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WHOOPING CRANE AND SANDHILL CRANE MONITORING AT FIVE WIND ENERGY FACILITIES

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Abstract: Biologists have expressed concern that individuals of the Aransas-Wood Buffalo Population of the federally-endangered whooping crane (*Grus americana*), numbering about 300, may be injured or killed by wind turbines during migration. To help address this concern and curtail (stop) turbine operations when whooping cranes approached turbines, we monitored the area around 5 wind energy facilities in North and South Dakota during spring and fall migration for whooping cranes and sandhill cranes (*G. canadensis*). Observers monitored cranes for 3 years at each facility from 2009 to 2013 (1,305 total days of monitoring), recording 14 unique observations for a total of 45 whooping cranes for which curtailment occurred during portions of 9 days. Observers also searched for dead cranes at the base of every turbine each day of monitoring. This resulted in approximately 92,022 cumulative individual inspections, during which no dead or injured cranes were detected. Based on our results and monitoring efforts at other wind energy facilities in the migration corridor, no whooping crane fatalities have been documented. Although migrating cranes use areas near turbines, they do not appear to be overly susceptible to collisions with wind turbines.

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Concerns have been raised regarding the impact that wind energy development may have on whooping cranes (*Grus americana*). In particular, there is concern for the Aransas-Wood Buffalo Population (AWBP), which migrates along a corridor with extensive wind energy development in the Great Plains of the United States (USFWS 2009, Stehn 2011). The AWBP is very small, consisting of about 300 individuals (Butler and Harrell 2016) and, along with all whooping cranes, is protected under the Endangered Species Act (USDOI OS 1967). Wind energy development may have direct impacts (i.e., mortality) and/or indirect impacts (i.e., a decrease in suitability of migratory habitat and/or displacement) on whooping cranes. Mortality seems to be the greatest concern, as expressed in the International Recovery Plan for the Whooping Crane (CWS and USFWS 2005): "The development of wind farms in the whooping crane migration corridor has the potential to cause significant mortality. Cranes could be killed directly by wind turbines or from colliding with new power lines associated with wind farm development. Management and research are needed to reduce this new threat."

Whooping cranes (and the closely related sandhill cranes [*Grus canadensis*]) are known for their susceptibility to collisions with power lines (e.g., Faanes 1987, Stehn and Wassenich 2008, APLIC 2012). For example, of 50 carcasses of whooping cranes recovered from 1950 to 2010, 10 individuals died from collision with power lines (with cause of death unknown for an additional 12 whooping cranes; Stehn and Haralson-Strobel 2014). Standard management guidelines for power lines discourage their placement near areas of crane use (APLIC 2012). Whereas power lines have been a fixture of the Great Plains landscape for decades, modern, industrial-sized turbines are a new potential threat (USFWS 2009).

The migration corridor used by the AWBP extends from southern Texas to the Northwest Territories and Alberta in northern Canada, and includes the U.S. states of North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas (Urbanek and Lewis 2015). In the middle of the corridor is a centerline representing the midpoint of the corridor (USFWS 2009). Whooping cranes use the migration corridor from roughly late March/early April to early May in spring and mid-September to mid-November in fall. The migration period is a vulnerable time because cranes may encounter storms in spring and fall; also recently fledged cranes will encounter hazards for the first time in new environments during the fall (Lewis et al. 1992,

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Stehn and Haralson-Strobel 2014).

Within the states crossed by the migration corridor, the number of wind turbines ranges from 583 turbines in South Dakota to 12,565 turbines in Texas (AWEA 2018); this includes areas outside of the corridor. Total area of these states ranges from 177,660 km^2 in Oklahoma to 676,587 km^2 in Texas (U.S. Census Bureau 2010). Development of wind turbines in all states along the migration corridor is ongoing (AWEA 2018).

Little is known for either species about whether use of an area is associated with increased risk of collision with turbines (USFWS 2009). No fatalities of whooping cranes have been attributed to collisions with wind turbines, but we know of 3 fatalities of sandhill cranes from collisions with wind turbines, all occurring outside of the migration period. One of these fatalities occurred between 2005 and 2007 at the Altamont Pass Wind Resource Area in California (Smallwood and Karas 2009) and 2 occurred on wintering grounds in Texas (Navarrete and Griffis-Kyle 2014). In a study of wintering sandhill cranes, Pearse et al. (2016) found only a slight overlap between the location of wind turbines in the Great Plains and winter habitat used by radio-tracked sandhill cranes before the towers came into existence. For other bird species, numerous factors have been studied regarding potential causes of collisions including characteristics of the birds, landscapes, and wind energy facilities, and correlations may be species and place dependent (e.g., Marques et al. 2014).

