

2016

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Recommended Citation

Jorgensen, J.G., and L.R. Dinan. 2016. Whooping Crane (*Grus americana*) behavior, habitat use and wildlife watching visitation during migratory stopover at two Wildlife Management Areas in Nebraska 2015-2016. Nongame Bird Program of the Nebraska Game and Parks Commission. Lincoln, NE.

ACKNOWLEDGEMENTS

Whooping Crane stopovers summarized in this report resulted in formal closures of two Wildlife Management Areas (WMAs) for extended periods. Initial decision to close the WMAs required coordination between Nebraska Game and Parks Commission (NGPC) Wildlife and Law Enforcement Divisions. Additional assistance to effectively and efficiently provide information to the public about the closures was done in coordination with NGPC's Communication Division. We thank Scott Taylor, Jeff Hoffman, Karie Decker, Pat Molini, Tom Welstead, Brad Seitz, Warren Schwanebeck, Richard Souerdyke, Craig Stover, Duane Arp, Christy Rasmussen, Cara Pesek and Jerry Kane for their efforts. On-the-ground-implementation of closures and extended hours of monitoring Whooping Cranes and visitors was conducted by area managers and staff that included Brad Seitz, Richard Souerdyke, Warren Schwanebeck, Brad Niemann and Brandon Esch. We thank Brad Seitz, Richard Souerdyke, Karie Decker and Ted LaGrange who assisted in the monitoring of the Whooping Cranes and collected habitat and behavior data used in this report. Mary Bomberger Brown and Edward J. Raynor reviewed drafts of this report and provided numerous helpful comments that improved its content and presentation. We also thank all the interested individuals that came to Father Hupp and Wilkinson WMAs to view and experience the Whooping Cranes. Funding was provided by the Nebraska Wildlife Conservation Fund, Nebraska State Wildlife Grant Program and the U.S. Fish and Wildlife Service Wildlife and Sportfish Restoration Program - Wildlife Surveys and Inventories - Project W-15-R.



The Whooping Crane (*Grus americana*) is one of the rarest bird species in the world (Harrell and Bidwell 2013). Whooping Cranes are listed as endangered by the United States and Canada under their respective Endangered Species Acts (CWS and USFWS 2007) and by the Nebraska Nongame and Endangered Species Conservation Act. Whooping Crane numbers in the Aransas-Wood Buffalo (AWB) flock, the only self-sustaining wild population, were estimated to be as low as 14 adults and 4 juveniles during the winter of 1938-1939 (CWS and USFWS 2007). During the winter of 2014-2015, the estimated size of the AWB flock was 308 individuals (USFWS 2015). Birds in the AWB flock migrate more than 3,500 km twice each year through the Great Plains of North America between their breeding grounds in Wood Buffalo National Park, Canada, and wintering sites in and around Aransas National Wildlife Refuge, Texas. Annually in spring and fall, usually all of the Whooping Cranes in the AWB flock migrate through Nebraska. Many birds in the AWB flock interrupt their migration and stop at sites in Nebraska where they locate nighttime roost sites, rest and feed. Migratory stopover in Nebraska is therefore an important part of their survival, conservation and recovery.

Even though the entire AWB Whooping Crane flock migrates through Nebraska, Whooping Cranes have been observed using Nebraska Game and Parks Commission (NGPC) properties on only seventeen occasions prior to the fall of 2015. Most of these observations at NGPC properties occurred in remote areas, such as the upper end of large water bodies (e.g., Calamus and Sherman Reservoirs) in central Nebraska where birds were unlikely to interact with humans. During fall 2015 and spring 2016, Whooping Cranes stopped over at two relatively small Wildlife Management Areas (WMA) owned and managed by NGPC. From 14 November to 2 December 2015, six Whooping Cranes (5 adults and 1 juvenile) stopped-over at Father Hupp WMA, Thayer County (Figure 1). From 25 March to 4 April 2016, three adult Whooping Cranes stopped-over at Wilkinson WMA, Platte County (Figure 1). During these two stopovers, NGPC closed the WMAs to public access and assigned personnel at each site to monitor human visitors. In this report, we summarize 1) events and general circumstances of each stopover, 2) Whooping Crane habitat use and behavior using data collected by NGPC staff, and 3) visitation by the public who came to the WMAs to view the Whooping Cranes.

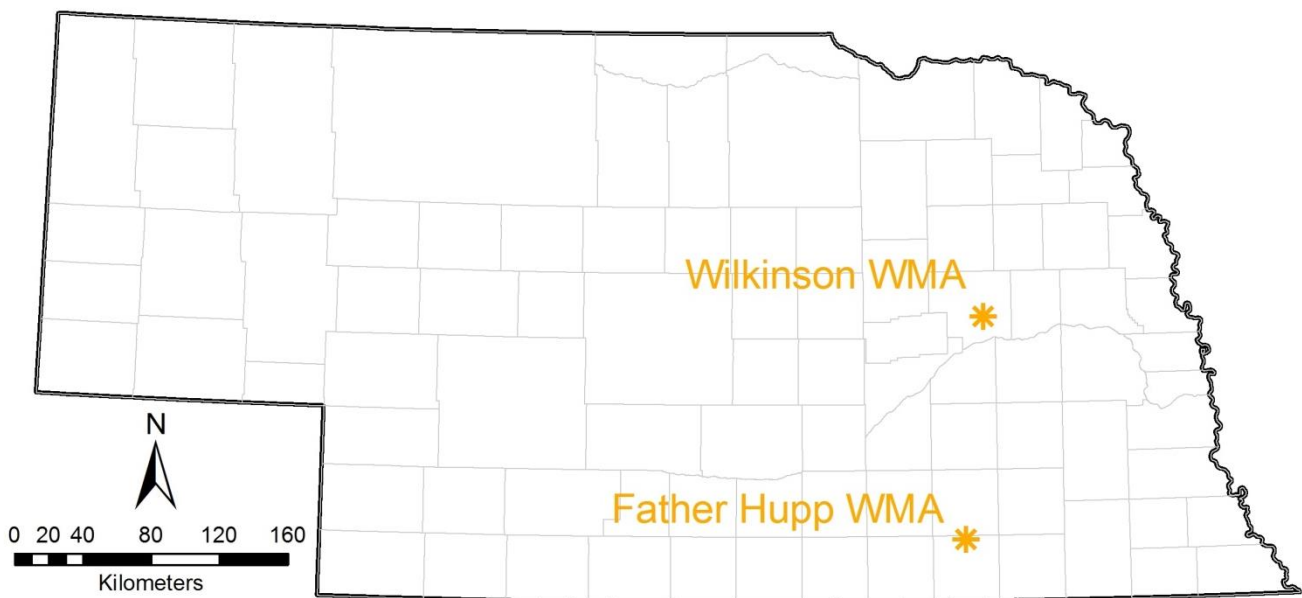


Figure 1. Location of Father Hupp and Wilkinson Wildlife Management Areas in Nebraska.

Section I: General event summaries and background information

FATHER HUPP WMA

Father Hupp WMA totals 160 acres and covers a portion of a large, albeit altered, Rainwater Basin wetland imbedded within an agricultural landscape. The private portion of the wetland is drained by a ditch located at the eastern side of the wetland footprint. In 2012, the Nebraska Game and Parks Commission (NGPC) partnered with Ducks Unlimited, the Rainwater Basin Joint Venture, U.S. Fish and Wildlife Service (USFWS), and the Nebraska Environmental Trust in an extensive restoration project at Father Hupp WMA; restoration of the wetland was completed in 2013. The restoration and current management at Father Hupp WMA, including pumping of supplemental ground water during the fall of 2015, has focused on providing habitat for migratory waterbirds (e.g., waterfowl, shorebirds, cranes, etc).

On 14 November 2015, six Whooping Cranes (five adults and one juvenile) were reported at Father Hupp WMA. The initial report from the public was received by NGPC staff on Saturday, 14 November 2015, during the opening weekend of firearm deer hunting season. Most personnel in NGPC's Wildlife Division, which include WMA managers, were assigned to deer check stations from 8:00 CST to 20:00 CST and the report was not immediately investigated. NGPC Biologist Richard Souerdyke confirmed the presence of the six Whooping Cranes on the morning of Monday, 16 November 2015. Immediately after the cranes were confirmed to be occupying the WMA, NGPC executed a full public closure of the WMA. Considerable public use was anticipated to occur at this site because waterfowl hunting seasons were open and waterfowl were using the WMA. NGPC distributed a press release informing media and the public about the closure and "Area Closed" signs were placed at parking areas around the perimeter of the WMA (Figure 2). Beginning 16 November 2015, NGPC personnel were present at the site before dawn and during most daylight hours to monitor the birds and interact with the public to ensure people did not disturb the cranes. Monitoring was limited during periods of inclement weather and near the end of the birds' stopover period. The Whooping Cranes were observed only using the WMA portion of the wetland and adjacent, privately-owned, agricultural fields (Figure 3).



Figure 2. "Area Closed" sign, wetland conditions and Whooping Cranes at Father Hupp WMA. Whooping Cranes are in the distance immediately below the trees.

The six Whooping Cranes at Father Hupp WMA included one family group (one adult male, one adult female, and one juvenile), a pair, and an unpaired adult. The cranes were typically observed in two sub-groups: the pair and the lone adult in one group and the family group in the other. The Whooping Cranes stayed within a relatively small area of approximately 60-80 acres during their entire stay, moving between the wetland within the WMA and an adjacent corn field immediately north of the WMA (Figure 3). The Whooping Cranes were not observed using the altered, privately-owned, portion of the wetland to the east of the WMA. NGPC staff were not present when the cranes departed. However, two observers from the public (Shari Schwartz and John Carlini) reported that the birds departed on 1 December 2015 at approximately 9:50 CST. After the cranes were no longer using the area, imagery from time-lapse cameras placed in the WMA to monitor wetland conditions was recovered and showed the six Whooping Cranes arrived at the site on the evening of 13 November 2015 (Figure 4).

