NOCTURNAL ROOST SITE SELECTION AND DIURNAL HABITAT USE BY SANDHILL CRANES DURING SPRING IN CENTRAL NEBRASKA

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Abstract: During spring 1998 and 1999, the Platte River Whooping Crane Maintenance Trust conducted ground and aerial surveys of staging sandhill cranes (*Grus canadensis*; hereafter, cranes) to determine roost site selection and habitat-use patterns along a 120-km stretch of the Platte River in south-central Nebraska. Cranes peaked at 232,023 during 22–28 March 1998 and 206,074 during 28 February–6 March 1999 in the study area, a portion of the total crane staging area in the Platte River Valley. Diurnal observations showed that 48% of the cranes were in corn fields, 34% in lowland grasslands, 13% in alfalfa fields, and 5% in other habitats (soybean, winter wheat, and upland grassland). In corn fields, 38%, 36%, 13%, and 11% of the cranes were in ungrazed, grazed, tilled, and mowed stubble, respectively, while in lowland grasslands, 64%, 23%, and 11% were in grazed, hayed, and idled fields. Most cranes (84%) roosted in river sections where channel widths were >200 m. Cranes preferred river sections where channel widths were >250 m in 1998 and >200 m in 1999, and avoided sections ≤150 m wide. Channel widths used by roosting cranes averaged 277 m ± 7.7 (SE) in 1998 and 237 m ± 5.5 in 1999 and were wider ($P < 0.001$) than unused sections (1998: 84 m ± 4.1; 1999: 88 m ± 4.4). In 1998 and 1999, 59% and 66% of roost sites, respectively, were in river sections where vegetation had been mechanically cleared. Clearing of channel vegetation appeared to enhance roost sites for cranes.

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Key words: *Grus canadensis*, habitat use, Nebraska, Platte River, roost sites, sandhill crane, vegetation clearing.

The Platte River Valley (PRV) in central Nebraska is an important staging area for 70–80% of the Midcontinent Population of sandhill cranes (Tacha et al. 1992). The importance of this region is related to high quality foraging and roosting habitats along the Platte River. Cranes rely on croplands (primarily corn) and native grasslands (primarily wet meadows) to replenish depleted energy and nutrient reserves (Krapu et al. 1984) and wide, unvegetated sections of the river for nocturnal roosting (U. S. Fish and Wildlife Service 1981). A long-term reduction in river flows has profoundly affected native grassland and river channel habitats. Because native grasslands adjacent to the river are hydrologically linked to river stage (Hurr 1983, Wesche et al. 1994), reduced flows have facilitated the conversion of grasslands to croplands, homesites, and commercial properties (Currier and Ziewitz 1987). Flow reduction also has allowed encroachment of woody vegetation on sandbars and narrowing of channels (Williams 1978, Eschner et al. 1981, Johnson 1994, Currier 1997). Crane distribution in the PRV has shifted significantly in response to these habitat changes, and the proportion of cranes that used the Lexington-Kearney reach declined from 60% to 5% from 1957–89, but increased 9% to 81% in the Kearney—Chapman reach (Faanes and LeValley 1993).

Tacha et al. (1992) noted that the most important factor regulating crane numbers is habitat availability. Consequently, data on habitat availability and use are key components to understanding crane-habitat relationships and for developing sound conservation plans. Krapu et al. (1984) provided information on crane habitat-use patterns relative to land use and habitat availability and crane nocturnal habitat-use patterns relative to existing river channel characteristics during spring 1978–79. However, since their study, information on crane habitat use and habitat conditions in the PRV has been lacking.

In 1998, the Platte River Whooping Crane Maintenance Trust (PRWCMT) initiated a long-term monitoring program in the PRV to assess (1) crane diurnal habitat-use patterns relative to changes in land-use practices and habitat availabilities, (2) crane roost site selection relative to river channel conditions, and (3) responses of roosting cranes to mechanically removing vegetation from islands within the PRV. Since 1982, the PRWCMT and other groups have been maintaining wide, unvegetated river channels by using heavy equipment to clear vegetation from islands (Currier 1991). In this paper, I report the results from the first 2 years (1998–99) of the monitoring program.

