THE MIGRATION ECOLOGY OF WHOOPING CRANES IN NEBRASKA, U.S.A.

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ABSTRACT

Nebraska is an important migration stopover for the wild flock of whooping cranes *Grus americana*. The ecology of this species on the winter and nesting grounds has been studied extensively; migration ecology, however, is poorly known. We studied habitat use and behavior of whooping cranes in Nebraska during their spring and fall migration periods. Activity budget data were collected from 1984 through 1986; site evaluations were dated from 1977 to 1986. We collected 100.7 bird-hours of activity budget data and reviewed site evaluation forms summarizing 74 confirmed sightings within the state. Comparisons were made between spring and fall sightings as well as between family and non-family groups. Wetlands, both riverine and palustrine, appear to be the most important habitat component for whooping cranes in Nebraska. Our findings provide resource managers with information vital to the future management of this endangered species.

INTRODUCTION

The ecology of the wild flock of whooping cranes, which is restricted to North America, has been studied on their wintering grounds in Texas (Allen 1952; Blankinship 1976; Bishop 1984) and their nesting grounds in the Northwest Territories of Canada (Allen 1956; Novakowski 1966; Kuyt and Goossen 1987). But there is little quantitative information available on habitat use during migration (Johnson and Temple 1980; Lingle et al. 1984, 1986). Howe (1987) recently described habitat use by 18 radio-marked whooping cranes in their 2400-mile (3865 km) migration corridor during three southbound and two northbound migrations. Nebraska, especially the area near the Platte River in the southcentral portion of the state, is an important migration stopover (Swenk 1933; Brooking 1943; Allen 1952; Johnsgard and Redfield 1977; U.S. Fish and Wildlife Service 1986; Lingle 1987). The Platte River's central location between the cranes' wintering and nesting grounds, and the river's abundant wetland complexes, especially prior to 1940 (Currier et al. 1985), regularly attract whooping cranes. Dates of occurrence in Nebraska in spring are from late March to early May with a peak in early April, and in fall from late September to early November with a peak in late October. This paper focuses on whooping crane migration ecology in Nebraska.

STUDY AREA AND METHODS

We reviewed site evaluation data of confirmed whooping crane sightings throughout their migration corridor within the state (Figure 1) and collected activity budget data primarily from southcentral Nebraska . Site evaluation information has been collected by the Nebraska Game and Parks Commission at areas used by Whooping Cranes since 1977. Daily movements and habitat use were recorded on the evaluations. Specific habitat-types were lumped into general habitat categories (Table 1). These data were collected through continuous surveillance of the cranes, through on-site inspection of areas used, and from interviews with persons sighting cranes. The data indicate the amount of time cranes spent in a particular habitat type. Diurnal habitat use was defined as the period between sunrise and sunset. Extreme observation dates were 29 March to 9 May during spring and 7 October to 22 November during fall.

For most sightings, the exact time of arrival and duration of stay were not known. Several sightings included nights where the actual roost location was not known. The following criteria were used to determine length of stay and habitat use. A known overnight stay included nights between initial and final sightings of groups as well as nights when an observation was made until dusk, at dawn,

or between dusk and dawn. An assumed overnight stay was when the initial sighting occurred after dawn but within two hours after sunrise or if the only observation occurred between sunset and dusk.

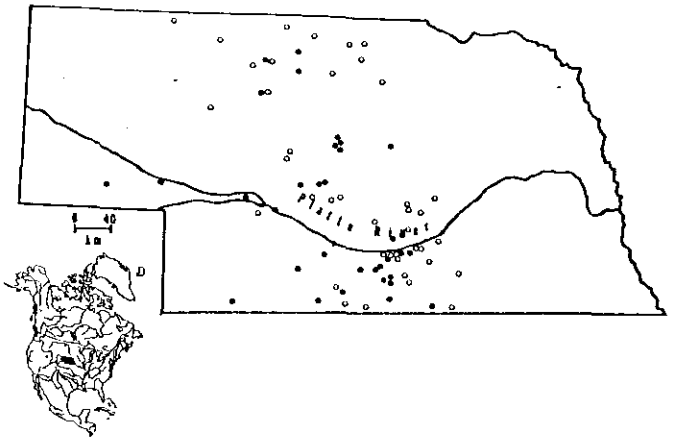

Figure 1. Map of Nebraska showing the location of confirmed whooping crane sightings from fall 1977 to fall 1986 (N = 74). The solid circles are spring sightings (N = 33) and the open circles are fall sightings (N = 41).