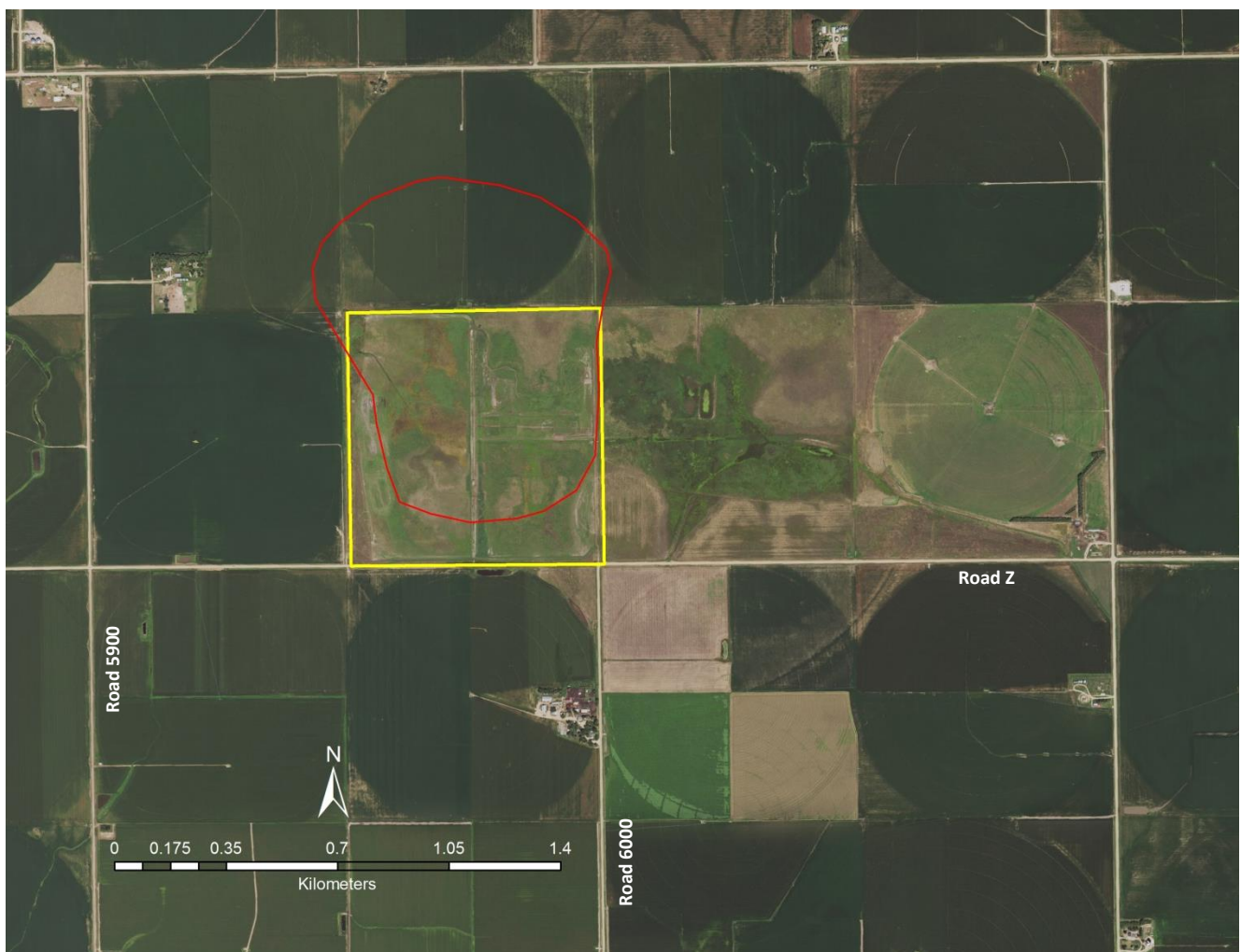


Figure 3. Father Hupp WMA, bounded by the yellow polygon, and the surrounding landscape. The red polygon shows the area the Whooping Cranes were observed using during their 19-day stopover.



Figure 4. Photograph from a time-lapse camera from the evening of 13 November showing the six Whooping Cranes at Father Hupp WMA at dusk.

WILKINSON WMA

Wilkinson WMA totals 939 acres, including approximately 300 acres of restored wetland. Wilkinson WMA encompasses most of the area that historically was a wetland on a poorly drained area of the Shell Creek watershed (Farrar 1998). The wetland was drained shortly after settlement by European Americans (Farrar 1998). Local landowners petitioned the Platte County clerk in 1902 to widen and deepen an existing drainage ditch to further improve the suitability of the area for cultivation (Farrar 1998). The ditch was referred to as the “Carrig & Jewel” drainage ditch and that name was applied to the wetland which once existed at this location. Attempts to farm the wetland had limited success. In the mid- to late 1990s, a portion of the area was purchased from willing sellers and restored through a partnership that included the Nebraska Environmental Trust, NGPC, Todd Valley Wetland Foundation, Ducks Unlimited, U.S. Fish and Wildlife Service, USDA Natural Resources Conservation Service, and Pheasants Forever (Farrar 1998).

On 27 March 2016, NGPC Biologist Warren Schwanebeck confirmed the presence of three adult Whooping Cranes at Wilkinson WMA. Local residents reported the birds were present as early as 25 March 2016. The Whooping Cranes were observed only in the eastern third of the WMA, the portion between U.S. Highway 81 and 280th Ave (Figure 5). During the early morning of 28 March 2016, the Whooping Cranes were not observed at the WMA and were believed to have used a Nebraska Department of Roads wetland mitigation site before returning to Wilkinson WMA in the late morning. The portion of the WMA the Whooping Cranes used underwent vegetation management (cattle grazing) the previous growing season. NGPC executed a partial or “soft” closure of the WMA since the birds were using only a portion of the WMA and public use was expected to be minimal because no hunting seasons were open. “Area Closed” signs were erected along the county road

on the perimeter of the cells where the Whooping Cranes were observed (Figure 6), but initially no press releases or other formal announcements were made. NGPC assigned staff to monitor the Whooping Cranes and human activity at the WMA during a majority of daylight hours, with the exception of early morning and late evenings.

On 30 March 2016, an article (Blum 2016) about the Wilkinson WMA Whooping Cranes was published online and in print by the Columbus Telegraph, which greatly increased the public's awareness of the cranes' presence. Shortly thereafter on 30 March, NGPC issued a press release announcing the formal closing of the eastern portion of the WMA. NGPC staff was present at the WMA from dusk to dawn after the newspaper article was published to monitor the birds and the public. Of particular concern at Wilkinson WMA was the presence of a distribution power line that bisects the wetland (Figure 5). Whooping Cranes typically avoid areas with power lines (Johns et al. 1997). However, the Wilkinson WMA Whooping Cranes were often in close proximity (as close as approximately 30 m; Figure 7) of the power line. NGPC personnel were concerned that a person approaching the cranes might spook the birds, causing them to take flight abruptly, and a bird(s) might collide with the lines causing injury or death. The Whooping Cranes were not observed on 5 April 2016 and apparently migrated north on favorable southerly winds the previous day.

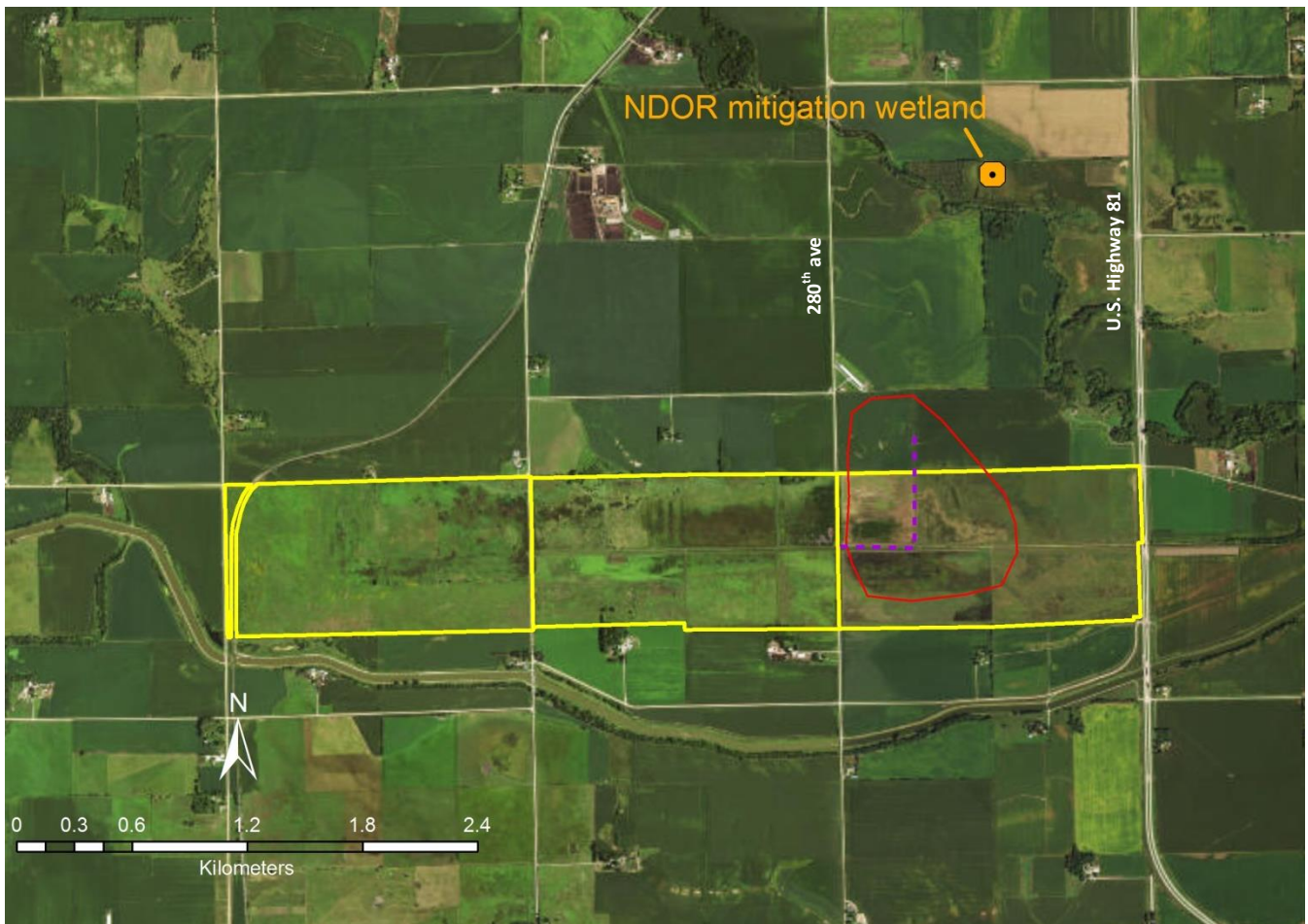


Figure 5. Wilkinson WMA, bounded by the yellow polygon, and the surrounding landscape. The red polygon shows the area where the Whooping Cranes were observed. The purple dashed line shows the location of the distribution power line that bisects the interior of the wetland between U.S. Highway 81 and 280th Ave. The orange icon shows the location of the Nebraska Department of Roads wetland mitigation site.



