WHOOPING CRANES AND WIND DEVELOPMENT - AN ISSUE PAPER

By Regions 2 and 6, U. S. Fish and Wildlife Service

April 2009

Photo by Steve Sykes

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EXECUTIVE SUMMARY

Wind energy development is increasing in the United States. Much of the highest wind energy potential in the country occurs in the Great Plains region of the U.S. Fish and Wildlife Service's (USFWS, or Service) Regions 2 and 6, which include the U.S. portion of the endangered Aransas-Wood Buffalo Population (AWBP) whooping crane migration corridor in North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. Ongoing and anticipated development of wind resources in the migration corridor of the AWBP is unprecedented and could place thousands more wind turbines, associated transmission lines, and other appurtenances in the Central Flyway path of the species in the coming decade.

The whooping crane is a species with a low reproductive rate and limited genetic material derived from the 15 whooping cranes that remained in the 1940s. Only 247 individuals occur in the current AWBP, the only wild self-sustaining population of the species. Although the species numbers are slowly increasing, they are far below the level required for recovery. A population viability analysis done in 2004 found that an additional 3% mortality, i.e., less than 8 individuals annually, would cause the species to undergo a decline, and preclude recovery.

Pursuant to Section 9 of the Endangered Species Act (ESA), it is unlawful for any person to take any federally-listed threatened or endangered fish or wildlife species, without special exemption. The ESA defines take as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or to attempt to engage in any such conduct. Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR 17.3). The risk of lethal take to whooping cranes from wind turbines is not known at this time, but it is acknowledged that the highest source of mortality to fledged cranes is from striking power lines. The best available information also indicates that whooping cranes may avoid stopover habitat that is developed with wind energy appurtenances, particularly turbines. This avoidance may deny them the use of important habitat, and thus may result in take in the form of harm by significant habitat modification.

As more wind energy facilities are built, including turbines, transmission lines, power stations, and roads, it is incumbent on the industry, Federal action agencies, and USFWS to provide the highest level of protection possible to whooping cranes, and to closely monitor the number of these birds killed and deterred from using preferred stopover locations. Wind energy companies with planned projects in the Great Plains should assess impacts, and if found likely to result in take of whooping cranes, projects without a Federal nexus should seek ESA compliance by applying for an incidental take permit through the section 10 permitting process. For projects with a Federal nexus, the Federal action agency would need to consult with the USFWS through the ESA Section 7 process for projects that may affect whooping cranes and must ensure that their activities will not jeopardize the continued existence of the species of adversely modify designated critical habitat.

Endangered Species Act compliance with USFWS on a project-by-project basis presents several problems: this approach does not provide for an efficient landscape-level analysis of impacts; it represents significant delays to the industry as projects are reviewed one-at-a-time by local Ecological Services field offices; it results in first-come first-served permitting without regard to a cohesive development strategy; and the cumulative amount of take anticipated would likely very quickly approach the maximum take that can be sustained by the population, leaving future projects with no prospects of receiving protection under Section 9 of the ESA. We believe that a more efficient approach, available through the habitat conservation planning process outlined in Section 10 of the ESA, is for the Service and industry to look collectively across the landscape at all existing, proposed, and reasonably foreseeable wind energy development, put in place adequate conservation measures, assess the cumulative impacts, and allocate take coverage that will not preclude recovery of the species. Section 10(a)(2)(A) of the ESA requires an applicant for an incidental take permit to submit a "conservation plan" that specifies, among other things, the impacts that are likely to result from the taking and the measures the permit applicant will undertake to minimize and mitigate such impacts. Conservation plans under the ESA have come to be known as "habitat conservation plans (HCP)." The HCP approach would help protect whooping cranes and would reduce the regulatory burden for both the wind industry and USFWS. This issue paper, prepared by USFWS Regions 2 and 6, provides a discussion of the status of the species, the threats posed by wind energy development, a description of options, and a recommendation to the industry to support the HCP approach.

INTRODUCTION

The USFWS supports the responsible development of renewable, sustainable energy sources, including wind energy. However, wind energy developments may present threats to wildlife and their habitats. Ongoing and anticipated development of wind resources in the migration corridor of the AWBP is unprecedented and could place thousands more wind turbines, associated transmission lines, and other appurtenances in the migratory path of the species in the coming decade. We recommend that potential impacts to whooping cranes be assessed and addressed cooperatively by the industry, the USFWS, and Federal action agencies.