CROPLAND[a]	WETLAND	GRASSLAND
Corn stubble	Natural wetland	Upland grassland
Wheat stubble	Tilled wetland	Lowland grassland
Milo/sorghum stubble	Riverine	Alfalfa
Soybean stubble	Stockdam	
Winter wheat	Reservoir	
Rye		
Fallow		

Table 1. Habitat types included in the general habitat categories. [a]We noted whether grain stubble was disced or grazed if known.

We considered the habitat of night roosts to be known if the cranes were observed in a wetland at or between dusk and dawn. Assumed roost types were assigned only if three conditions were met: 1) cranes were observed in or near [less than 2 mi (3.2 km)] a wetland within two hours of sunrise or sunset, 2) use of that wetland was confirmed by tracks or a subsequent observation, and 3) no other wetland types occurred in proximity to the crane's use area. Otherwise, the roost type was considered unknown. To quantify habitat use for assumed overnight stays and roost types, we assigned time periods to habitat categories as follows. When the roost type was unknown, the entire period from sunset until the initial sighting time was assigned to the unknown habitat category. If a roost type was assumed or known, the period from sunset to sunrise was assigned to that roost type. The period from sunrise to initial sighting was also assigned to that roost type if the initial sighting occurred in the roost, but was assigned to the unknown category if the initial sighting occurred away from the roost. When the initial sighting occurred before sunrise or after sunset, times were adjusted according to actual observations. We compared seasonal habitat use (spring versus fall) as well as habitat use of family and non-family groups. Family groups were defined as those groups consisting of one chick and one or both parents while non-family groups contained all other combinations of birds. Sightings with both family and non-family components were separated into their respective groups.

Activity budget data were collected on a single crane or simultaneously on groups of up to three cranes. Continuous observation periods ranged from 20 minutes to two hours with a desired goal of at least one hour. Behavior was recorded according to the categories in Table 2, which are similar to those used by Howe (1987). In most cases, two people collected the data. One person kept track of time and recorded the behavior codes while the other person made observations through a 25x spotting scope. On six occasions, a single observer collected data using an audible timer that beeped at 10-second intervals. Behavior codes were recorded with a cassette tape recorder. The date, time, and habitat type that cranes used were recorded for each observation period. We also recorded age, whether individuals were banded, and whether individuals were part of a family group.

Category "No data"	**Category "Feeding"**
Bird out of view	Feeding
Other cause for no data	Adult feeding juvenile
	Drinking
Category "Locomotion"	Other feeding
Stand	
Stand in alert position	**Category "Comfort"**
Walk	Preen
Fly	Sleep
Other locomotion	Bathe
	Other comfort
Category "Interaction"	
Threat	**Category "Vocalizations"**
Submission	Unison call
Fight	Alarm call
Dance	Other vocalization
Other interaction	

Table 2. Behavior categories used for collection of activity budget data.

During observations, a crane would occasionally wander out of view, or for some other reason a crane's behavior could not be determined, and a "no data" behavior category was recorded. When a crane flew, a behavior category for flight was recorded, but a habitat type could not be recorded. A total of 3.0 bird-hours of observations was collected under these circumstances and were excluded from the analyses.