Figure 6. "Area Closed" sign and wetland conditions at Wilkinson WMA during the Whooping Crane's stopover. The Whooping Cranes are visible in the distant cornfield north of the WMA.



Figure 7. Two of the three Whooping Cranes in close proximity to a distribution power line present in the interior of the wetland at Wilkinson WMA. U.S. Highway 81 is visible in the background.

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Section II: Whooping Crane (*Grus americana*) behavior and habitat use during migratory stopover at two restored palustrine wetlands imbedded in agricultural landscapes in Nebraska

Effective conservation and management of wildlife occupying human-dominated agricultural landscapes must be based on understanding how altered, natural, and restored habitats affect native species (Miller and Cale 2000). In the Great Plains of North America, this includes understanding how widely dispersed and isolated wetlands located within agricultural landscapes are used by birds during migration (Niemuth et al. 2006). Migration is an important and potentially dangerous life history event in the annual cycle of many birds. Individuals must locate safe stopover habitats that provide sufficient food resources needed to replenish their energy reserves so that they are able to continue on and complete their migration (Alerstam and Högstedt 1982). Conditions at stopover locations experienced during migration may impact subsequent life history events such as reproduction (Newton 2006). Individuals that fail to find sufficient food resources or expend disproportionate energy during migratory stopovers may arrive in breeding areas in poor physical condition, or not at all, and are thus will be less likely to breed successfully (Newton 2006).

Whooping Cranes (*Grus americana*) are one of the most critically endangered species in the world. Whooping Cranes of the only wild, self-sustaining population, the Aransas–Wood Buffalo (AWB) flock, migrate through the Great Plains of North America between their wintering areas on the Texas Gulf Coast, USA, to breeding sites in northwestern Alberta, Canada, twice each year. During migration, Whooping Cranes stopover and use wetlands and riverine habitats for nighttime roosting and for daytime feeding. They also use adjacent terrestrial habitats for daytime feeding (Richert 1999). Since settlement by European Americans, a substantial proportion of wetlands in the Great Plains have been destroyed or altered with a high proportion of these areas converted to row-crop agriculture (Smith 2003, Samson et al. 2004). The types, amount, and distribution of habitats, as well as threats, in landscapes which Whooping Cranes (and other birds) utilize during migration today are different than prior to settlement by European Americans. Understanding the role and relative importance of different habitats, including spatially-isolated wetland habitats within agricultural landscapes, is important in providing habitat of sufficient quality and quantity for migrating Whooping Cranes and other migratory birds.

A first step in identifying Whooping Crane's resource needs during migratory stopover is to document what behaviors birds are engaged in while using stopover habitats (McCarty et al. 2009). Even though Whooping Crane migratory stopovers have been extensively studied (Richert 1999, Johns et al. 1997, Austin and Reichert 2001), previous research focused largely on identifying the general characteristics and composition of stopover sites (Armbruster 1990, Richert 1999, Austing and Richert 2001), roost sites (Lingle et al. 1984, 1986, Faanes et al. 1992) and feeding sites (Austin and Richert 2001). Previous studies have shown Whooping Cranes most often use palustrine wetlands, broad, shallow rivers, and lacustrine wetlands, as stopover sites (Austin and Richert 2001). In general, Whooping Cranes use riverine and wetland habitats primarily for nighttime roosting, and like Sandhill Cranes (*Antigone canadensis*), they are dependent on terrestrial agricultural fields for feeding (Austin and Richert 2005, Howe 1987, Lingle et al. 1991, Johns et al. 1997).

Whooping Cranes, like other migratory birds, must locate resources following their initial decision to stop in an area during migration. Considerably less research has focused on how Whooping Cranes use the available habitats during migratory stopovers. This is important to address because birds select habitats during migratory stopover at multiple spatial scales (Buler et al. 2007). Once individuals choose a site based on gross landscape attributes, they make subsequent decisions, usually in unfamiliar areas, about specific habitats to occupy in order to locate resources (Moore and Aborn 2000).

Johns et al. (1997) showed temporary and seasonal wetlands were used primarily for roosting and agricultural fields (i.e., wheat, barley fields) were used mostly for feeding. Lingle et al. (1991) studied Whooping Crane stopover behavior in Nebraska and found Whooping Cranes spent a majority (53%) of their time during the day in terrestrial habitats, mostly in agricultural fields (47% of all observations) and particularly (37% of all observations) in fields grown in corn the previous season. Other studies of Whooping Cranes using the central Platte River valley of Nebraska showed the birds may spend higher proportions, and even approaching as much as 100% of daytime observations, using agricultural habitats (Lingle and Howlin 2012, 2013, 2014, 2015). Lingle et al. (1991) also showed that cranes spent more time preening and engaging in social interactions in wetlands compared to terrestrial habitats. Habitat quality may indirectly impact behaviors of individuals during migratory stopover (Liu and Swanson 2014). Previous studies of Whooping Crane stopover behavior and habitat use did not consider variations in habitat quality and how it may influence crane behavior and habitat use during migratory stopover. For example, Lingle et al. (1991) lumped habitat types into general categories and specifically grouped riverine, reservoir, stock dams, natural and farmed wetlands and did not evaluate behavior by wetland type or quality.

Here, we studied Whooping Crane behavior and habitat use during extended stopovers at two palustrine wetlands imbedded in agricultural landscapes in Nebraska during their fall 2015 and spring 2016 migration. Wetland areas included portions which were restored and intensely managed to control vegetation height and structure for migratory waterbirds and portions which were altered and/or unmanaged. Surrounding agricultural landscape included an abundance of fields where corn or soybeans were grown during the previous growing season. Our goal is to evaluate Whooping Crane behavior and use of habitat during migratory stopover. Our hypothesis is that Whooping Crane behavior and use of habitats will be different at restored and managed wetlands compared to previous reports of Whooping Crane behavior and habitat use at wetlands and riverine habitats.

METHODS

We studied Whooping Cranes at the 160-acre Father Hupp Wildlife Management Area (WMA), Thayer County, during fall migration 2015 and the 936-acre Wilkinson WMA, Platte County, during spring migration 2016. Both properties are owned and managed by the Nebraska Game and Parks Commission (NGPC). Six Whooping Cranes that included a family group (adult male, female and juvenile), a pair of adults, and an unpaired adult were present at Father Hupp WMA from 14 November through 1 December 2015. Three adult Whooping Cranes that included an adult pair and one unpaired adult were present at Wilkinson WMA from 27 March to 5 April 2016. Habitat and behavior observations were conducted after each WMA was closed to public access and NGPC staff was assigned to monitor the birds and human visitors.

We used instantaneous sampling method (Altman 1974) to record behaviors every ten minutes of all six Whooping Cranes present at Father Hupp WMA. We followed the same approach at Wilkinson WMA but observers recorded behavior every five minutes to increase the number of observations. At both locations, individual birds were identifiable because of bands, plumage, or associations with other individual cranes (e.g., the mate of a banded bird). We identified individual cranes as follows:

Father Hupp WMA

- Alpha: Unbanded adult male in family group.
- Beta: Adult female with yellow band in family group.
- Juvenile: Juvenile associated with Alpha and Beta.
- Adult X: Adult male paired to Adult Y.
- Adult Y: Adult paired to Adult X.
- Unpaired: Unpaired adult.

Wilkinson WMA

- Male: Adult with green over white band on left leg, paired to Female.
- Female: Adult with yellow band and satellite transmitter on right leg, paired with Male.
- Unpaired: Unpaired adult.

We recorded the behaviors as follows: foraging (searching for, pecking at or consuming prey), resting (loafing or sleeping), self-maintenance (preening or bathing), locomotion (flying and walking while not engaged in another behavior), social interactions (dancing, chasing), and alert (stationary with neck upright and scanning area). All observers were experienced biologists and were provided definitions of individual behaviors to ensure behaviors were assigned consistently. We recorded the habitat each bird was using during each instantaneous sampling observation. Habitats in the immediate area of where all Whooping Cranes were observed included, 1) restored wetlands where vegetation management was recently conducted within each WMA, 2) privately owned and altered wetland habitats (Father Hupp WMA) or wetland areas not recently managed (Wilkinson WMA), 3) harvested agricultural fields with corn residue from the previous growing season (herein referred to as cornfield), and, 4) harvested agricultural fields with soybean residue from the previous growing season (herein referred to as soybean field). Both WMAs are imbedded within landscapes dominated by row crop agriculture and Whooping Cranes were < 0.5 km from agricultural fields at all times. On a small number of occasions, individual birds were out of view and not visible due to obstructions and thus behavior and/or habitat were not recorded.

We used data to construct diurnal time activity budgets showing the percent time each Whooping Crane spent in each behavior overall and while in specific habitats. We also provide basic summarizations of the total number of individual and total observations of behavior and habitat use by site, and summarizations of individual and total behavior observations by individual, habitat and hour of day. We tested whether behavior and habitat use was independent between individual cranes within family units and among all individual present within and between sites using Chi-square tests of independence. Whooping Cranes were observed making trips from the wetland to nearby agricultural fields, therefore, we calculated the temporal duration of trips and compared trip duration within site by individual and between sites using an one-way ANOVA. All statistical analyses were performed in Program R 3.1.3 (R Development Core Team 2014). Statistical significance was set at $P < 0.05$.