Direct mortality of whooping cranes may occur as whooping cranes encounter turbines in bad weather or low light conditions at the beginning or end of migration flights, or when flying between roosts and foraging areas at stopover sites. However, this direct mortality due to collisions with turbines is expected to occur infrequently, because of low numbers of whooping cranes and their migration behavior. Currently, collisions with power lines are the greatest known source of mortality for fledged whooping cranes and have accounted for the death or serious injury of 46 whooping cranes since 1956 (Stehn and Wassenich 2008). In addition to direct impacts from power lines, the avoidance of stopover habitat by cranes, as well as the loss such habitat, due to the presence of turbines is a substantial indirect impact that is anticipated with the increase in wind energy development.

For wind energy development projects in the whooping crane migration corridor with a Federal nexus, the action agency will need to initiate section 7 consultation under the Endangered Species Act, as amended (ESA). A federal nexus is triggered when a federal ("action") agency provides funding, authorizes or carries out a program or project. Many wind energy projects do not have a Federal nexus; however; even in the absence of a Federal nexus, developers still need to avoid violating the take prohibitions contained in section 9 of the ESA, as well as the prohibitions in the Migratory Bird Treaty Act (MBTA) and Bald and Golden Eagle Protection Act (BGEPA). This issue paper is intended to:

1) Provide background information on whooping cranes, the threat posed by wind development in the whooping crane migration corridor, and opportunities to work with the wind industry.

2) Provide some options available to USFWS Regions 2 and 6, Federal action agencies, and the wind energy industry to avoid and minimize anticipated impacts of wind farm development and associated power line construction on whooping cranes.
3) Provide guidance to wind energy companies on compliance with the ESA.

STATUS OF WIND DEVELOPMENT IN THE WHOOPING CRANE MIGRATION CORRIDOR

Existing wind farms

The current level of existing wind energy development within the migration corridor of the AWBP is increasing. In Canada, the majority of wind farms being constructed in the prairie region appear to lie mostly outside of the migration corridor. The Service has not independently tabulated the number of wind farms operating, under construction, or proposed in the 7 states within the U.S. portion of the migration corridor (MT, ND, SD, NE, KS, OK, and TX). However, the Department of Energy, Western Area Power Administration figures indicate that approximately 2,433 known wind turbines have been constructed in the 1,400 mile whooping crane corridor in the United States (U.S.), with another 1,355 proposed for construction in the near to midterm future that will be connected to the federal power grid (Western Area Power Administration (WAPA), 2007). There are an additional substantial number of projects that would not be connected to the federal power grid and are not included in WAPA's database. The location of existing wind energy facilities is provided on a Department of Energy web page at http://www.eere.energy.gov/windandhydro/windpoweringamerica/wind_installed_capacity.asp.

Projected future wind energy development

Wind energy is the fastest growing form of energy development occurring in the United States today, and is an important component of a range of renewable energy resources, brought about by a new focus by the Federal and State governments on renewable energy and Federal government tax incentives through the provisions in the American Recovery and Reinvestment Act of 2009. Much of this development is currently occurring without Federal regulation as most projects to date are developed on private lands by private companies, without interconnections to federally owned transmission lines, Federal funding, or other Federal nexuses. Many states have developed, and, presumably more will develop, renewable energy portfolio standards requiring that certain proportions of energy generated or sold in their States be supplied by renewable forms of energy. Precise information on the number, size, and location of proposed wind farms and turbines is difficult to ascertain because wind energy companies are operating in a highly competitive market and avoid revealing their plans to competitors. Many wind energy developments implement a phased approach that is dependent on the performance of initial projects. The Service knows of several projects per state currently operating and multiple others under construction or in the planning stages. A large amount of project planning information is proprietary; however, the Service is aware of projects planned in the Central Flyway that consist of several thousand turbines. We cannot predict with accuracy how great an increase in wind turbine numbers to expect, but, depending on market forces, we anticipate several thousand new turbines and appurtenances in the whooping crane migration corridor in the next decade. Actual growth will become apparent as Federal action agencies and companies request review of their proposals under Federal wildlife protection laws.

The Great Plains states traversed by the whooping cranes during their fall and spring migrations are among the windiest states in the nation. The best places for wind energy development in these states overlap to a large extent the whooping crane migration corridor, and many of these areas provide attractive stopover sites. Thus, the potential for impacts to whooping cranes from future wind energy development is high. The Service, land owners, Federal regulatory and funding agencies, and the wind energy industry are responsible for ensuring that this new development occurs in a manner that is compatible with the recovery of the whooping crane.