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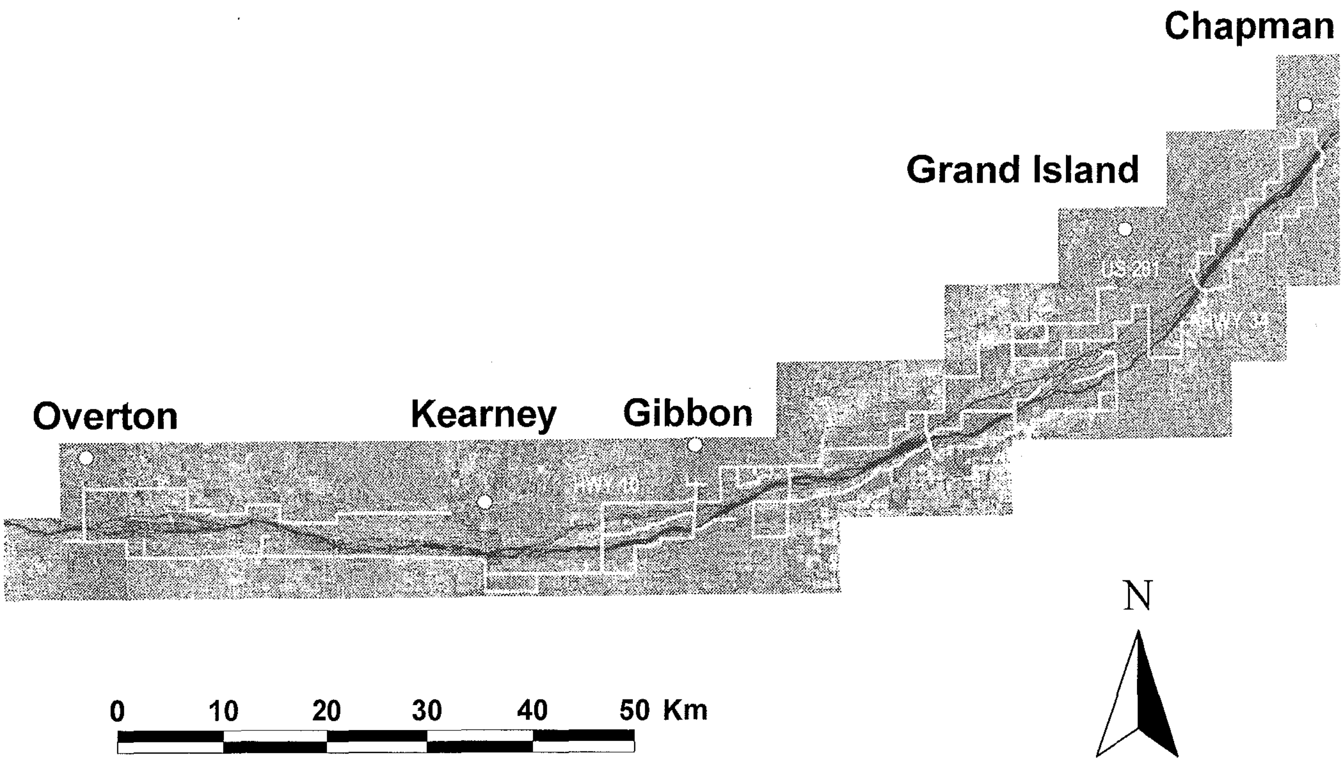

Fig. 1. Location of sandhill crane vehicle survey routes along the Platte River from Chapman to Overton, Nebraska.

STUDY AREA

The study area encompassed 774 km^2 along a 120-km stretch of the PRV between Chapman and Overton, Nebraska (Fig. 1). The dominant topographic features of the PRV are alluvial bottomlands, river terraces with lowland prairie and cultivated fields, and loess bluffs with upland prairie (U. S. Fish and Wildlife Service 1981, Currier et al. 1985). Dominant vegetation of alluvial bottomlands includes cottonwood (*Populus deltoides*), green ash (*Fraxinus pennsylvanica*), red mulberry (*Morus rubra*), rough-leaf dogwood (*Cornus drummondii*), sandbar willow (*Salix exigua*), and American elm (*Ulmus americana*). Lowland prairies are dominated by big bluestem (*Andropgon gerardi*), Indian grass (*Sorghastrum avenaceum*), switchgrass (*Panicum virgatum*), and sedges (*Carex* spp.). Upland prairies are dominated by big bluestem, blue gramma (*Bouteloua gracilis*), buffalo grass (*Buchloe dactyloides*), and little bluestem (*Andropogon scoparius*) (U. S. Fish and Wildlife Service 1981). Corn is the principal crop in cultivated fields.