To address potential crane mortality, we developed and implemented standardized survey methods for monitoring use (defined as flying and/or standing) by whooping cranes and sandhill cranes at 5 wind energy facilities in North Dakota and South Dakota. Our objectives were to 1) identify whooping cranes using the area surrounding the facility during spring and fall migration periods, such that turbine operation could be curtailed (i.e., blades stopped) if whooping cranes were seen near the facilities; 2) document use (i.e., occurrence) of the facilities and surrounding areas by whooping cranes and sandhill cranes; and 3) document crane casualties. Although power lines are part of wind energy infrastructure, they were not evaluated in this study. Indirect effects were not specifically studied.

Because whooping cranes are rare, we also recorded observations of sandhill cranes in the Mid-Continent Population, which number in the hundreds of thousands with an overall stable population (Gerber et al. 2014). During each spring in 2009-2013, it is estimated that about 340,000 to 870,000 sandhill cranes passed through the Central Platte River Valley in Nebraska (Dubovsky 2016), which is located about 350 km south of the our southernmost study area. While similarly estimated numbers in North and South Dakota during migration are not known, in the Great Plains, sandhill cranes use a similar but broader migration path as whooping cranes and migrate during a similar timeframe—late February to late April in spring and mid-September to mid-December in fall (Gerber et al. 2014). Additionally, sandhill cranes use similar habitats during migration, are also susceptible to collisions with power lines (e.g., Murphy et al. 2009), and therefore may be at similar risks for collisions with turbines. They can be in the same locations as whooping cranes during migration and are protected under the Migratory Bird Treaty Act (USDOI 1918). Because of these similarities and relatively large population size, we consider the sandhill crane as a surrogate species for the whooping crane.

STUDY AREA

We monitored cranes at 5 wind energy facilities and associated buffer areas: PrairieWinds ND1, Baldwin, and Wilton Expansion facilities in North Dakota; and the Wessington Springs and PrairieWinds SD1 (also known as Crow Lake) facilities in South Dakota (Fig. 1). Although the Baldwin and Wilton Expansion facilities are adjacent, they were monitored in different years so are treated as separate facilities. A buffer area (i.e., land adjacent to but outside the facility) was delineated for each facility in order to focus efforts for curtailment, although this did not limit areas where observers could observe cranes. We used 1.6-km buffers to the outside of the turbines for the Prairie Winds ND1, Wessington Springs, Wilton Expansion, and combined Baldwin/Wilton Expansion studies, while 3.2-km buffers were used at Baldwin and PrairieWinds SD1. Buffer distances were determined based on direction from the U.S. Fish and Wildlife Service (USFWS) as well as permit conditions outlined in each project's Biological Assessment. Land covers were primarily grassland and cropfield, and the facilities ranged from 5 to 115 km from the centerline of the defined migration corridor of the AWBP of whooping cranes (Fig. 1, Table 1; USFWS 2009); the facilities are also in the broader migration