RESULTS

Whooping Cranes used Father Hupp WMA for 19 days and Wilkinson WMA for a minimum of nine days. The Whooping Crane's 19-day stay at Father Hupp WMA is the 4th longest stopover recorded during fall migration in Nebraska (n = 293) from 1941 to spring 2016 (USFWS - Nebraska Ecological Services Field Office 2016).

However, there are three other stopovers on record totaling 19 days. Mean recorded stopover length of all confirmed Nebraska reports during fall is 3.2 ± 0.3 days. The Whooping Cranes' nine-day stay at Wilkinson WMA is the 40th longest stopover during spring migration in Nebraska ($n = 406$) from 1941 to spring 2016 (USFWS - Nebraska Ecological Services Field Office 2016). However, there are nine other stopovers on record totaling 9 days. Mean recorded stopover length of confirmed Nebraska reports during spring is 4.1 ± 0.3 days.

From 16 November to 1 December 2015, NGPC staff spent a total of 129 hours monitoring the cranes and tallied 3,456 habitat and 3,235 behavior observations at Father Hupp WMA. From 30 March to 4 April 2016, NGPC staff spent a total of 70 hours monitoring cranes and tallied 2,106 habitat and 2,132 behavior observations at Wilkinson WMA.

Whooping Cranes spent a majority of their time using the restored and managed wetland at Father Hupp WMA (76% of all observations; Table 1, Figure 8) and at Wilkinson WMA (85%; Figure 9). Less time was spent in nearby cornfields at both Father Hupp WMA (24%) and at Wilkinson WMA (15%). Whooping Cranes were only observed using a soybean field at Father Hupp WMA, but < 1% of all observations were in this habitat type. Other than one morning when Whooping Cranes were absent at Wilkinson WMA and were believed to be using a wetland approximately 1 km away, Whooping Cranes traveled < 0.5 km from wetland to nearby agricultural fields at both sites. Whooping Cranes were not observed using the altered and privately-owned portion of the wetland adjacent to Father Hupp WMA or unmanaged wetland habitats at Wilkinson WMA. Individual crane habitat use was different from one another at Wilkinson WMA ($\chi^2 = 49.60$, $df = 10$, $p < 0.001$), but was not different at Father Hupp WMA ($\chi^2 = 17.74$, $df = 15$, $p < 0.28$). The pair and unpaired individual at Wilkinson WMA were less likely to occupy the same habitats compared to the cranes at Father Hupp WMA.

Foraging was the most frequently observed behavior at both sites (Table 2, Figure 10, 11), but Whooping Cranes spent more time foraging at Father Hupp WMA (54.6%) than at Wilkinson WMA (39.7%). At Father Hupp WMA, the second most frequently observed Whooping Crane behavior was resting (16%), followed by self-maintenance (11.5%), alert (10.8%), social interactions (4.4%) and locomotion (2.7%). At Wilkinson WMA, the second most frequently observed Whooping Crane behavior was self-maintenance (25.9%), followed by resting (11.4%), alert (9.5%), locomotion (8.8%) and social interactions (4.6%). Individual crane behavior was not different between individuals within family units at Father Hupp WMA (all p 's > 0.05). However, behavior of the paired male and female crane at Wilkinson was different from each other ($\chi^2 = 14.59$, $df = 5$, $p < 0.01$). Overall, individual crane behavior was different from one another at Father Hupp WMA ($\chi^2 = 67.91$, $df = 25$, $p < 0.001$) and Wilkinson ($\chi^2 = 46.75$, $df = 10$, $p < 0.001$), and also between sites ($\chi^2 = 328.15$, $df = 5$, $p < 0.001$).

Foraging was the most frequently observed behavior of cranes in both wetland and cornfield habitats at both sites (Figures 12, 13). A greater proportion of absolute time engaged in any one behavior was spent in wetland habitats compared to cornfields at both Father Hupp WMA (Figure 14) and Wilkinson WMA (Figure 15). Whooping Cranes were observed using wetland and agricultural fields throughout the day at both sites (Figure 16, 17). All behaviors were observed throughout the day (Figure 18, 19).

Whooping Crane feeding trips to agricultural fields were relatively brief, but were longer at Father Hupp WMA (30.84 ± 1.08 minutes; range 10 to 80 minutes) compared to Wilkinson WMA (23.44 ± 1.32 minutes; range 5 to 45 minutes) and the difference was significant ($F_{1,344} = 12.13$, $P < 0.001$). Duration of individual crane's trips to agricultural fields was not different from one another at Father Hupp WMA ($F_{5,262} = 1.73$, $P = 0.13$) or Wilkinson WMA ($F_{2,75} = 1.70$, $P = 0.19$).

Table 1. Summary of Whooping Crane habitat use observations at Father Hupp and Wilkinson WMAs. All Whooping Cranes spent similar proportions of time in each wetland and agricultural habitats. Values represent percent of all observations.

Individual	Wetland	Cornfield	Soybean Field
<u>Father Hupp WMA</u>			
Alpha (n = 576)	77.8	22.2	0.0
Beta (n = 576)	77.8	22.2	0.0
Juvenile (n = 576)	77.8	22.2	0.0
Adult X (n = 576)	73.8	25.7	0.5
Adult Y (n = 576)	73.8	25.7	0.5
Unpaired (n = 576)	74.8	25.0	0.2
Total (n = 3,456)	76.0	23.8	0.2
<u>Wilkinson WMA</u>			
Male (n = 704)	84.1	15.9	-
Female (n = 707)	83.9	16.1	-
Unpaired (n = 695)	86.3	13.7	-
Total (n = 2,106)	84.8	15.2	-

Table 2. Whooping Crane time activity budgets during migratory stopover at Father Hupp and Wilkinson WMAs. Whooping Cranes spent a higher proportion of their time foraging and engaged in self-maintenance in spring compared to fall. Values represent percent of all observations.

Bird ID	Foraging	Resting	Self-maintenance	Social Interaction	Locomotion	Alert
<u>Father Hupp WMA</u>						
Alpha (n = 542)	51.5	19.0	14.0	2.4	2.4	10.7
Beta (n = 540)	49.3	17.2	14.6	3.1	2.4	13.3
Juvenile (n = 542)	57.0	19.7	8.9	2.0	3.0	9.4
Adult X (n = 535)	54.0	14.6	10.3	6.2	2.8	12.1
Adult Y (n = 538)	58.0	12.5	10.4	5.9	2.4	10.8
Unpaired (n = 538)	57.8	13.2	11.0	6.5	3.2	8.4
Total (n = 3,235)	54.6	16.0	11.5	4.4	2.7	10.8
<u>Wilkinson WMA</u>						
Male (n = 705)	35.0	11.2	27.1	6.1	8.9	11.6
Female (n = 707)	38.3	9.9	29.7	2.4	9.5	10.2
Unpaired (n = 720)	45.6	13.2	13.2	5.4	8.1	6.8
Total (n = 2,132)	39.7	11.4	25.9	4.6	8.8	9.5

Table 3. Whooping Crane time activity budgets while using cornfield habitat during migratory stopover at Father Hupp and Wilkinson WMAs. Values represent percent of all observations.

Bird ID	Foraging	Resting	Self-maintenance	Social Interaction	Locomotion	Alert
<u>Father Hupp WMA</u>						
Alpha (n = 124)	76.6	1.6	0.8	3.2	3.2	14.5
Beta (n = 124)	71.8	1.6	0.8	5.6	5.6	16.9
Juvenile (n =123)	78.9	2.4	0.8	3.3	3.3	11.4
Adult X (n = 138)	75.4	2.9	0.0	5.8	5.8	14.5
Adult Y (n = 139)	77.7	0.7	0.0	5.0	5.0	14.4
Unpaired (n = 140)	80.0	0.7	0.0	5.7	5.7	11.4
Total (n = 788)	76.8	1.6	0.4	4.8	4.8	13.8
<u>Wilkinson WMA</u>						
Male (n = 112)	58.0	0.9	1.7	8.0	16.9	14.2
Female (n = 114)	58.8	1.7	4.3	3.5	18.4	13.1
Unpaired (n = 95)	68.4	0.0	1.1	8.4	12.6	9.4
Total (n = 321)	61.4	0.9	2.5	6.5	16.2	12.5

Table 4. Whooping Crane time activity budgets while using wetland habitat during migratory stopover Father Hupp and Wilkinson WMAs. Values represent percent of all observations.

Bird ID	Foraging	Resting	Self-maintenance	Social Interaction	Locomotion	Alert
<u>Father Hupp WMA</u>						
Alpha (n = 418)	44.0	24.2	17.9	2.2	2.2	9.6
Beta (n = 416)	42.5	21.9	18.8	2.4	2.2	12.3
Juvenile (n =419)	50.6	24.8	11.2	1.7	2.9	8.8
Adult X (n = 395)	51.4	16.7	14.2	5.8	2.5	9.4
Adult Y (n = 395)	50.3	17.5	15.0	6.3	3.6	7.4
Unpaired (n = 394)	46.8	18.7	13.9	5.8	3.3	11.4
Total (n = 2,437)	47.8	20.7	15.2	4.0	2.7	9.8
<u>Wilkinson WMA</u>						
Male (n = 593)	30.7	13.2	31.9	5.7	7.4	11.1
Female (n = 593)	34.4	11.5	34.6	2.2	7.8	9.6
Unpaired (n = 625)	42.1	15.2	30.0	5.0	7.4	6.4
Total (n = 1,811)	35.8	13.3	30.0	4.3	7.5	9.0