METHODS

Habitat and land-use classes within the study area were classified during ground surveys in mid-February 1999. Habitat types (lowland grassland including wet meadows, upland grassland, corn, alfalfa, smooth brome [*Bromus inermis*], and soybean) and land-use practices (grazed, ungrazed/idled, hayed, tilled, and mowed) were recorded on digital orthophoto quadrangles. ArcView GIS Version 2.0a (Environmental Systems Research Institute 1996) was used to assess area of each habitat type and land-use practice. Availability of each habitat type and land-use practice was expressed as a percentage of the total area classified.

Ground surveys were conducted weekly along 5 designated routes during 15 February–25 April 1998 and 25 February–15 April 1999. PRWCMT staff drove approximately 1,452 km on assigned routes during morning (sunrise-1200 hr) and afternoon (1201 hr-sunset) once each week. Routes were located along county roads north and south of the river and were generally within 3.2 km of the river. Habitat use was quantified by recording the number of cranes observed along survey routes, the habitat type in use, and the land-use practice associated with each habitat.

Thirteen aerial surveys, beginning at sunrise and continuing for approximately 2 hr, were conducted from Chapman to Overton during 1998 and 1999 (20 February–10 April 1998, n = 5; 1–29 March 1999, n = 8) to document roost site locations. During flights, 1 person videotaped crane roosts with an 8-mm video camera, while a second person delineated locations and approximate size of roosts on 1996 aerial photographs. Individual roosts were defined by groups of cranes that were separated from other groups by ≥100 m (Iverson et al. 1987). Roost locations and sizes recorded on aerial photographs were later confirmed from video tapes.

Roost site selection was evaluated by comparing channel widths of sites used and unused by cranes. Unobstructed channel widths (i.e., view was not impeded by high islands or trees) for used and unused sites were determined from 1996 aerial photos. Flight videos were used to delineate unobstructed views for measurements on aerial photographs. For sites used by cranes, 1–4 measurements were taken depending on the length of the roost site (Sidle et al. 1993), and channel widths for roosts with multiple measurements were averaged. For unused channels, widths were recorded at 0.8-km increments and only those increments without roosts were used to compare with used sites. To evaluate crane response to mechanical removal of vegetation, locations of roost sites that occurred in river sections where clearing activities had occurred within the last 2 years were also recorded.

A 1-way analysis of variance was used to evaluate differences in unobstructed channel widths of used and unused sites during each year (SYSTAT 1992). Unobstructed channel width was the dependent factor, and site type (used versus unused) was the independent factor. Preference or avoidance of habitat types and channel widths was determined using the log likelihood ratio test for goodness of fit (G-test; Sokal and Rohlf 1981) and Bonferroni Z-statistic (Neu et al. 1974). Preference or avoidance of land-use classes were not determined because these changed weekly (i.e., due to tilling, sowing, and other agricultural practices) during the study. Habitat availability was based on percent of each habitat type within the study area, while channel width availability was based on percent of 0.8-km segments that occurred in each channel width class (≤50 m, 51–100 m, 101–150 m, 151–200 m, 201–250 m, 251–300 m, and ≥301 m). Habitat use was based on percent of cranes (based on total number of cranes observed each year during ground surveys) observed in each habitat type, and roost use was based on percent of cranes (based on total number of cranes observed each year during aerial surveys) observed in each channel width class. Habitat and channel width availability greater than the upper end of the confidence interval on proportional use indicated avoidance, while values less than the lower end indicated preference (Neu et al. 1974). All statistical tests were considered significant at $P \leq 0.10$.

RESULTS

Crane Numbers and Migration Chronology

During both years, approximately 5,000–10,000 cranes arrived in the PRV in mid- to late January prior to initiation of surveys. In 1998, crane numbers continued to increase until peaking at 232,023 during 22–28 March (Fig. 2). In contrast, crane numbers in 1999 peaked at 206,074 during 28 February–6 March and remained relatively stable (175,000-206,000) through March. Crane numbers declined after early April during both years (Fig. 2).