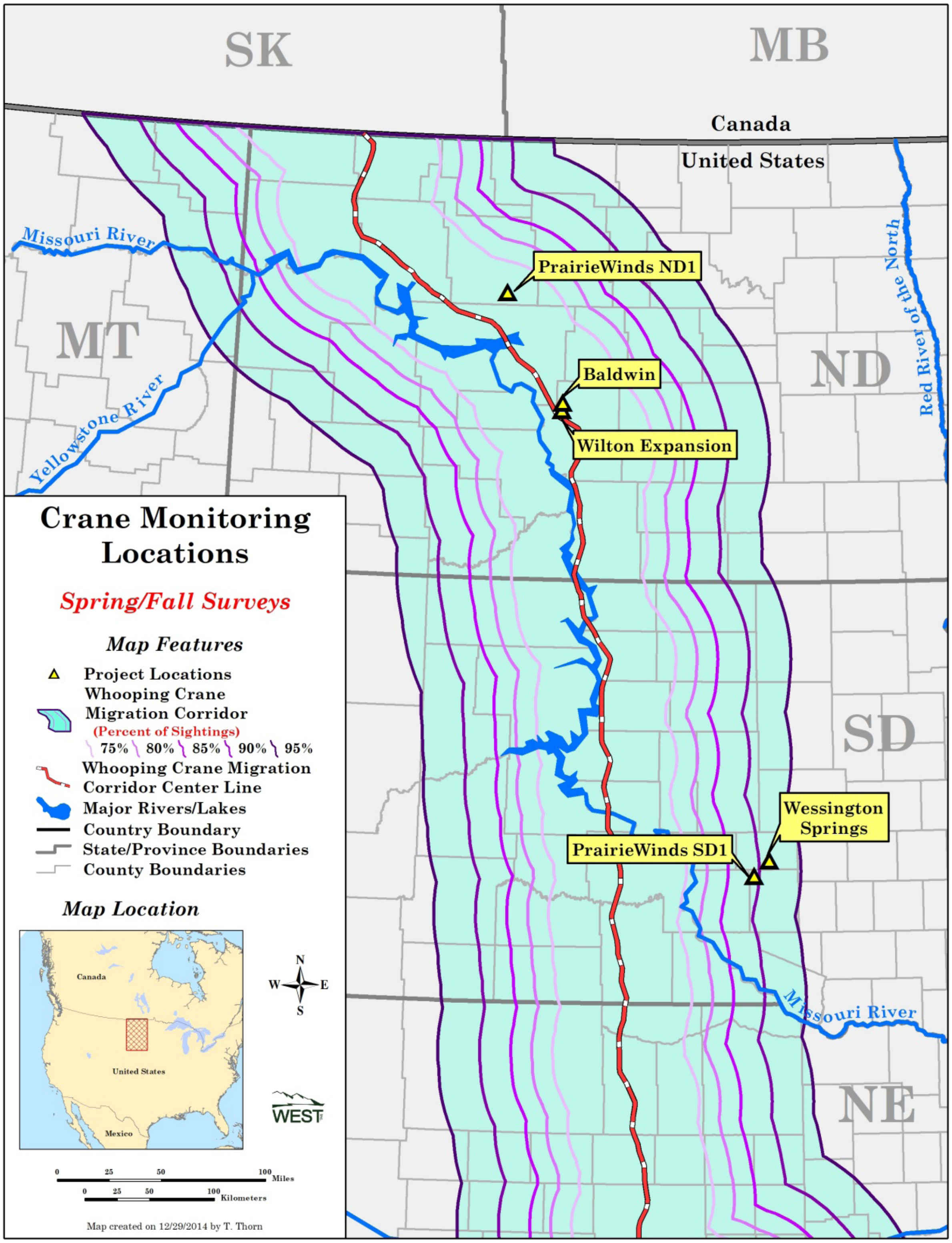

Figure 1. Wind energy facilities used as study areas in North Dakota and South Dakota for monitoring of use (flying and/or standing) by whooping cranes and sandhill cranes during spring and fall migration seasons from 2009 to 2013 (1 Apr-15 May and 10 Sep-31 Oct, respectively). The facilities are shown in relation to the migration corridor for the Aransas-Wood Buffalo Population of whooping cranes. U.S. migration corridor adapted from CWCTP (2009) after Austin and Richert (2001).

Table 1. The location, facility characteristics, and study years for wind energy facilities in North Dakota and South Dakota where monitoring of use (flying and/or standing) by whooping cranes and sandhill cranes was conducted for 3 years during spring and fall migration seasons from 2009 to 2013 (1 Apr-15 May and 10 Sep-31 Oct, respectively).

Wind energy facility	Location[a]	No. of turbines	Tower height (m)	Blade length (m)	Year online	Study years
PrairieWinds ND1	Max, Ward Co., N.D. (47.93700°N, 101.28288°W)	77	80	38	2009	2010-2012
Wilton Expansion[b]	Wilton, Burleigh Co., N.D. (47.12586°N, 100.69449°W)	33	80	38	2009	2010-2012
Baldwin[b]	Wilton, Burleigh Co., N.D. (47.17625°N, 100.68944°W)	64	80	40.3	2010	2011-2013
Wessington Springs	Wessington Springs, Jerauld Co., S.D. (44.00088°N, 98.60474°W)	34	80	38	2009	2009-2011
PrairieWinds SD1 (Crow Lake)	White Lake; Aurora, Brule, and Jerauld cos.; S.D. (43.89199°N, 98.74808°W)	108	80	38	2010-2011	2011-2013

[a] Nearest town followed by county, state, and coordinates.

[b] Due to close proximity, the Baldwin and Wilton Expansion wind energy facilities were monitored jointly in 2011 and 2012 and results were combined for those seasons.

path of sandhill cranes (Gerber et al. 2014). The number of turbines at each facility ranged from 33 to 108, and turbine towers were 80 m tall (Table 1).