STATUS OF THE WHOOPING CRANE POPULATION

The migratory AWBP is the only self-sustaining flock of whooping cranes remaining in the wild. These birds breed in the wetlands of Wood Buffalo National Park (WBNP) in Alberta and the Northwest Territories of northern Canada, and spend winters on the Texas coast at Aransas National Wildlife Refuge (Aransas NWR), Austwell, Texas, and surrounding areas.

Whooping cranes are currently listed as endangered except where two nonessential experimental populations exist in 18 eastern states adjoining or east of the Mississippi River, including the reintroduced population that migrates between Wisconsin and Florida (Figure 1) and a non-migrating population in Central Florida. In the United States, the whooping crane was listed as "threatened with extinction" in 1967 and as "endangered" in 1970. Both of these listings were grandfathered into ESA protection which established the U.S. Whooping Crane Recovery Team and facilitated further conservation actions on behalf of the species. In Canada, the whooping crane was designated as "endangered" in 1978 by the Committee on the Status of Endangered Wildlife in Canada and listed as endangered under the Canadian Species at Risk Act (SARA) in 2003 (Canadian Wildlife Service [CWS] and USFWS 2007). In the United States, critical habitat was designated in 1978 at five sites in four states that include portions of the Platte River in Nebraska; Cheyenne Bottoms State Waterfowl Management Area and Quivira National Wildlife Refuge, Kansas; Salt Plains National Wildlife Refuge, Oklahoma; and Aransas NWR and vicinity on the Texas coast. In Canada, critical habitat is pending. Proposed critical habitat areas in Canada consist of the nesting grounds in and adjacent to WBNP and migration staging and stopover areas in Saskatchewan (CWS and USFWS 2007).

Reasons for Listing and Current Threats

Growth of human populations in North America resulted in significant whooping crane habitat alteration and destruction. Historically, whooping cranes declined or disappeared as agriculture claimed the northern Great Plains of the United States and Canada (Allen 1952). Hundreds of whooping cranes were shot and, as the species became increasingly rare, eggs were collected and sold to collectors (Allen 1952). Declines also resulted from displacement by human activities and agricultural practices. The extensive drainage of wetlands in the prairie pothole region of Canada and the United States resulted in a tremendous loss of migration habitat available to whooping cranes (CWS and USFWS 2007). Original migration stopover habitat became unsuitable due to draining, fencing, sowing, and subsequent conversion of pothole and prairie wetlands to hay and grain production.

The International Whooping Crane Recovery Plan (CWS and USFWS 2007) lists the following as current threats and reasons for listing: human settlement/development, insufficient freshwater inflows, shooting, disturbance, disease, parasites, predation, food availability, sibling aggression, severe weather, loss of genetic diversity, climate change, red tide, chemical spills, collisions with power lines, fences, and other structures, collisions with aircraft and pesticides. Major current threats include limited genetics of the population with an estimated 66% of the genetic material lost during the decimation of the population, loss and degradation of migration stopover habitat, construction of additional power lines and communication towers, fences, degradation of coastal habitat, and threat of chemical spills in Texas. A spill from commercial vessels carrying dangerous, toxic chemicals that travel the Gulf Intracoastal Waterway daily through the heart of whooping crane winter habitat could contaminate or kill the cranes' food supply, or poison the cranes (Robertson et al. 1993). Another threat to the whooping crane is the decrease in the suitability of the species' winter habitat due to accelerating development within and adjacent to the designated critical habitat in Texas.