We collected 100.7 bird-hours of activity budget data at four observation time intervals: 24.0 bird-hours at 10-second, 52.6 at 12-second, 4.0 at 15-second, and 20.1 at 30-second intervals. Because data taken at different observation intervals must be transformed to a common interval for analysis, we examined the feasibility of transforming the 12-, 15-, and 30-second observations to a common interval of 10 seconds. We subsampled the two largest activity budget samples, the 10- and 12-second observations, taking every third datum to create data sets

	# BIRD-HOURS				# HOURS				
	Total	Mean	SD[a]	Range	Total	Mean	SD	Range	N
SPRING	3889	134	190	1 to 984	1590	55	93	<1 to 492	29
Family	1165	116	104	33 to 253	388	39	35	11 to 118	10
Non-family	2724	143	225	1 to 984	1202	63	113	<1 to 492	19
FALL	3847	99	176	<1 to 934	1449	37	60	<1 to 311	39
Family	2728	170	258	41 to 934	939	59	86	14 to 311	16
Non-family	1120	49	40	<1 to 175	510	22	22	<1 to 88	23
TOTAL	7737	114	182	<1 to 984	3040	45	76	<1 to 492	68

Table 3. Length of stay of whooping cranes by season and by family versus non-family groups.
[a]SD = standard deviation.

equivalent to 30- and 36-second observations, respectively. We tested the null hypothesis that the distributions of the original samples and their subsamples were identical using a chi-square test.

The 10- and 30-second data were very similar ($p > 0.99$). Threat behavior, which occured twice in the 10-second data, did not occur in the 30-second subsample. The 12- and 36-second data were also very similar ($p > 0.99$), with all behaviors occuring in both data sets. Based on these results, we transformed all data to 10-second-equivalent observations. The 30-second data were multiplied by 3.0, the 15-second by 1.5, and the 12-second by 1.2 to obtain 10-second-equivalent data.

Activity budget data were analyzed as frequency distributions of the behavior categories. We compared behavior in wetlands versus croplands, in family groups versus non-family groups, and in spring versus fall migrations. We tested the null hypothesis that the frequency distributions in these paired subsets were identical using chi-square test.

RESULTS

Site Evaluations

Length of stay— The length of stay was calculated from 68 confirmed sightings involving 193 individual whooping cranes (Table 3). We did not include radio-tagged cranes in this analysis. Length of stay was highly variable thus data in Table 3 should be used with caution. A total of 3040 hours were recorded from groups ranging in size from one to seven cranes. Individual sightings ranged from less than 1 to 492 hours with the longest stay recorded by a non-family group. Family group stays totaled 1327 hours (3893 bird-hours); non-family groups totaled 1712 hours (3844 bird-hours).

Thirty percent of the spring habitat use based on bird-hours was by family groups as compared to 70% spring use by non-family groups. This difference is probably due to the greater number of visits by non-family groups. In contrast, 71% of the fall use was by family groups (Table 3). This was due to a greater length of stay per visit by family groups. A similar relationship appears when the number of hours are examined; family groups made up 24 and 65% of the spring and fall use respectively. The longest known stay of two or more cranes was in spring 1984 when two 2-year old individuals spent 22 days adjacent to the North Platte River near Hershey, Nebraska. Both birds were radio-tagged.

Diurnal habitat use— Diurnal habitat use was described from 51 confirmed sightings. Of the 2280 bird-hours of use, 1527 bird-hours (67%) were in known habitat types. Corn stubble received the greatest use (37%) followed by tilled wetlands (18%) and natural wetlands (17%) (Table 4). When the habitat types were lumped according to groups, 53% of the use was in uplands and 47% was in wetlands.

Habitat Type	Bird-hours	Percent
Corn stubble	559	37
Winter wheat	102	7
Grassland[a]	79	5
Fallow	36	2
Small grain[b]	32	2
Total for UPLAND	808	53
Tilled wetland	277	18
Natural wetland	261	17
Stock dam	97	6
Riverine	61	4
Reservoir	23	2
Total for WETLAND	719	47

Table 4. Diurnal habitat use by whooping cranes based on site evaluations (N = 1527 bird-hours).
[a]Also includes rye and alfalfa
[b]Includes wheat, soybean, and milo/sorghum stubble.