Diurnal Habitat Use

The principal habitat types within the study area were corn and lowland grassland with most cranes using these 2 habitat types (Table 1). Corn accounted for 54% and 42% of the observations during 1998 and 1999, respectively (Table 1). In 1998, 31% of crane observations in corn fields were in grazed stubble, 43% in ungrazed stubble, 16% in tilled stubble, and 8% in mowed stubble, while in 1999, 41% were in grazed stubble, 34% in ungrazed stubble, 11% in tilled stubble, and 13% in mowed stubble. In 1998 and 1999, 30% and 38% of the crane observations, respectively, were in lowland grasslands (Table 1). During 1998, 47% of the crane observations in lowland grasslands were in grazed pastures, 31% in hayed meadows, and 21% in idled grasslands. In 1999, 81% of the cranes observed in lowland grasslands were

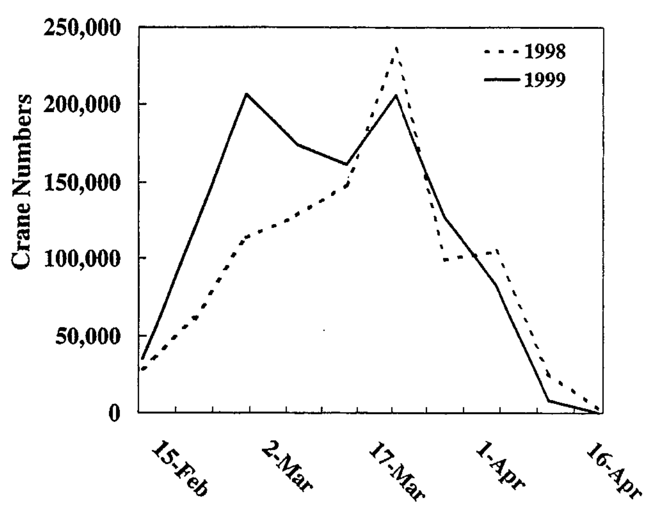

Fig. 2. Sandhill crane numbers from vehicle surveys conducted along the Platte River in central Nebraska from Chapman to Overton, Nebraska during spring 1998 and 1999.

Table 1. Diurnal habitat use and availability for sandhill cranes along the Platte River in central Nebraska during spring migration, 1998–99.

Habitat	Habitat available (%)[a]	Habitat use (%)	
		1998	1999
Corn	62.1	54.2[-b]	41.5[-]
Grazed	15.2	16.8	17.0
Ungrazed	21.3	23.6	14.3
Tilled	14.9	8.6	4.4
Mowed	10.6	4.8	5.6
Other[c]	0.1	0.4	0.2
Soybean	2.7	1.9[0]	2.4[0]
Alfalfa[d]	5.4	12.3[+]	13.0[+]
Winter wheat	0.3	0.5[0]	0.1[-]
Lowland grassland	26.6	29.7[+]	37.5[+]
Grazed	13.4	13.8	30.3
Hayed	6.2	9.2	5.4
Burned	2.6	0.3	1.4
Idled	4.4	6.4	0.4
Upland grassland	1.5	0.5[-]	4.5[+]
Shrub-grassland	1.3	0.2[-]	0.9[0]
Other[e]	0.1	0.7[+]	0.1[0]

[a] Habitat availability is based on an inventory conducted in late winter 1999.

[b] + and − indicate habitat used in proportion > or < than expected. 0 indicates habitat used in proportion to expected.

[c] Includes burned and silage.

[d] Includes smooth brome grasslands.

[e] Includes farmsteads and feedlots.