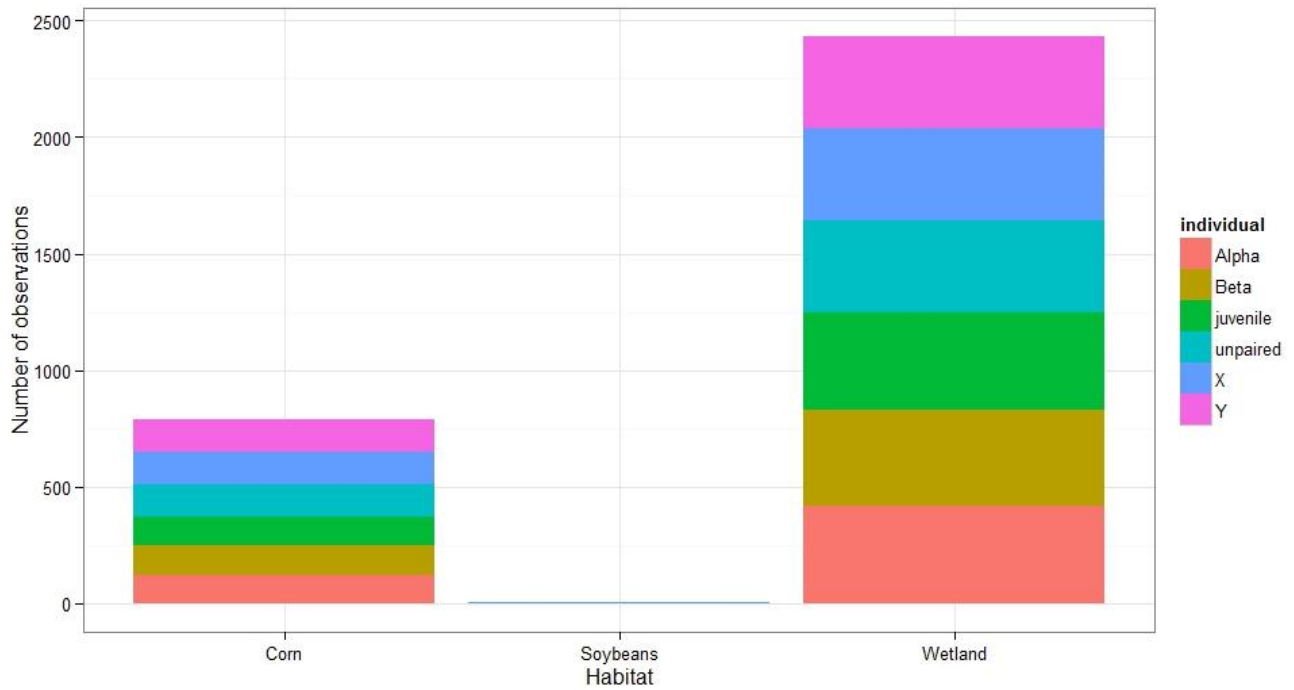


Figure 8. Habitat use by individual Whooping Crane at Father Hupp WMA during fall 2015.

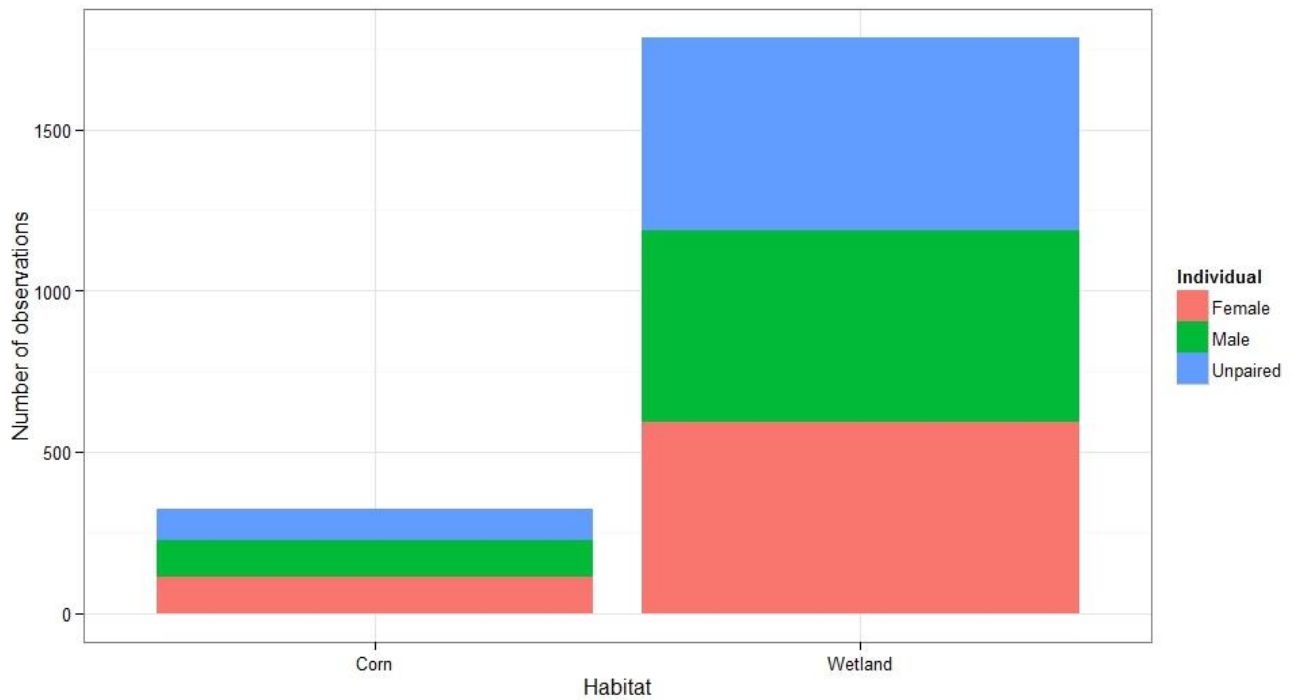


Figure 9. Habitat use of individual Whooping Crane at Wilkinson WMA during spring 2016.

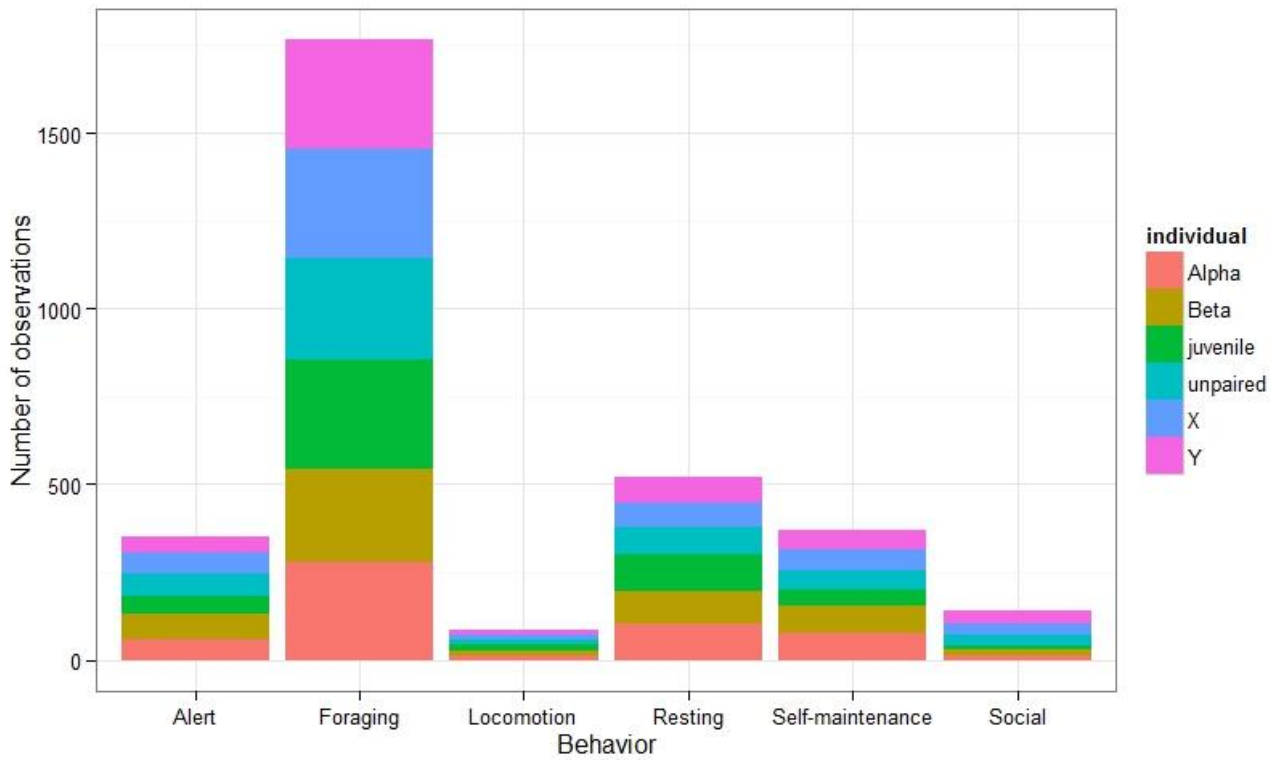


Figure 10. Behavior type observations summary by individual at Father Hupp WMA.