Habitat use varied by season with greater use of wetlands and grasslands in the fall and greater use of croplands in the spring (Figure 2). Within season use was greatest for croplands in spring (57%) and greatest for wetlands in fall (51%). We believe this resulted from the proportionally greater fall use of wetlands and grasslands by non-family groups and of croplands by family groups (Figure 3). Spring habitat use was similar among family and non-family groups (Figure 4).

Nocturnal habitat use— We examined 313 bird-nights of use from 54 confirmed sightings for which nocturnal roosting habitat was known or assumed. Wetlands were used for roosting in all cases. Natural wetlands accounted for 45% (141 bird-nights) of the bird-nights followed by tilled wetlands with 23% (Figure 5). Reservoirs made up only 2% (6 bird-nights) of the total.

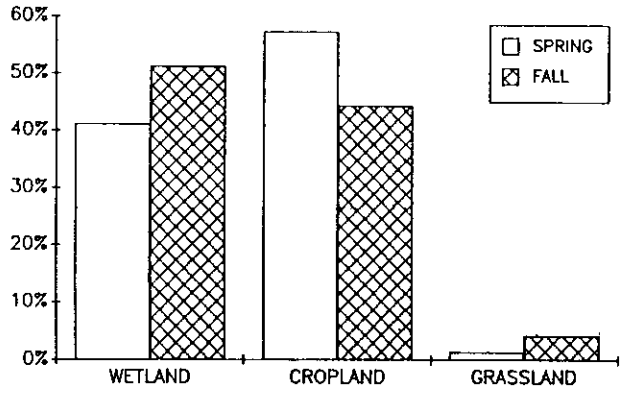

Figure 2. Diurnal habitat use by season (based on 1527 bird-hours in known habitats).

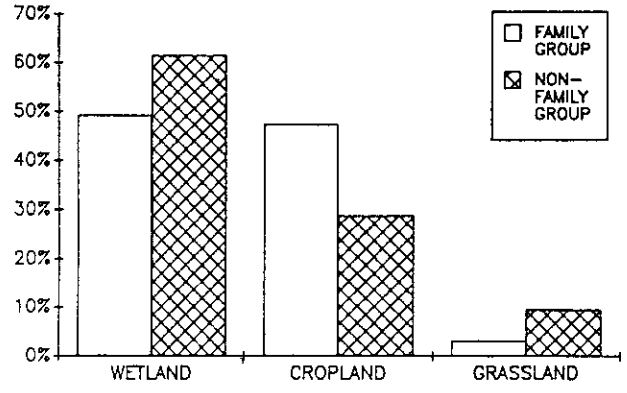

Figure 3. Diurnal habitat use by family and non-family groups during fall (based on 890 bird-hours in known habitats).

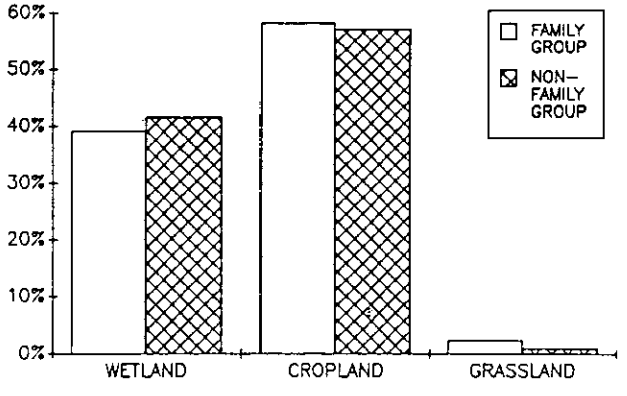

Figure 4. Diurnal habitat use by family and non-family groups during spring (based on 636 bird-hours in known habitats).