METHODS

We monitored use at each of these facilities daily, weather permitting, from approximately 1 April through 15 May and 10 September through 31 October, which included the 5-95% occurrence date range in North Dakota and South Dakota for the AWBP during migration (Austin and Richert 2001, CWCTP 2009). Migration timing for sandhill cranes in the Dakotas is roughly similar where most birds migrate through during April and again in September through November (Gerber et al. 2014). We conducted crane surveys for 3 years (6 migration seasons) at each facility (Table 1). We monitored the Baldwin and Wilton Expansion facilities jointly for 2 years when monitoring seasons overlapped because the facilities are adjacent to each other, and results are combined for those 2 years.

Crane Use Surveys and Curtailment

We conducted driving surveys along public roads and other accessible roads (e.g., turbine access roads) within each wind facility and surrounding area to record location and number of cranes. During surveys each observer used a map showing the turbines, buffer area, and roads to assist in maximizing survey coverage. Observers monitored crane use daily from approximately sunrise to 1000 hours and from about 1600 hours to sunset.

Observers drove at speeds allowing them to drive safely and look for cranes, generally 32-56 km per hour, driving more slowly near areas cranes preferred such as cropfields and wetlands. Observers drove the same roads more than 1 time during a single morning or evening session. Observers stopped at vantage points to look and listen for cranes for roughly 3-10 minutes per stop (sometimes longer if cranes were detected). Vantage points were selected while on site by the observer as opposed to pre-selected vantage points in order to minimize the time observers spent looking at their map and allow the observer to determine in the field what constituted a vantage point. During these stops observers used binoculars and/or spotting scopes to scan the landscape for cranes whose relatively large bodies (at least 1 m in length) and loud flight calls aid in detectability. If a whooping crane was observed flying toward the turbines and flying at about the same height as the turbines, the observer called the operation manager at the facility, who then shut down operating wind turbines within a minimum of 3.2 km of the whooping crane location.

During migration, cranes use wetlands for roosting at night from which they fly to nearby crop fields and grasslands to feed during the day (Iverson et al. 1987, Anteau et al. 2011). Therefore, observers focused attention on areas of potential roosting habitat (e.g., shallow wetlands and ponds) during early morning and late evening. Later in the morning and earlier in the late afternoon, observers focused on potential foraging areas such as cropfields and hayfields. Observers also checked other potential roost habitat outside of the buffer area periodically to determine if cranes, especially whooping cranes, were near any of the study facilities. If whooping cranes were known to be in the area but outside the buffer zone (and not flying toward turbines), observers monitored their use during midday as well but we did not include these extra observation hours in our results. During inclement weather, observers also conducted monitoring during the middle of the day because cranes were more likely to remain on the ground in the absence of thermal updrafts for migration (Urbanek and Lewis 2015).

For each individual or group of whooping cranes or sandhill cranes seen or heard, observers recorded the approximate number of individuals, location (on a paper map), habitat type (for standing birds), and if any were flying. As part of coordinating our effort with the USFWS, we consulted with and informed them of any sighting of whooping cranes. For every observation of whooping cranes the observer(s) completed a Whooping Crane Report Field Sheet to document the sighting; each Field Sheet was submitted to the USFWS after the observation.

Casualty Searches

Although our primary purpose was to have observers on site to spot whooping cranes and curtail movement of turbine blades to prevent collisions, we did not have the manpower to simultaneously observe multiple locations along the perimeter of the facility, which can span several kilometers. For example, the footprint of turbines at PrairieWinds SD1 measured about 8 km by 20 km. There was a possibility that whooping cranes could have entered the air space of a facility without being detected. Therefore, observers also checked the ground below all the turbines at every facility daily for crane fatalities between the morning and evening monitoring periods (about 1000 to 1600 hr), or occasionally while conducting crane use surveys if convenient. Casualty searches included a visual scan of the area from a truck or by walking around the turbine. This method was chosen because cranes are relatively large-bodied birds deemed detectable from a distance, especially from a taller vehicle like a truck. Observers chose at their discretion a place with a good vantage point and with binoculars scanned the area underneath the turbine out to approximately 100-150 m away from the turbine for dead or injured cranes on the ground. If a portion of the search area was not visible from the truck, the observer left the vehicle and walked to that area. Search intensity and duration depended upon the terrain and vegetation around the turbine (e.g., grassland, cropfield) but was generally about 1-2 minutes. Typically the same observers were at a facility for the entire season and they became familiar with the terrain and search areas, enhancing their ability to notice if a crane body was suddenly present. This was not intended as a formal carcass search with bias correction efforts, such as is done for general bird fatality studies.