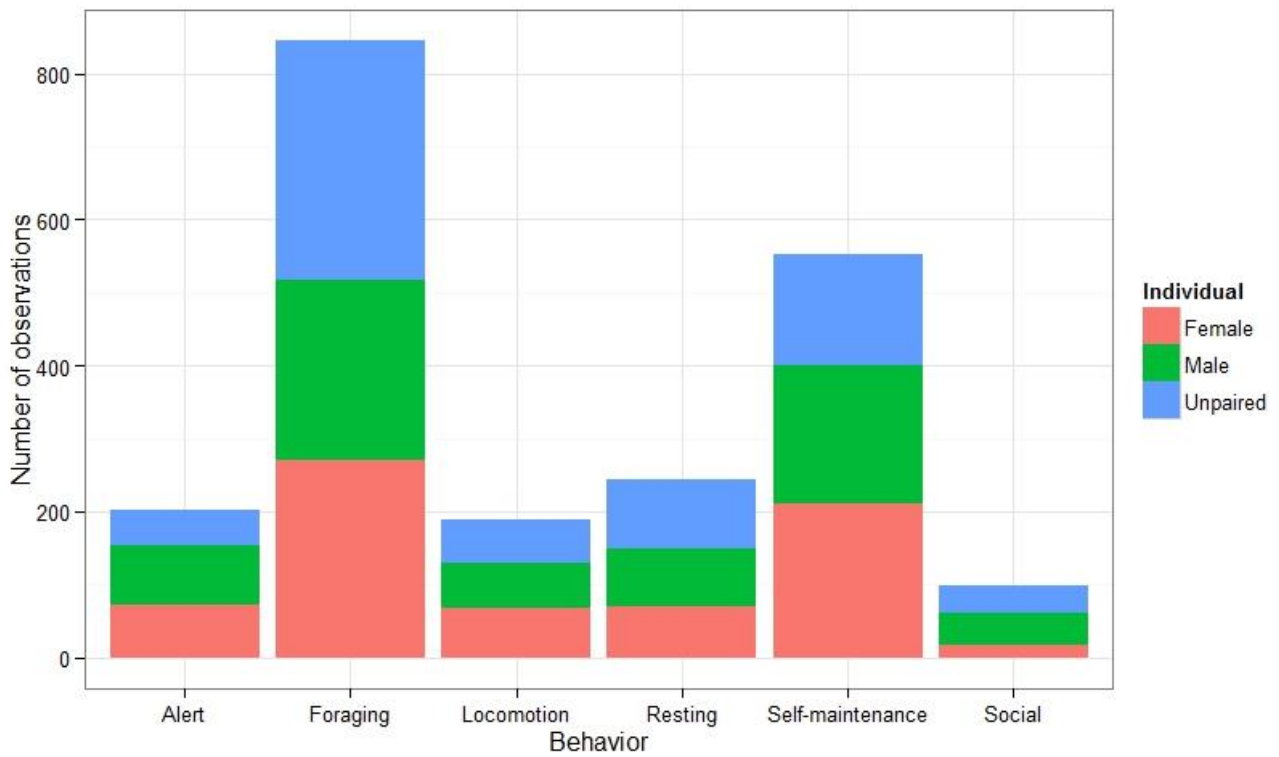


Figure 11. Behavior observations summary by individual at Wilkinson WMA.

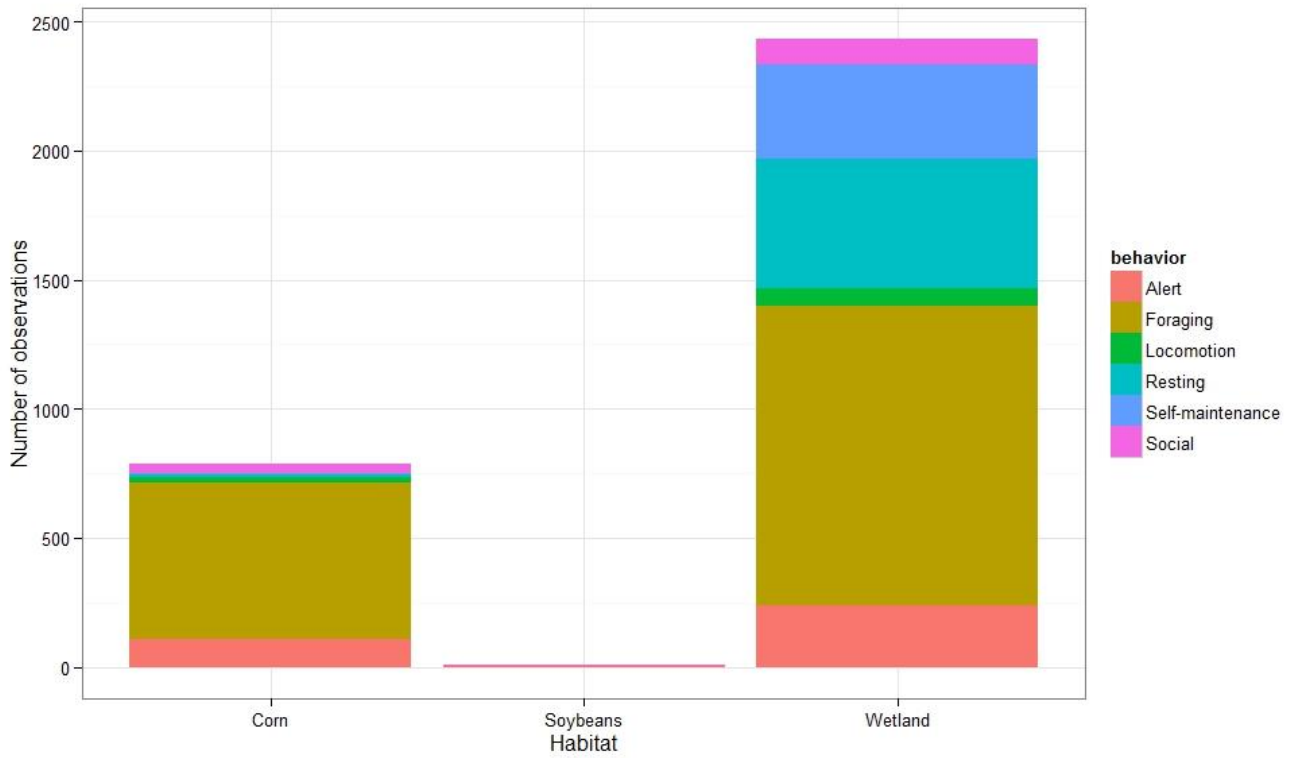


Figure 12. Individual Whooping Crane behavior observation summary by habitat at Father Hupp WMA.

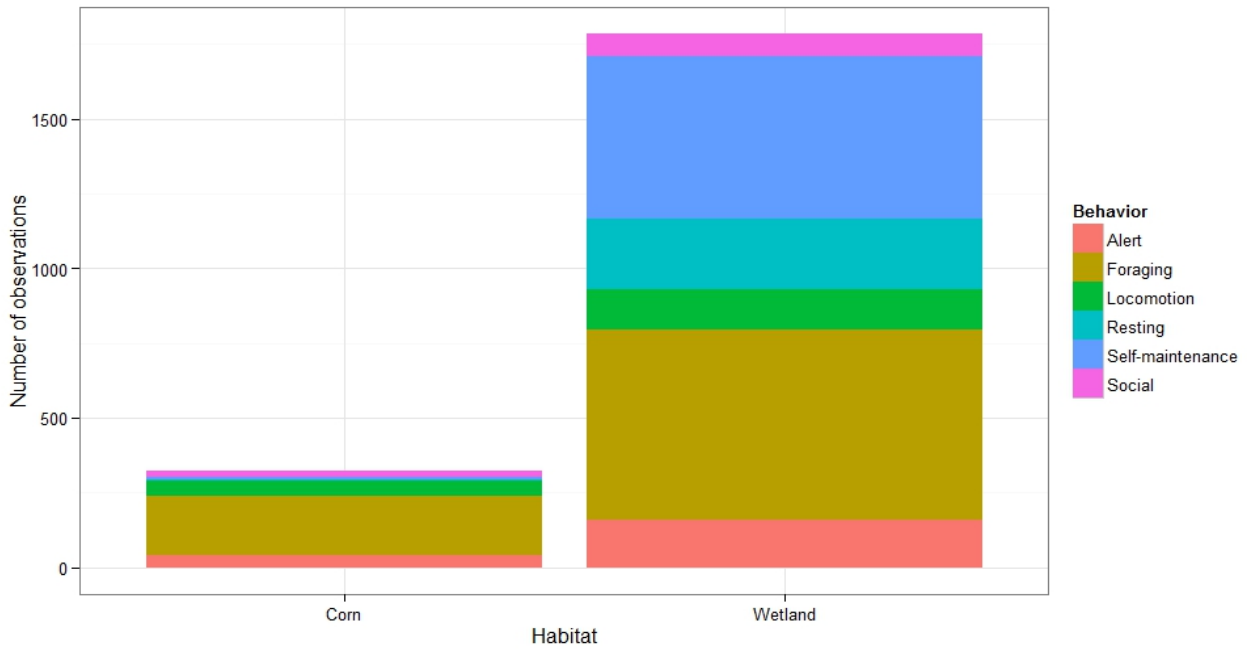


Figure 13. Individual Whooping Crane behavior observation summary by habitat at Wilkinson WMA.

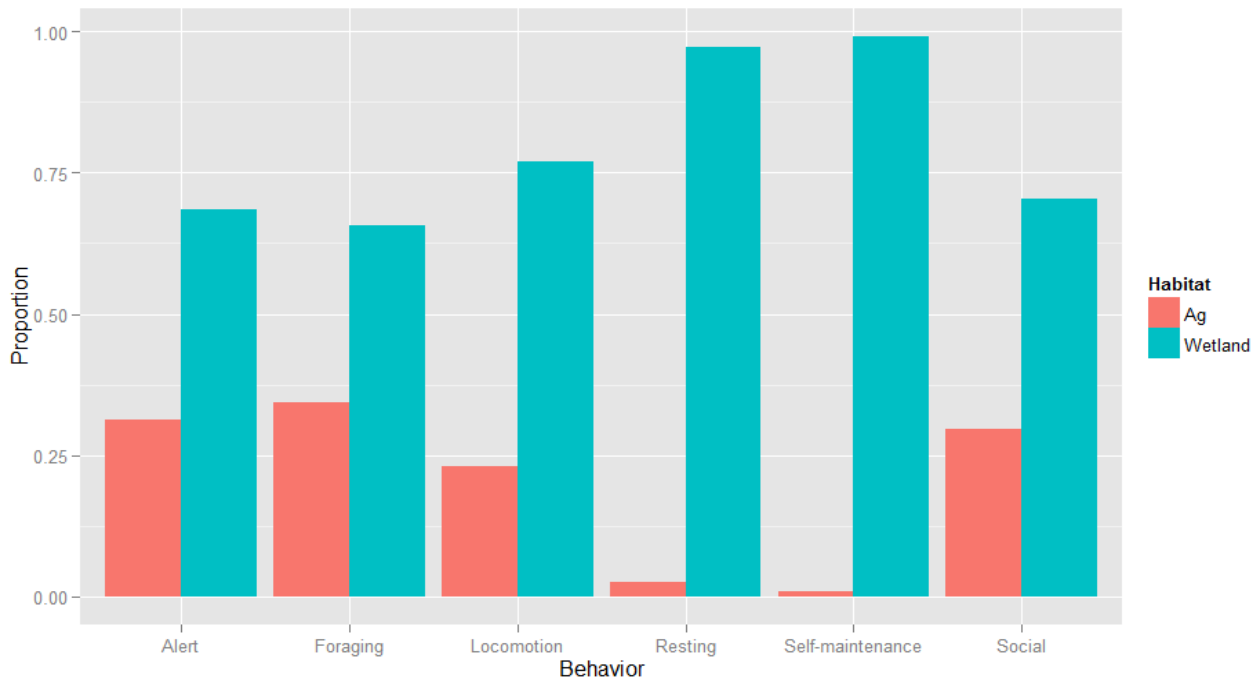


Figure 14. Proportion of each behavior observed by habitat at Father Hupp WMA. Total proportion of each individual behaviors = 1. A greater proportion of Whooping Cranes time engaged in any one behavior was observed in wetlands.