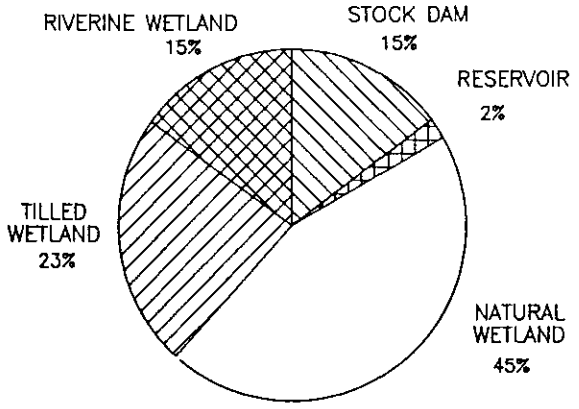

Figure 5. Distribution of roost habitat types based on 313 bird-nights.

For the five roost habitats, family groups showed a relatively greater use of tilled wetlands, stock dams, and reservoirs while non-family groups had greater use of natural and riverine wetlands (Figure 6). Seasonal use of roost habitats was greater in spring for tilled and natural wetlands while the other roost types had a greater fall use (Figure 7). About 75% of the spring non-family groups roosted in natural wetlands. About 77% of the spring family groups roosted in natural and tilled wetlands. There were no records of reservoir use in the spring. The greatest use by non-family groups in the fall was of riverine wetlands (52%) followed by natural wetlands and stock dams (24% each). Fall family groups used natural and tilled wetlands the most (68%) with stock dams comprising 21% of the bird-nights. Reservoirs and riverine wetlands accounted for six bird-nights each for 10% of the known fall family group use.

Activity Budget

Duration of observations in wetlands versus croplands, family groups versus non-family groups, and spring versus fall are shown in Table 5. Most observations were of non-family groups in croplands in the spring (47.5 bird-hours or 49%). Of the 32.3 bird-hours collected in wetlands, 18.6 hours were in natural wetlands, 8.1 were in tilled wetlands, and 5.6 were in stock dams. All of the fall observations were collected from a single family group.

The frequency distribution of behavior among wetland types was significantly different from behavior among croplands ($p < 0.01$, Figure 8). About one third of the observations in both wetlands and croplands were of cranes feeding (33 and 32%, respectively), but cranes spent more time in comfort and interaction behaviors in wetlands than in croplands (27 versus 10% and 2 versus 1%, respectively), and less time in locomotion behaviors (38 versus 57%).

The frequency distribution of behavior for family groups was significantly different from the distribution for non-family groups ($p < 0.01$, Figure 9). One half of the family group observations were of cranes feeding, compared to 22% of non-family group observations. Family groups spent

less time in locomotion and comfort behaviors than did non-family groups (38 versus 58% and 11 versus 18%, respectively), and slightly more time in interaction behaviors (2 versus 1%).

Habitat	Family or Non-family Group	Season	Bird-hours
Wetland			32.3
	Family	Spring	12.1
		Fall	5.6
	Non-family	Spring	14.6
		Fall	0
Cropland			65.4
	Family	Spring	9.6
		Fall	8.3
	Non-family	Spring	47.5
		Fall	0
Total			97.7

Table 5. Duration of activity budget observations (excluding observations where a behavior or habitat type could not be recorded).

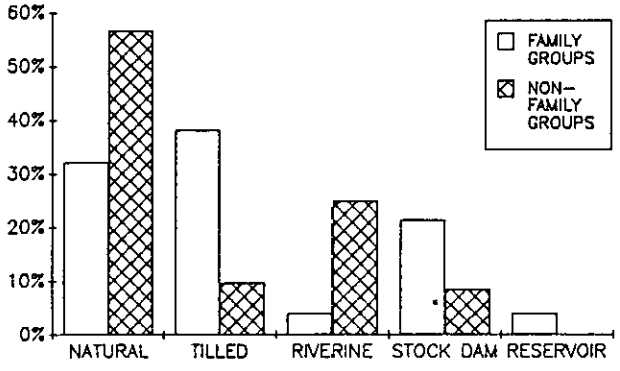

Figure 6. Whooping crane roost types by family and non-family groups.