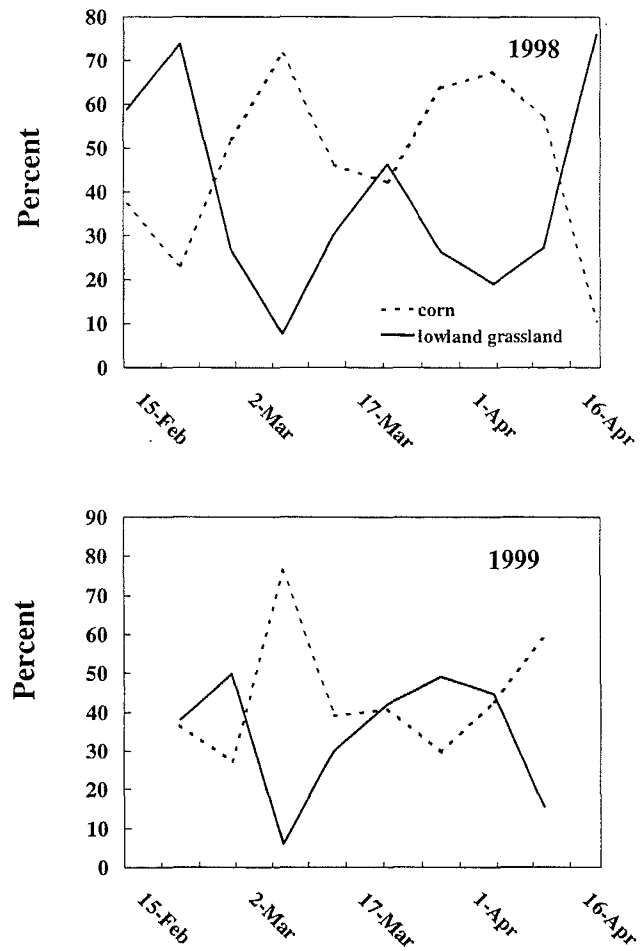

Fig. 3. Weekly habitat-use (% of total weekly observations) of sandhill cranes along the Platte River in central Nebraska during spring migration 1998 and 1999.

in grazed pastures, 14% in hayed meadows, and 1% in idled grasslands. Although alfalfa constituted <6% of the available habitat in 1998 and 1999, 13% of the cranes utilized this habitat (Table 1). Crane use of the remaining habitats was minimal, except for upland grassland (5%) in 1999. Cranes did not use habitat types in proportion to availability in 1998 (G = 12.10, 7 df, P = 0.097) and 1999 (G = 23.85, 7 df, P = 0.001). During both years, cranes exhibited preference for lowland grasslands and alfalfa and used corn less than its availability (Table 1). Although the 1998 habitat-use results were significant, the results should be viewed with some reservation because the data violate the independence assumption (i.e., cranes are gregarious) (Alldredge and Ratti 1992). Violation of the independence assumption may result in P-values being artificially low (W. L. Kendall, Patuxent Wildlife Research Center, personal communication).

Crane use of corn fields and lowland grasslands during the entire staging period was more variable in 1998 than 1999 (Fig. 3). In 1998, the highest percentages of crane observations in lowland grasslands (59–76%) occurred in mid- to late February and mid-April, and the highest percentages in corn fields (52–71%) occurred in early and late March. In 1999, the highest percentage of crane observations in lowland grasslands (50%) occurred in late February and late March, while the highest percentage in corn fields (59–76%) occurred in early March and early April.

Nocturnal Roost Site Selection

The maximum number of cranes observed roosting on the river was 207,725 on 28 March 1998 and 284,500 on 15

March 1999. Numbers recorded during aerial surveys fluctuated because cranes frequently left some roost sites before sunrise. Crane numbers at each roost site averaged 3,693 ± 415 (SE) (n = 400 roost sites, range = 10–60,000). Most roosting cranes (96.8%) were observed in the Highway 34-Shelton reach, a 43-km river stretch, and the Gibbon-Highway 10 reach, a 9-km river stretch (Fig. 1).

Eighty-four percent of all roosting cranes were in 0.8-km segments where channel widths were >200 m. During both years, cranes did not use channel widths in proportion to availability (1998: G = 376.46, 6 df, P < 0.001; 1999: G = 224.72, 6 df, P < 0.001). Cranes avoided 0.8-km segments having channel widths ≤150 m, but preferred 0.8-km segments having channel widths >250 m in 1998 and >200 m in 1999 (Table 2). The mean channel width for roost sites was 276.9 m ± 7.72 (SE) (n = 135) in 1998 and 236.8 m ± 5.47 (n = 264) in 1999. During both years, channel widths at roost sites were wider than unused river sections (1998: 83.73 m ± 4.11, n = 343; $F_{1,476}$ = 562.04, P < 0.001; 1999: 88.34 m ± 4.37, n = 349; $F_{1,611}$ = 460.21, P < 0.001). In 1998 and 1999, 59% and 66% of roost sites, respectively, were in river sections that had been mechanically cleared.

Table 2. Availability and use of 0.8-km river segments by roosting sandhill cranes in the central Platte River Valley, Nebraska during spring 1998–99.

Channel width class (m)	Available (%)[a]	% roosting cranes	
		1998	1999
≤50	37.4	0.0- [b]	0.5-
51-100	25.9	0.5-	2.4-
101-150	11.6	0.3-	6.7-
151-200	5.2	2.0 0	9.9 0
201-250	7.1	13.7 0	15.7+
251-300	4.9	14.2+	24.4+
≥301	7.9	69.2+	40.4+

[a] Habitat availability based on the proportion of 406 0.8-km river segments within each channel width class.
[b] + and - indicate habitat used in proportion > or < than expected. 0 indicates habitat used in proportion to expected.