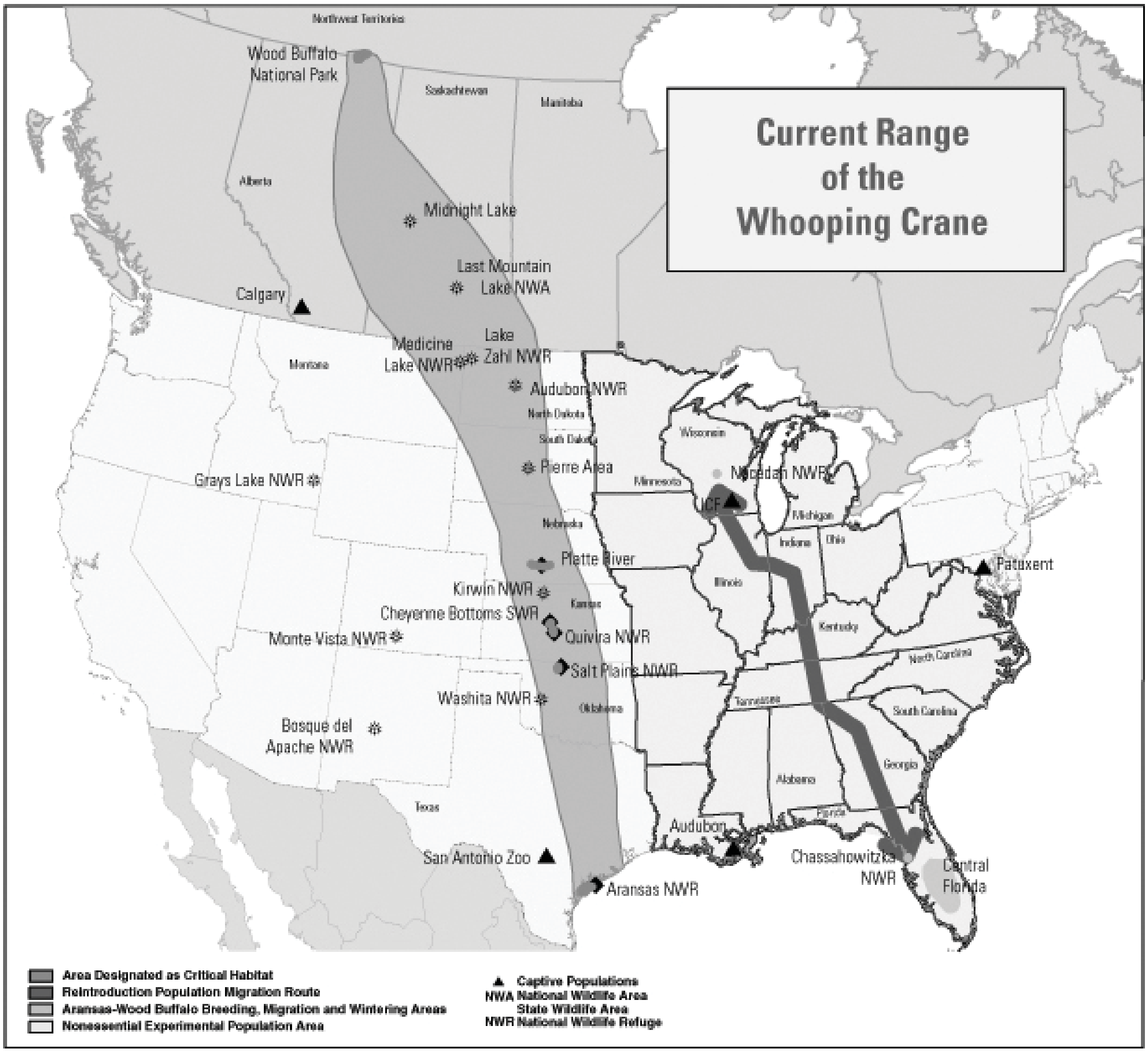

Figure 1 – Current Range of the Whooping Crane (Stehn and Wassenich 2008).

The threat of global climate change may adversely affect the water regime of WBNP, with potentially severe impacts on whooping crane reproduction (CWS and USFWS 2007). Permanently lowered water tables, for example, would shrink wetlands, reduce the availability of quality nesting sites, reduce invertebrate food availability, and allow predators to access nests and young. On the wintering area, a reduction in rainfall would reduce inflows and reduce the blue crab population that the cranes rely on for food. Sea level rise combined with land subsidence are projected to be about 17 inches on the Texas coast over the next 100 years (Twilley et al. 2001, as cited by CWS and USFWS 2007). This would reduce suitability of salt marsh and open water areas, making much of the present acreage too deep for use by whooping cranes (T. Stehn, USFWS, personal communication).

A catastrophic event could eliminate the wild, self-sustaining AWBP because this population has low numbers of individuals, slow reproductive potential, and limited genetic diversity. Therefore, the recovery strategy as stated in the International Recovery Plan includes protection and enhancement of the breeding, migration, and wintering habitat for the AWBP to allow the wild flock to grow and reach ecological and genetic stability. The numerical population (1,000 individuals) criterion for downlisting the species can only be achieved if threats to the species' existence are sufficiently reduced or removed (CWS and USFWS 2007).