RESULTS

Crane Use Surveys

Whooping Cranes.—Observers detected whooping cranes at 4 facilities (none at PrairieWinds ND1). A total of 45 whooping cranes were recorded within or adjacent to our study areas. This number may represent multiple observations of the same individuals during multi-day observations at the PrairieWinds SD1 facility in spring 2013 (see below). Of 1,305 days of cumulative monitoring, curtailment of turbines occurred on portions of 9 days (0.7%) and only for short periods (<1 to 6 hr) on these 9 days.

Sandhill Cranes.—Observers monitored crane use for approximately 13,182 hours and recorded 486 observations of about 42,727 sandhill cranes at all facilities combined during this study. These sightings likely included multiple observations of the same individuals if they remained in the area for >1 day. Sandhill cranes were observed at all 5 facilities, but use varied greatly by year and facility, ranging from 0 to 9,662 cranes being observed per facility and per migration season and 519 to 10,171 cranes per facility annually (Fig. 2).

Curtailment

Below we summarize whooping crane sightings and curtailment actions for 4 facilities where whooping cranes were detected:

Baldwin/Wilton Expansion.—1) An observer watched 1 group of 3 whooping cranes for 2 days in

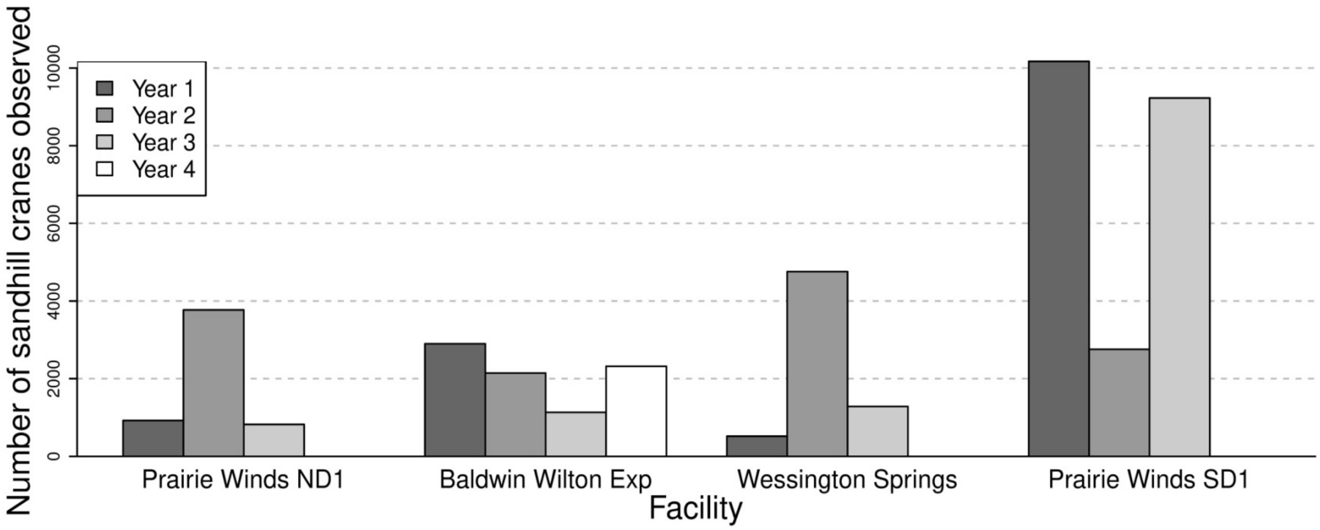

Figure 2. The annual total number of sandhill cranes observed during monitoring of use (flying and/or standing). The study occurred at 5 wind energy facilities in North Dakota and South Dakota from 2009 to 2013. Because the Baldwin and Wilton Expansion facilities were adjacent but had crane monitoring schedules that only partially overlapped, the Year 1 value for the Baldwin/Wilton Expansion is from monitoring at the Wilton Expansion facility only, and the Year 4 value is from the Baldwin facility only.

a flooded field of harvested corn 4.8 km east of the facilities in spring 2011, outside of the 1.6-km buffered study area. No turbines were curtailed. 2) In fall 2011 an observer detected 1 group of 2 whooping cranes flying approximately 200 m above the most southern group of turbines and traveling southeast away from the facilities. No turbines were curtailed because the cranes were migrating more than 100 m above the height of turbines and were already south of the wind facility and traveling south.