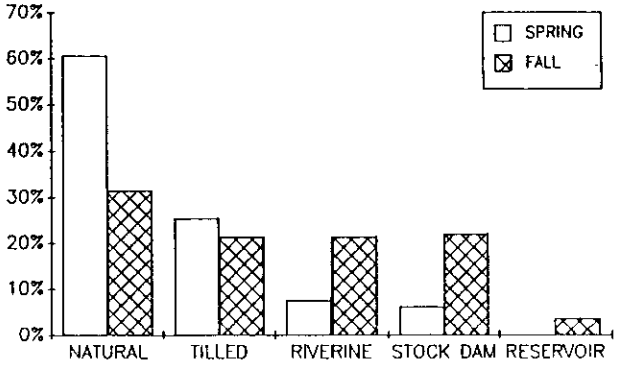

Figure 7. Whooping crane roost types by season.

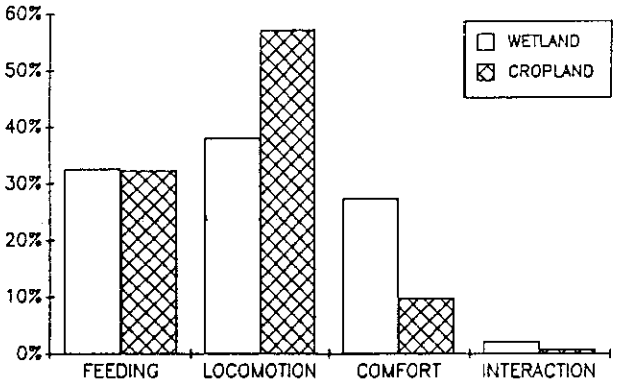

Figure 8. Frequency distribution of behavior for whooping cranes observed in wetlands (N = 32.3 bird-hours) versus croplands (N = 65.4 bird-hours).

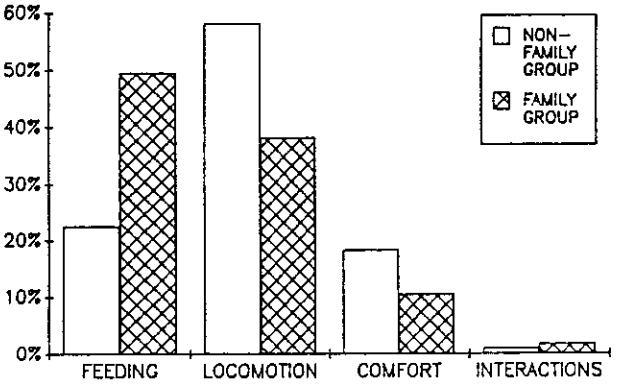

Figure 9. Frequency distribution of behavior for family groups (N = 35.6 bird-hours) versus non-family groups (N = 62.1 bird-hours).

Because our fall observations were of a single family group, we compared the spring versus fall behavior of family groups only. In both wetlands and croplands, the frequency distribution of behavior in spring was significantly different from fall behavior (in wetlands, $p < 0.01$, Figure 10; in croplands, $p < 0.01$, Figure 11). The most notable difference was behavior in wetlands; cranes spent a much greater percentage of their time feeding in the fall (62 versus 40%), and a much greater percentage of their time engaged in comfort movements in the spring (27 versus <1%). In croplands, more time was spent in feeding and comfort behavior in spring (61 versus 49%), while locomotion was more prominent in fall (39 versus 50%).