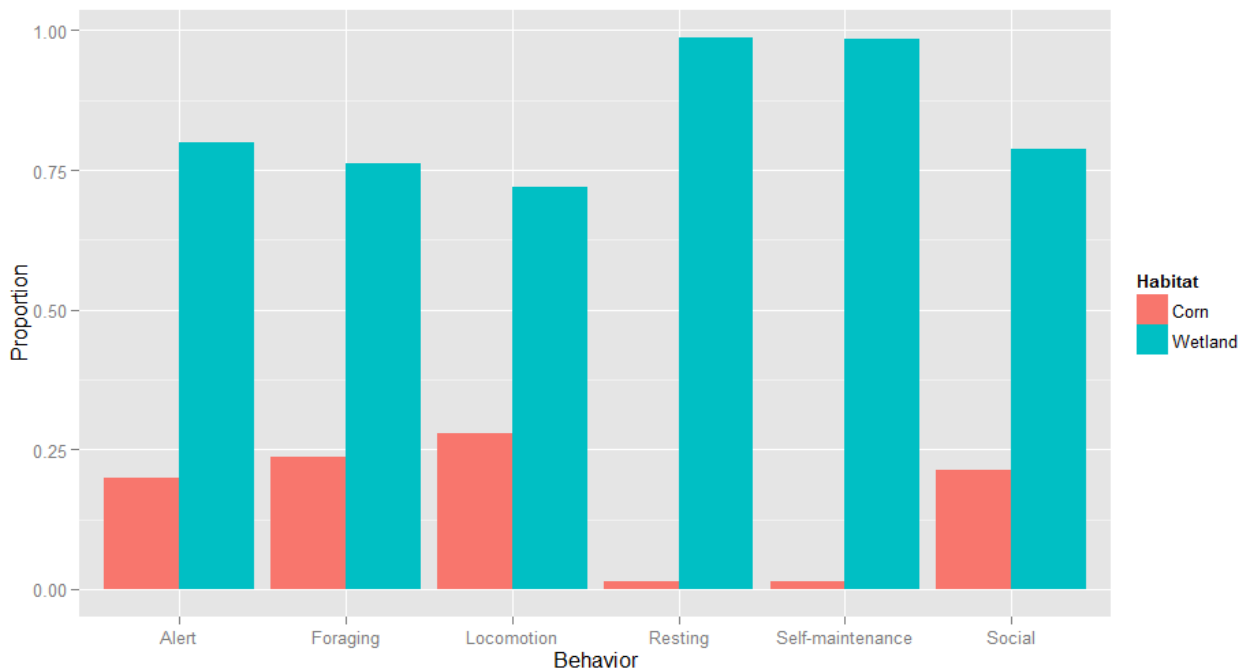


Figure 15. Proportion of each behavior observed by habitat at Wilkinson WMA. Total proportion of each individual behaviors = 1. A greater proportion of Whooping Cranes time engaged in any one behavior was observed in wetlands.

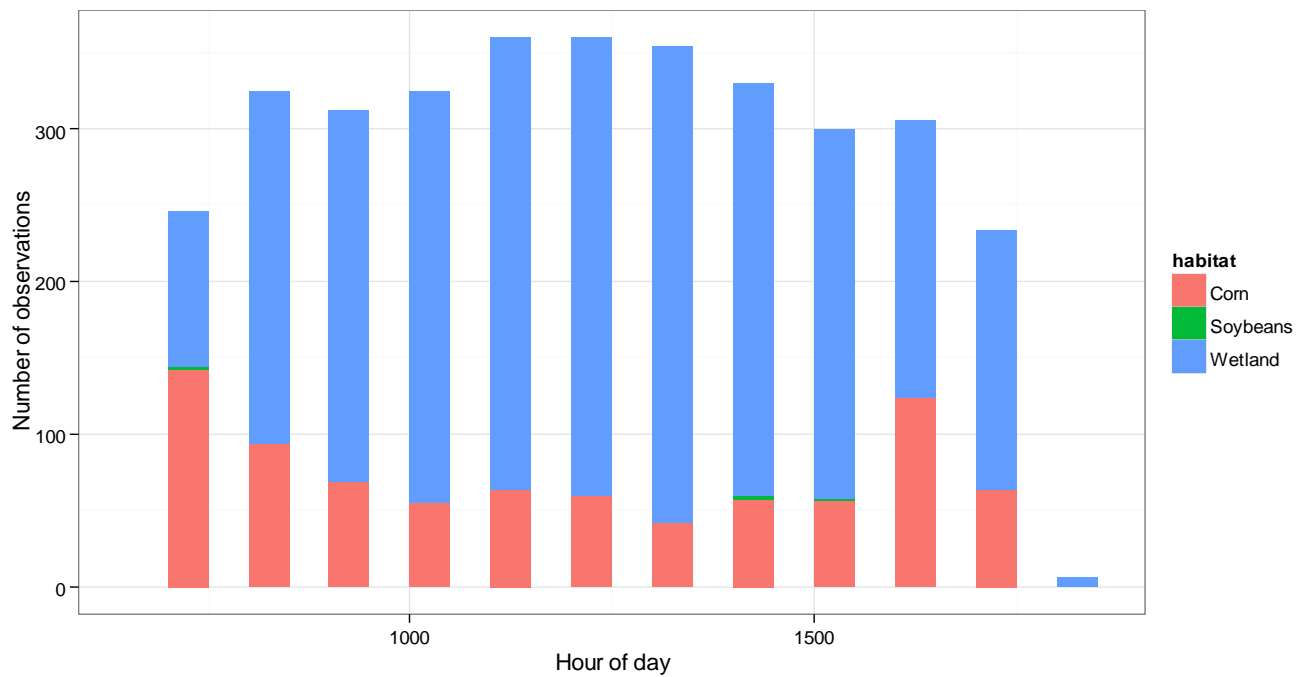


Figure 16. Number of habitat observations by hour of day of all Whooping Cranes at Father Hupp WMA during spring 2015.

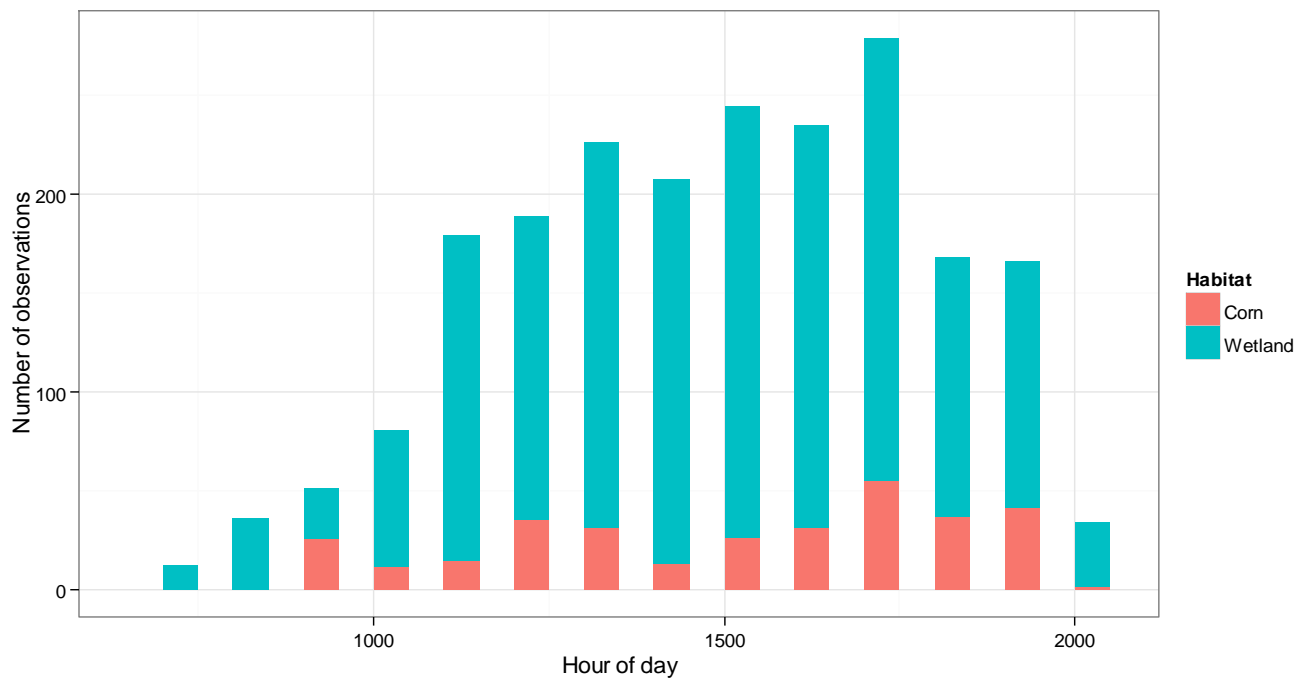


Figure 17. Number of habitat observations by hour of day of all Whooping Cranes at Wilkinson WMA during fall 2016.

