetated islands and between unvegetated banks and vegetated islands ($P < .005$). Sandhill Cranes roosted a mean distance of 45 m from unvegetated banks, 50 m from vegetated banks, and 27 m from vegetated islands.

CHANNEL WIDTH.—There was a relationship between the minimum unobstructed channel width and distance to the nearest visual obstruction. The distance to the nearest visual obstructions was a function of less than one-half the minimum unobstructed channel width.

There was a significant difference between the distribution of flock locations and random points relative to minimum unobstructed channel width ($P < .005$). Sandhill Cranes used channels 100–200 m wide in greater proportion than those generally available. Channels narrower than 100 m were avoided, while those >200 m wide were used in proportion to their availability. The mean minimum unobstructed channel width used by roosting flocks was 196 m (range = 34–445 m). Nearly 100% of the flocks were in channels with a minimum unobstructed channel width of >50 m, and over 97% and 80% of the flocks were in channels with a minimum unobstructed width of >100 and >150 m, respectively. The mean relative flock size (surface area) was 3883 m^2 (range = 19–55,354 m^2). There was no relationship between flock size and minimum unobstructed channel width. Both large and small flocks were located in wide, as well as narrow, channels.

Human Disturbance Features

PAVED ROADS.—Sandhill Crane flocks were not distributed randomly with respect to distance from paved roads ($P < .001$). Sandhill Cranes showed avoidance of sites closer than 500 m from the nearest paved road ($P < .05$), but used sites as close as 301–400 m. Sites located 701–900 m from the nearest paved road were used more than expected ($P < .05$). Sandhill Cranes roosted a mean distance of 1260 m from the nearest paved road when a visual obstruction was present, but a mean distance of 1575 m from the nearest paved road in the absence of visual obstructions.

GRAVEL ROADS.—There was a significant difference between the distribution of used sites and random locations relative to distance from gravel roads ($P < .01$). Sandhill Cranes showed avoidance of sites that were closer than 400 m from the nearest gravel road ($P < .05$), but flocks were located as close as 301–400 m. Sites that were 601–800 m from the nearest gravel road were used more than expected ($P < .05$). The presence of visual obstruction between a roosting flock and the nearest gravel road did not appear to reduce the disturbance potential created by gravel roads.

SINGLE DWELLINGS.—There was a significant difference between the distribution of used and random locations relative to the distance to the nearest single dwelling ($P < .01$). In general, Sandhill Cranes showed an avoidance for sites closer than 400 m from a single dwelling ($P < .05$). Sites 501–600 m from the nearest single dwelling were used more than expected ($P < .05$). The presence of a visual obstruction between a flock and the nearest single dwelling did not affect the disturbance potential created by single dwellings.

BRIDGES.—Sandhill Crane flocks were not distributed randomly with respect to distance from bridges ($P < .001$). They showed avoidance of sites closer than 400 m from the nearest bridge ($P < .05$). Similarly, they used sites >400 m from the nearest bridge.

OTHER DISTURBANCES.—No significant differences were found between urban dwellings, gravel pits, commercial development, transmission lines, and the distribution of Sandhill Crane flocks.

DISCUSSION

DEPTH DISTRIBUTION.—This study indicated that Sandhill Cranes prefer water depths of 1–13 cm for roosting but roost in greater depths. Lataka and Yahnke (1986) developed a predictive model for Sandhill Crane roosting habitat and stated that the majority roosted in water depths between 0 and 12 cm, which is presumably the optimal depth for roosting. Similarly, Frith (1986) suggested a water depth of 2–15 cm as optimum for roosting sites. Currier (1982) reported a slightly deeper range of depths from 10–15 cm as optimum for roosting. Lewis (1974) suggested that roost sites be characterized by depths 10–20 cm, and Folk (1989) reported an even greater range of depths used for roosting: 0.1–21.0 cm for Sandhill Cranes along the North Platte River in Nebraska.

Despite a change in the availability of water depths with over a 50% reduction in discharge over the period of study (Table 1), only slight differences were detected in the overall use of specific water depths. The fact that habitat use remained the same despite a change in habitat selection suggests that selection indices more strongly refelect changes in habitat availability than habitat preference. If habitat selection had reflected habitat preference, then habitat selection indices would have been more similar between the beginning and end of the study period.