DISCUSSION

Crane Numbers and Migration Chronology

In past years, cranes normally began to arrive in the PRV in mid-February and increased through February (U. S. Fish and Wildlife Service 1981, Currier et al. 1985). During 1998 and 1999, ≤10,000 cranes arrived in late January, and increased to 60,000–100,000 by late February. Possibly early arrival and high number of cranes in late February resulted from mild weather conditions throughout most of the Southern High Plains during January and February. Temperatures during January and February 1998 and 1999 ranged from 3° to 6°C above normal for the PRV (National Oceanic and Atmospheric Administration 1998–99).

Peak crane numbers were higher in 1998 than 1999. The decline in peak numbers may be due to less waste corn being available in 1999 than 1998. In fall 1997, a storm caused substantial losses of corn in unharvested fields, whereas in fall 1998, weather conditions were more favorable for corn production and harvest efficiency of corn was higher (G. L. Krapu and D. A. Brandt, Northern Prairie Wildlife Research Center [NPWRC], unpublished data). Research by NPWRC indicated that cranes were responding to declining corn availabilities in the PRV by foraging up to 20 km from the river (G. L. Krapu and D. A. Brandt, unpublished data). Because availability of waste corn was greater in 1998, cranes did not need to forage greater distances from roost sites, and more cranes remained in the study area.

Diurnal Habitat Use

In general, diurnal crane habitat-use patterns in the PRV during this study were similar to patterns reported by Krapu et al. (1984) in the PRV and Iverson et al. (1987) in the North Platte River Valley (NPRV). In the earlier studies, the primary habitats used by cranes were corn stubble, native grasslands, and alfalfa. Iverson et al. (1987) reported that diurnal habitat-use patterns varied little between years, while Krapu et al. (1984) reported that diurnal habitat-use patterns varied between years. In this study, use of corn stubble and lowland grasslands varied between years, but may have been weather-related. For both years, weather conditions were similar during February, but differed during March. In mid-March 1998, blizzard conditions with extremely low temperatures reaching -26°C and a snowfall of 20 cm occurred, whereas in 1999, weather conditions were milder. During harsh weather in 1998, cranes probably depleted energy reserves for body maintenance and additional thermoregulation, and they spent more time feeding on corn to replenish energy reserves (Fig. 3). Mild weather in 1999 maintained open water in sloughs and depressions in lowland grasslands and invertebrate activity may have been initiated earlier. Hence, the higher crane use of lowland grasslands in 1999 may have reflected better habitat conditions to loaf, drink, forage for invertebrates, and conduct pair formation activities (Krapu et al. 1984, Iverson et al. 1987, Tacha 1988).

Land-use practices influenced crane habitat-use patterns in the PRV. Cranes exhibited high use of ungrazed and grazed corn stubble compared to tilled and mowed corn stubble during both years. Although availability of these habitat types may have influenced use patterns, the high use of ungrazed and grazed corn stubble is likely related to waste corn being more available in those fields compared to tilled and mowed fields. Baldassarre et al. (1983) found that tilling of corn stubble reduced waste corn availability by 77% in western Texas. The impact of mowing on waste corn availability is unknown. However, mowing likely reduces waste corn availability less than tilling because less corn is buried in the shredded harvest litter during mowing. Moreover, whole ears, which cranes generally do not utilize, are shattered into smaller pieces by mowing.

In this study, grazed and hayed native grasslands were extensively used by cranes, although idle grasslands, to a lesser extent, were used in 1998. Cranes prefer grasslands with lower stature vegetation (<25 cm) and sparse cover (Lovvorn and Kirkpatrick 1982, VerCauteren 1998). Lovvorn and Kirkpatrick (1982) suggested that an unobstructed view of the surrounding area and freedom of movement were important characteristics that restrict crane use of grasslands. Grazing and haying enhanced grasslands for cranes by creating lower stature vegetation. Also, grazing may increase soil invertebrate numbers, particularly scarab beetles (Scarabaeidae) and earthworms, by adding organic matter to open pastures (Ritcher 1958, Edwards and Lofty 1977, Davis and Vohs 1993*a*). Scarab beetles and earthworms are the primary crane foods in PRV grasslands (Reinecke and Krapu 1986, Davis and Vohs 1993*b*).

Nocturnal Roost Site Selection

Krapu et al. (1984) reported that cranes in the PRV preferred open channels >150 m wide and avoided river channels ≤50 m wide. In this study, cranes preferred river sections that were >200 m wide and avoided sections <150 m wide. Currently, roost space is not limiting crane abundance in the PRV (Tacha et al. 1994). However, availability of wide channels (>150 m) is low (25%) in the Chapman-Overton reach (Table 2). Consequently, cranes are concentrated in only a few river sections, which increases their vulnerability to disease, severe weather (e.g., hail, tornadoes, and ice storms), food shortages, and human disturbance.