CONCLUSIONS

Our data reveal that family groups of whooping cranes spend more time in Nebraska during their fall migration than do non-family groups. The reverse is true in the spring when non-family groups have longer stays. A biological hypothesis for this observation is that during the spring

migration, successful nesting adults from the previous year have to return to their nesting territories to reproduce during a short nesting season. Chicks accompanying these birds would be nearly one year old and would have acquired the strength and stamina to remain with their parents on the northward migration. Family bonds are generally severed in Saskatchewan, Canada, as evidenced by the radio-telemetry study (U.S. Fish and Wildlife Service, unpublished data). Non-family groups generally consist of sub-adult individuals. These birds are not pressured to head north in order to nest, and thus their spring migration is more leisurely. On the southbound migration, family groups include a chick that is less than six months of age. These chicks are unaccustomed to the rigors of migration, and the parents migrate at a much slower pace for the chick's benefit. Also, it is not as urgent for the adults to reach the wintering grounds as it is for them to reach the nesting grounds. Non-family groups contain individuals that have experienced one or more round-trip migrations, and thus they spend less time in Nebraska.

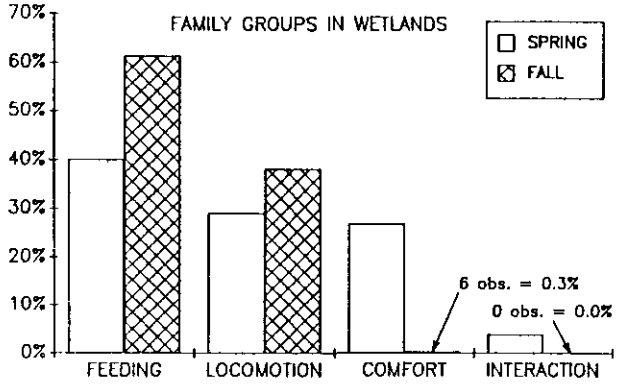

Figure 10. Frequency distribution of behavior for family groups in wetlands during spring (N = 12.1 bird-hours) versus fall (N = 5.6 bird-hours).

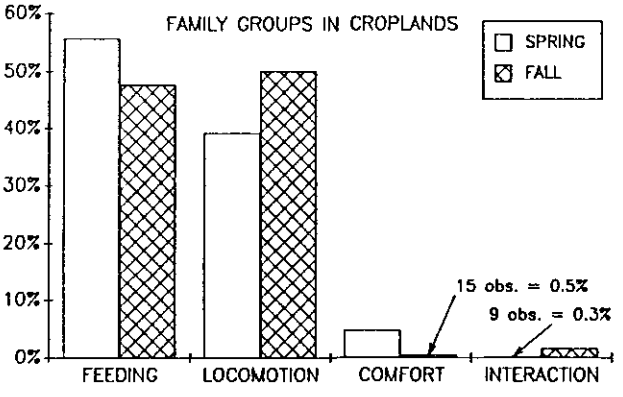

Figure 11. Frequency distribution of behavior for family groups in croplands during spring (N = 9.6 bird-hours) versus fall (N = 8.3 bird-hours).

Diurnal activities were always in proximity to wetlands. Wetlands provided a source of drinking water, aquatic food, and loafing habitat. During wet weather, whooping cranes would drink from small puddles in croplands; wetland habitats, however, were visited daily during daylight hours. Croplands and upland grasslands are not limiting throughout the majority of the area in their migration corridor in Nebraska. Nocturnal roosts were always in a wetland.

Based on the percent use, natural wetlands may be preferred over tilled wetlands, especially in the spring (Figure 7). If tilled and natural wetlands were selected based on availability, then we would expect higher percent use of tilled wetlands since they are more abundant. This is especially true since over 90% of the natural wetlands occuring in southcentral Nebraska have been drained, making ephemeral sheetwater areas in tilled wetlands more available (Lingle 1987). In spring, however, natural wetland roost sites have about 2.4 times as many bird-nights as tilled wetlands and 1.4 times as many in the fall. The richer biota found in natural wetlands may attract whooping cranes to these sites. We believe that the availability of an adequate wetland complex is the most important factor limiting occurrence of whooping cranes and the extent of their stay in Nebraska.