Wessington Springs.—An observer saw 1 group of 12 whooping cranes during the 2010 fall migration, initially about 1.6 km south of the southernmost turbines and flying south. The facility operator chose to curtail turbines for the remaining daylight hours while observers searched for additional whooping cranes; no more were observed.

PrairieWinds SD1.—1) An observer detected 1 whooping crane in spring 2011 along the southern edge of the buffer (i.e., about 3.2 km from the nearest turbine). The whooping crane was flying east-northeast with a group of 15 sandhill cranes. The observer followed the group for 6.4 km until it was past the facility along the southern edge of the buffer. No curtailment was implemented. 2) During the spring of 2013, whooping cranes were observed throughout the season as spring snow storms seemed to stall migration for several weeks. Observers recorded 26 whooping cranes over 9 days within the buffer area of the facility during surveys. Turbines were curtailed on portions of 8 days because cranes approached the facility. A minimum of 35 whooping cranes were also observed at White Lake, about 8.5 km south of the facility. These may have included some of the same individuals also recorded at the facility proper. 3) In fall 2013, an observer recorded 1 whooping crane flying with a group of sandhill cranes high over the facility outside of the survey period. No curtailment was implemented as they were flying above the height of turbines.

Casualty Searches

Observers found no injured or dead sandhill cranes or whooping cranes during daily scans at turbines during migration seasons. Observers found fatalities of other species incidentally, including bats, small birds, and raptors. For the 5 facilities combined, we conducted approximately 92,022 scans over the entire study period.

DISCUSSION

Whooping cranes and sandhill cranes were present near the 5 monitored wind facilities during migration. Their number and location varied greatly across seasons and years near these wind energy facilities.

Sometimes cranes stopped in the general area within a few kilometers of the turbines while at other times they flew high overhead, sometimes so high they were only heard. Of the 6 observations of whooping cranes described above, half were during the spring and half during the fall and they occurred during 3 different years. No crane casualties were recorded, and as a result of the relatively few sightings of whooping cranes over the 3-year study period per facility, minimal curtailment of turbines was required.

Our results could be a product of population size for the whooping cranes; the existence of so few whooping cranes makes the probability of 1 flying near a wind energy facility extremely small. However, during the same time period, 2009-2013, at least 40 whooping cranes in the AWBP died of causes other than turbine collisions, including 29 individuals from 2010 to 2011 alone (Stehn 2010, 2011; Harrell and Bidwell 2013; Harrell 2014). For sandhill cranes it is interesting that so many were observed during our study—over 42,000 cranes, yet we found no causalities under the wind turbines.

Across the migratory corridor of the AWBP, other researchers have also reported an absence of crane fatalities while monitoring at turbines. Within the region of this study, no crane fatalities were detected during crane use surveys at the Titan I wind energy facility in Hand County, South Dakota, in 2010, where both whooping cranes and sandhill cranes were observed (Nagy et al. 2012). Farther away, no crane fatalities were found during post-construction monitoring studies for fatalities of bats and birds at 4 other wind energy facilities within the migration corridor, including NPPD Ainsworth in Brown County, Nebraska; Barton Chapel in Jack County, Texas; and Buffalo Gap I and Buffalo Gap II in Nolan and Taylor Counties, Texas (see Appendix S1 of Erickson et al. 2014). Our study and these other studies suggest that whooping cranes and sandhill cranes do not necessarily avoid the general areas where turbines are located, yet collisions with turbines have so far not occurred.

Wind energy facility operators who choose to locate facilities in the migration corridor have to weigh the cost of curtailment efforts against the cost of doing nothing and potentially killing an endangered species, which would likely incur fines and negative publicity. As a preemptive strategy many wind energy developers place turbines away from wetlands used by cranes to the highest extent possible. This may be even more important for power lines associated with wind energy facilities since they are a known risk of crane mortality. Wind developers are able to obtain quality data on crane use to aid their decision making by working with USFWS personnel to obtain approximate locations of whooping crane sightings from the Whooping Crane Tracking Project Database (CWCTP 2016) and radio-tracked whooping cranes studied by Pearse et al. (2015). In fact, it is a common practice for wind developers with which we work to follow the USFWS's Wind Energy Guidelines (USFWS 2012), obtain information on crane use during the planning stage, and create a model of whooping crane use (TWI 2012) to assess the likelihood for whooping cranes to use a potential wind farm location.

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