Crane roost site selection (Fig. 4) appears to depend on availability of wide, unobstructed channels and availability of adjacent lowland grasslands (Folk and Tacha 1990, Faanes and LeValley 1993, Sidle et al. 1993). Folk and Tacha (1990) suggested that the interaction between availability of river roost space and off-river habitats may influence crane distribution and abundance in the NPRV. In this study, roosting cranes were primarily concentrated within 2 reaches of the Platte River, Highway 34-Shelton and Gibbon-Highway 10. Crane concentrations within these reaches appeared to be related to availability of roost site habitat (i.e., wide, unobstructed channels) and proximity to lowland grassland habitat. Some of the widest sections of the river (>250 m) and largest tracts of lowland grasslands were located within these reaches.

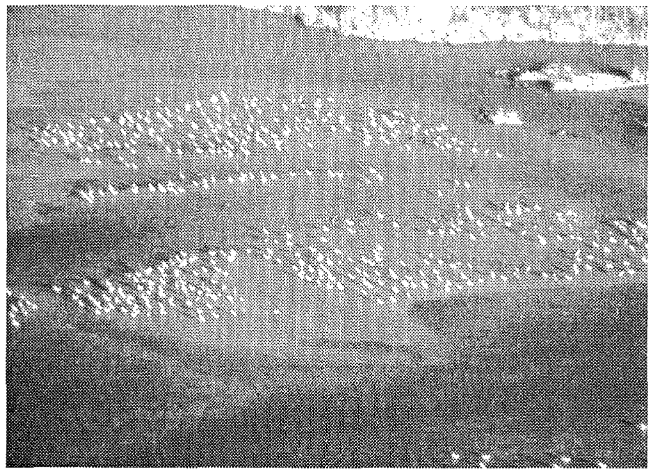

Fig. 4. Sandhill cranes at roost on the Platte River. Spacing between cranes allows for accurate counts. Note avoidance of deeper water. (Photo by William Weber.)

Spring river flows varied between years. During 1998, flows were above normal for most of the staging period. From 15 February–28 March, flows averaged 97 m^3/sec or 31 m^3/sec above the long-term historic flows (1936–97) (D. Hitch, U. S. Geological Survey, unpublished data). The higher flows appeared to have minimal impact on roosting cranes, except during 29 March–11 April when river flows averaged 170 m^3/sec (113 m^3/sec above long-term historic flows) (D. Hitch, unpublished data). These extremely high flows, which were caused by above normal precipitation in Colorado and storage releases from reservoirs on the North Platte River, impacted roosting cranes. Many traditional roost sites were inundated by deep water, and large numbers of cranes were forced to search for alternative roost sites after sunset. Cranes were observed roosting in shallow water areas adjacent to islands, on top of cleared islands, and in grasslands adjacent to the river (C. A. Davis, PRWCMT, unpublished data). Because cranes were forced to search for alternative roost sites after sunset, they were more susceptible to powerline collisions. An increase in powerline mortalities and cripples occurred during this period (P. Tebble, Audubon Rowe Sanctuary, personal communication).

In 1999, river flows were normal for most of the staging period, averaging 64 m^3/sec, which was 0.4 m^3/sec below the long-term historic flows (D. Hitch, unpublished data). Crane responses to these flows appeared normal, except during 2 days in late March when flow releases were restricted to 31 m^3/sec during routine maintenance of the J-2 power plant near Overton. Cranes temporarily used new roost sites created by the low flows in river sections that were normally too deep for roosting.

MANAGEMENT IMPLICATIONS

Since 1982, the PRWCMT and other conservation groups have cleared approximately 279 ha of vegetation in the Platte River from Overton to Chapman. Cranes responded positively to vegetation clearing: during this study, over 63% of roosts were located in river sections that had been cleared. The shift eastward of cranes from lower quality roosting habitat in the Lexington-Kearney reach to higher quality roosting habitat in the Kearney-Chapman reach has been attributed to vegetation clearing (Faanes and LeValley 1993).

Currently, vegetation clearing has primarily focused on maintaining wide, unobstructed river channels within the Kearney-Chapman reach. Future vegetation clearing projects should focus on the Kearney-Overton reach to disperse cranes throughout the entire Overton-Chapman reach. Vegetation clearing should also focus on sites near existing lowland grasslands. Creation of habitat complexes composed of wide, unobstructed river channels in close proximity to lowland grasslands should encourage cranes to use recently cleared roost sites.