The behavior of whooping cranes in wetlands as compared to croplands confirms the importance of wetlands for comfort activities and social interactions. About an equal proportion of time is spent feeding in both habitats. Locomotion is most prominent in croplands, undoubtedly the result of the cranes' behavior of walking while foraging in fields. Family groups spend more time feeding than do non-family groups, probably due to the presence of a chick. The fact that family groups spend more time feeding in wetlands in fall as compared to spring may be due to the prior foraging experience of the chicks; wetlands provide the only foraging habitat on the nesting grounds and that is where hatch-year chicks are accustomed to feeding. Also, the chick may require particular animal proteins that may occur only in wetlands. Aquatic habitats are primary foraging areas on the wintering grounds as well. Cropland habitats are used more during migration, and the older, more experienced birds exploit these areas.

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REFERENCES CITED

Allen, R. P. 1952. The whooping crane. National Audubon Society Report No. 3. New York, New York. 246 pp.

Allen, R. P. 1956. The whooping crane's northern breeding grounds. National Audubon Society, Supplement to Report No. 3. New York, New York. 60 pp.

Bishop, M. A. 1984. The dynamics of subadult flocks of whooping cranes wintering in Texas, 1978-79 through 1982-83. M.S. Thesis, Texas A&M University, College Station, Texas. 127 pp.

Blankinship, D. R. 1976. Studies of whooping cranes on the wintering grounds. Pages 197-206 *in* J.C. Lewis, ed., Proceedings International Crane Workshop. Oklahoma State University, Stillwater.

Brooking, A. M., 1943. The present status of the whooping crane in Nebraska. Nebraska Bird Review 11:5-8.

Currier, P. J., G. R. Lingle, and J. G. VanDerwalker. 1985. Migratory bird habitat on the Platte and North Platte rivers in Nebraska. The Platte River Whooping Crane Critical Habitat Maintenance Trust, Grand Island, Nebraska. 177 pp.

Howe, M. A. 1987. Habitat use by migrating whooping cranes in the Aransas-Wood Buffalo corridor. Pages 303-311 *in* J. C. Lewis, ed., Proceedings 1985 Crane Workshop. Platte River Whooping Crane Trust and U.S. Fish and Wildlife Service, Grand Island, Nebraska.

Johnsgard, P. A., and R. Redfield. 1977. Sixty-five years of whooping crane records in Nebraska. Nebraska Bird Review 45:54-56.

Johnson, K. A., and S. A. Temple. 1980. The migratory ecology of the whooping crane. Unpublished report, contract 14-16-0009-78-034, U. S. Fish and Wildlife Service, Washington, D. C. 120 pp.

Kuyt, E., and J. P. Goossen. 1987. Survival, age composition, sex ratio, and age at first breeding of whooping cranes in Wood Buffalo National Park, Canada. Pages 230-244 *in* J. C. Lewis, ed., Proceedings 1985 Crane Workshop. Platte River Whooping Crane Trust and U.S. Fish and Wildlife Service, Grand Island, Nebraska.

Lingle, G. R. 1987. Status of whooping crane migration habitat within the Great Plains of North America. Pages 331-340 *in* J. C. Lewis, ed., Proceedings 1985 Crane Workshop. Platte River Whooping Crane Trust and U.S. Fish and Wildlife Service, Grand Island, Nebraska.

Lingle, G. R., P. J. Currier, and K. L. Lingle. 1984. Physical characteristics of a whooping crane roost site on the Platte River, Hall County, Nebraska. Prairie Naturalist 16:39-44.

Lingle, G. R., K. J. Strom, and J. W. Ziewitz. 1986. Whooping crane roost site characteristics on the Platte River, Buffalo County, Nebraska. Nebraska Bird Review 54:36-39.

Novakowski, N. W. 1966. Whooping crane population dynamics on the nesting grounds, Wood Buffalo National Park, Northwest Territories, Canada. Canadian Wildlife Service Research Report No. 1. 20 pp.

Swenk, M. H. 1933. The present status of the whooping crane. Nebraska Bird Review 1:111-129.

U. S. Fish and Wildlife Service. 1986. Whooping Crane Recovery Plan. U. S. Fish and Wildlife Service, Albuquerque, New Mexico. 283 pp.