VISUAL OBSTRUCTIONS.—This study indicated that Sandhill Cranes will not roost closer than 5 m from a visual obstruction and that distances from 11 to 25 m are the most frequently used. Latka and Yahnke (1986) reported that Sandhill Cranes did not roost <15 m from the bank. Folk (1989) suggested that Sandhill Cranes preferred to roost >25 m from a visual obstruction, but he observed roosting as close as 4 m from a visual obstruction. Our results indicate that various forms of visual obstructions have different impacts on roost site selection. Overall, vegetated islands have little influence on the selection of roost sites, whereas vegetated banks have greater influence.

It is generally believed that Sandhill Cranes maintain an optimum distance from a visual obstruction to increase their security from terrestrial predators, primarily candids. This is evidenced by the fact that the majority of flocks are located in closer proximity to vegetated islands than to unvegetated or vegetated banks.

Channel morphology may also be a factor influencing the distribution of roosting areas relative to banks or islands. This assertion is supported by observations from depth measurements which suggest that water depths and velocities near banks are deeper and faster than depths near islands due to bank undercutting. Thus, sites near islands may contain a greater proportion of suitable roosting depths than sites adjacent to banks.

CHANNEL WIDTH.—Sandhill Cranes selectively used channels 100–200 m wide, while channels narrower than 100 m were avoided. Nearly 100% of the roosting Sandhill Crane flocks were located in channels with an unobstructed channel width >50 m, and over 80% were located in channels >150 m wide. Wide channels potentially provide more space for roosting Sandhill Cranes, more security from predators, and more available water depths to choose from. However, since channel width was evaluated independently of channel depth, it is possible that use of narrow channels (<100 m wide) is limited not so much by a requirement for wider channels, but by deeper water that flows through these channels (Latka and Yahnke 1986).

Our findings corroborate the results of Krapu et al. (1984), who reported that over 99% of all roosting Sandhill Cranes were in unobstructed channels over 50 m wide and almost 70% were in channels >150 m wide. In contrast, data from nighttime aerial thermography by Pucherelli (1988) suggested that almost half of all roosts were in channels <150 m wide and that the greatest proportion of roosts were in channels 51–150 m wide.

Folk and Tacha (1990) studied roosting along the North Platte River in Nebraska and reported a channel width criterion that was different from this study. They reported that 82% of the roosts were in channels >48 m wide and 18% were in channels from 16–47 m wide.

HUMAN DISTURBANCE.—Our study demonstrated that human disturbance features influence selection of roost sites by Sandhill Cranes. In general, the greatest disturbance potentials were attributed to roads (paved and gravel), bridges, and single dwellings where irregular but considerable human activity might occur. Gravel pits, private roads, railroads, and power lines had infrequent disturbances and did not seem to affect roost site selection. In all likelihood some form of acclimation occurs between the constant disturbance on commercial and urban development.

There is little literature that objectively describes the zones of influence exerted by various human disturbance features on the selection of roost sites by Sandhill Cranes along the Platte River. Folk (1989) suggested that riparian forest along the river provides a visual barrier against most types of potential disturbances and that Sandhill Cranes roost in sections of the river as close as 80 m from a bridge. In contrast, our study indicates that Sandhill Cranes roost in sections of the river that are >400 m from the nearest bridge. We feel that our results provide an objective description of potential zones of influence exerted by various disturbance features and the effect these features have on roost site selection by Sandhill Cranes along the Platte River.

In summary, our study shows the importance of sandbars with water less than 20 cm in depth surrounded by deeper water. These sandbars must be at least 5 m from some form of visual obstruction such as dense vegetation. This apparently allows the Sandhill Cranes to see approaching predators. As a result, Sandhill Cranes normally roost in channels 100–200 m wide. These sites are generally away from human disturbances such as roads, bridges, and private dwellings. Sandhill Cranes could tolerate irregular disturbances such as private roads and railroads.

The fact that 80% of the midcontinent population of Sandhill Cranes uses this area for staging in the spring indicates its importance. It is during this period that the birds apparently build up energy reserves allowing them to continue their northward migration. If the area were to become unfit for Sandhill Cranes, the population would likely suffer decline.

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