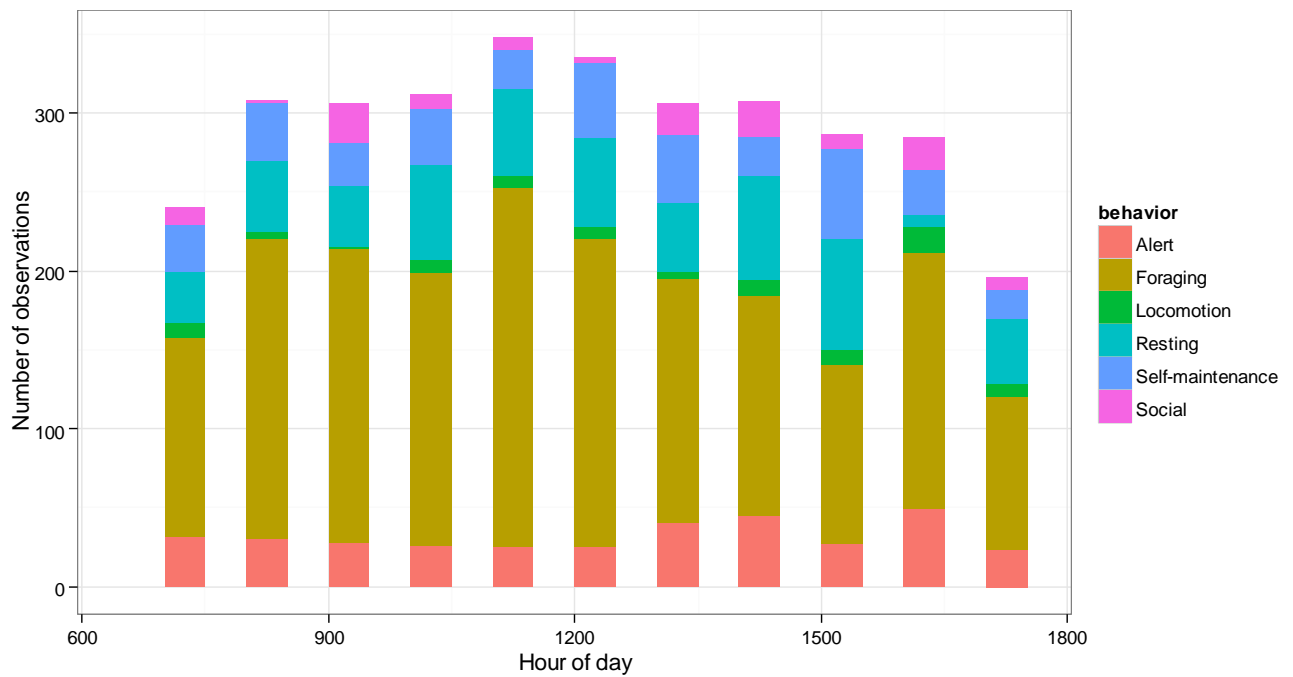


Figure 18. Whooping Crane behavior summary by hour of day at Father Hupp WMA.

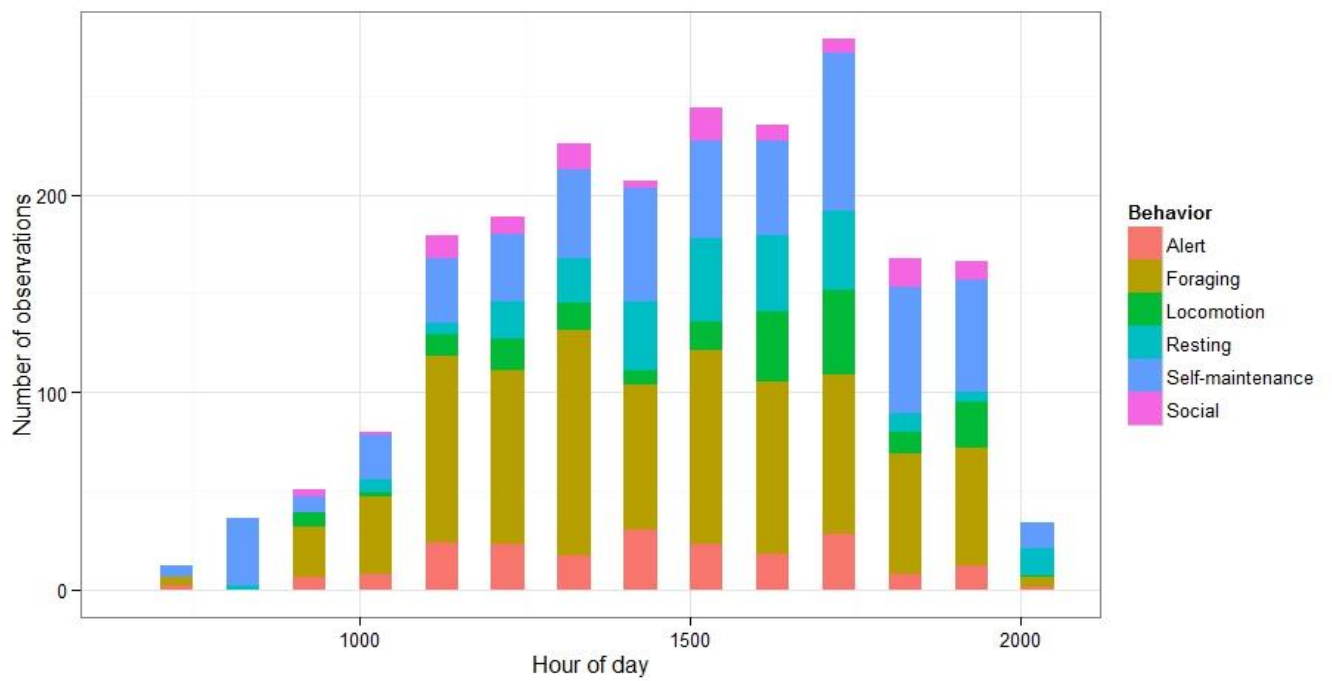


Figure 19. Whooping Crane behavior summary by hour of day at Wilkinson WMA.

DISCUSSION

In this study, Whooping Cranes used two restored and managed palustrine wetlands imbedded within agricultural landscape for nighttime roosting and for significant proportions of their daytime activities. Whooping Cranes rested and engaged in self-maintenance almost entirely in restored and managed wetlands at Father Hupp and Wilkinson WMAs. Whooping Cranes spent a greater proportion of time engaged in all behaviors, including foraging, in wetlands compared to agricultural fields (cornfields). Whooping Cranes generally made short flights (<0.5 km) to adjacent cornfields and usually spent < 1 hour in those fields, primarily foraging, before returning to the wetland.

Our results are somewhat different than other studies which showed Whooping Cranes used wetland sites primarily for nighttime roosting and agricultural habitats primarily for daytime use, including foraging. Previous research (Lingle et al. 1991) showed Whooping Cranes used agricultural fields for larger proportions of time compared to other habitats during daylight hours in Nebraska during migratory stopover. Furthermore, additional work (Lingle and Howlin 2012, 2013, 2014, 2015) from the central Platte River valley showed Whooping Cranes traveled up to 8.4 km to use agricultural fields during the day and spent a majority of their time in those habitats. For example, 50.5 hours of Whooping Crane behavioral observations from the central Platte River valley in spring 2012 were of birds using only agricultural fields (Lingle and Howlin 2012). In the central Platte River valley, wetland habitats have been greatly reduced over time due to alterations to rivers flows and changes in land use (LaGrange 2005, Currier et al. 1985) and wetland habitats are now limited, and thus often not available to Whooping Cranes, in this region.

Habitats used by Whooping Cranes at both Father Hupp and Wilkinson WMA had been restored and recently underwent targeted vegetation management, specifically cattle grazing (B Seitz, W. Schwanebeck and T. LaGrange, personal communications). At Father Hupp WMA water levels were augmented by groundwater pumping (B. Seitz, personal communication). Since Whooping Cranes were not observed using altered and unmanaged portions of the wetlands, it is reasonable to conclude that, without restoration and management, habitat at these sites would not have been suitable or favorable for Whooping Cranes. These observations stress the importance of restoration and management efforts of widely-dispersed and/or isolated wetlands that provide stopover habitat and resources for migratory waterbirds, including Whooping Cranes, in landscapes, such as the Rainwater Basin, which are now dominated by agriculture in Nebraska.

Whooping Cranes habitat use during migration stopover is flexible (Urbanek and Lewis 2015). Since there is variation in the types, amount, distribution, and quality of habitats available to Whooping Cranes when migrating through Nebraska and elsewhere, we would expect variation in Whooping Cranes behavior and use of these different habitats. Many landscapes in which Whooping Cranes stop over during migration in Nebraska are dominated by agriculture; corn and other agricultural fields are abundant. Lingle et al. (1991) concluded inadequate wetland habitat was an important factor limiting Whooping Crane occurrence and length of stay in Nebraska. It is interesting to note that the two stopover events summarized here were much longer than most Whooping Cranes stopovers in both spring and fall. Additional research should more closely scrutinize both short and long-term consequences of variation in Whooping Crane stopover habitats with emphasis on how an abundance or limited availability of high quality palustrine wetland habitat affects Whooping Cranes.

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Section III: Wildlife viewing summary at Father Hupp and Wilkinson Wildlife Management Areas during Whooping Crane stopovers

Nebraska Game and Parks Commission staff monitoring Whooping Cranes at Father Hupp and Wilkinson Wildlife Management Areas (WMA) counted the number of visitors who came to each WMA to view the birds (Figure 20). We recorded all observed visitors and provide summary of the number of wildlife viewers for each site. On some occasions, visitors were engaged in conversation. A total of 188 and 376 people visited Father Hupp and Wilkinson WMAs, respectively, to view and observe the Whooping Cranes. Visitors to Father Hupp WMA were from Nebraska, Kansas, Colorado and Iowa. Visitors to Wilkinson WMA were from Nebraska, but also included one party from northeast Kansas that made the trip with the sole purpose of seeing the cranes. Other individuals from Minnesota, South Dakota Michigan and North Carolina were visiting the central Platte River region of Nebraska to see the Sandhill Crane migration and made impromptu trips to Wilkinson WMA to see the Whooping Cranes. Most visitors remained in their vehicles while viewing the cranes. On a few occasions, visitors standing outside of their vehicles or on a raised dike were asked to reposition themselves in order to be less visible to the cranes. No major incidents (e.g., violation of the WMA closure that altered Whooping Crane behavior) with the public were encountered or observed.



Figure 20. Vehicles on county road as wildlife viewers observed the three Whooping Cranes. View from 280th north of Wilkinson WMA looking south.