Vegetation clearing has been criticized by Johnson and Boettcher (1999). They claimed that vegetation clearing destroys habitat for neotropical migrants, promotes expansion of invasive plants, and releases sediment into the channel which stimulates vegetation growth downstream. The impact of vegetation clearing on neotropical migrants appears negligible. Recent studies (Colt 1997; C. A. Davis, unpublished data) have shown that most neotropical migrants using Platte River riparian woodlands are habitat generalists whose populations are stable or increasing throughout their ranges. The amount of woodland that has been cleared is <2% of the total in the Overton-Chapman reach (C. A. Davis, unpublished data), and woodland habitat is not becoming a limited resource. Some invasive plants (e.g., purple loosestrife [*Lythrum salicaria*]) have become established on cleared sites. However, it is difficult to assess the role of vegetation clearing in the spread of invasive plants because they also are well established in uncleared stretches. Additionally, establishment of invasive plants on cleared sites is reduced because these sites are periodically disced once every 1 to 3 years. The amount of sediment released from cleared sites during high flows has not been measured. However, because most cleared sites are nearly intact several years post-clearing and show little evidence of erosion, the amount of sediment released from these sites during high flows is likely insignificant, especially when compared to the total amount of sediment transported through the system.

Although improved harvesting technology has reduced availability of waste corn in the PRV (G. L. Krapu, and D. A. Brandt, unpublished data), availability of waste corn currently does not appear to be limiting to staging cranes. However, if increased competition for corn by lesser snow geese (*Chen caerulescens*) continues, waste corn availability could limit cranes. Moreover, increased fall tillage of cornfields, which has occurred in recent years during dry conditions, could dramatically reduce supplies of waste corn. Future management in the PRV should consider discouraging fall tillage in areas heavily used by cranes.

Another concern with snow geese is that they may begin competing with cranes for riverine roost sites. Normally, competition for roost sites is minimal because cranes roost primarily in the Platte River, whereas, snow geese roost primarily in wetlands in the Rainwater Basins south of the river. Large numbers of snow geese generally only roost in the Platte River when wetlands in the Rainwater Basins are frozen or dry. In 1998, adequate wetland roosting habitat existed for snow geese in the Rainwater Basins, but hundreds of thousands of geese dispersed to the river due to heavy hunting pressure in the eastern Rainwater Basins. Most of these geese roosted in river sections used by cranes (C. A. Davis, unpublished data). The Platte River and a 0.8-km buffer around its channels are currently closed to snow goose hunting and therefore, serves as a "refuge" for snow geese. An early snow goose season will open in both the eastern and western Rainwater Basins in spring 2000 from 3 February–10 March. A "conservation" season which is specifically designed to reduce the midcontinent snow goose population may also be opened from 11 March–2 April (J. Drahota, U. S. Fish and Wildlife Service, personal communication). With increased off-river hunting pressure on snow geese in 2000, goose-crane competition for roost sites on the river may increase. Additionally, goose-crane competition for food may increase along with increased chances for transmission of diseases (e.g., avian cholera) from geese to cranes. Such impacts from snow geese on staging cranes should be closely monitored.

Tacha et al. (1994) noted that conservation and management of habitat complexes composed of riverine roost sites in close proximity to corn stubble, lowland grasslands, and alfalfa should be a high priority for crane management in the central PRV. Protection of existing habitat complexes and development of future habitat complexes must be an important component of management activities. Management activities should also focus on maintaining adequate instream flows in the Platte River for roosting cranes. Because lowland grasslands are the most limited habitat in the central PRV (Currier and Ziewitz 1987) and play a crucial role in crane pair formation and foraging activities, restoration of marginal croplands to lowland grasslands, especially those croplands adjacent to wide river channels, should be a major focus in management plans for the central PRV. The goal of habitat management should also be to disperse staging cranes throughout the central PRV to reduce their vulnerability to disease outbreaks, food shortages, and severe localized storms. Although the central PRV population of cranes appears to be stable (Sharp et al. 2001 unpublished), the future of this population could be in jeopardy if habitat quality and food availability declines further. Consequently, future management strategies must take a comprehensive and active approach that includes protecting existing habitats, restoring habitats in selective reaches, managing appropriate instream flows, and ensuring adequate and available food resources.

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