Threats to whooping cranes have been alleviated to a degree sufficient to allow the AWBP to increase in size over a half century. Whooping cranes have responded positively to some conservation efforts. Marking of power lines to make them more visible, a technique shown to reduce sandhill crane collisions with power lines (Morkill 1990, Morkill and Anderson 1991, Brown and Drewien 1995), also helps reduce whooping crane mortality. Cooperative protection plans implemented by provincial, state, and Federal agencies are believed to have reduced losses due to shooting and disease (Lewis 1992). Forested riverine areas along the Platte River in Nebraska are being cleared to restore stopover habitat. Loss of critical winter habitat along the Gulf Intracoastal Water Way due to erosion has been reduced significantly through the use of concrete matting (Zang et al. 1993, Evans and Stehn 1997). Dredged material has been used to create winter habitat (Evans and Stehn 1997).

Current numbers

As of April 2009, the three populations of whooping cranes in the wild numbered 365 birds. Thirty whooping cranes form a non-migratory wild population in central Florida, and 88 whooping cranes form an eastern population that migrates between Wisconsin and Florida. The April, 2009 estimate for the size of the Aransas-Wood Buffalo flock is 247, down from 266 in November 2008 (T. Stehn, USFWS, personal communication). The AWBP is the only self-sustaining population of whooping cranes in the wild. Captive populations totaled 151 individuals at 11 facilities. Thus, as of April 2009, there were a total of 516 whooping cranes in North America.

Changes in population numbers

An estimated 10,000 whooping cranes were present in North America during pre-colonial times with the species ranging from the Canadian Arctic to Mexico and from the Rocky Mountains to the Atlantic Ocean (CWS and USFWS 2007). Numbers were reduced to less than 1,400 whooping cranes by the 1870s (Allen 1952). The species disappeared from the heart of its breeding range in the north-central United States by the 1890s. By the mid-1900s, only the small

AWBP population survived. Ironically, the steadfast use of a traditional summer area that appears to have saved the whooping crane as a small relict breeding population in WBNP prevents its voluntary return to what was once its principal nesting range in the prairies. Conversion of potholes and prairie to hay and grain production made much of the historic nesting habitat unsuitable for whooping cranes. The AWBP virtually reached the brink of extinction with just 15 birds left in the flock, including only 3 or 4 adult females, in 1941 (CWS and USFWS 2007). The continued existence of the species remained very much in doubt in the 1930s, 1940s and 1950s as the AWBP ranged between 15 and 33 individuals. With key conservation measures put in place, the population made a notable comeback after the 1950s. Key actions included the passage of the Migratory Bird Treaty Act in 1918 that gave the birds protection from shooting and egg collection, establishment of the Aransas National Wildlife Refuge in 1937 to conserve the wintering grounds, and discovery of the nesting area of AWBP in 1954 in the already existing Wood Buffalo National Park, Northwest Territories, Canada (CWS and USFWS 2007).

In the 1960s, numbers finally increased to a high for the decade of 56 in 1969. The flock first exceeded 100 individuals in 1986 and surpassed 200 individuals in 2004, a period of 18 years in which the population doubled (CWS and USFWS 2007).

The AWBP has a long-term recruitment rate of 13.9%, the highest of any North American crane population including sandhill cranes (Drewien et al. 1995). However, recruitment is lowered when the nesting grounds experience drought conditions. Annual mortality has averaged 9.4% in recent years (Reed 2004). Annual growth of the population during the past 65 years has averaged 4.5% per year. Population studies indicate there is a 10-year cycle in mortality/survival of unknown cause (Boyce and Miller 1985, Boyce 1987, Nedelman et al. 1987), though the crane cycle appears to correlate with population cycles of boreal forest predators (M. Boyce, U. of Calgary, personal communication). If new threats do not arise and habitat quality can be maintained, it is likely that the AWBP will continue to grow and maintain a low probability (<1.0%) of extinction over the next 100 years (Mirande et al. 1993, 1997).

Potential for population growth

The inherent capacity of whooping cranes to rebound demographically is low due to delayed sexual maturity (age 3-4 years) and a low reproductive rate (2 eggs in the annual nesting attempt with only 1 chick typically fledging). Furthermore, given the many threats to breeding, migration, and wintering habitat, it is unlikely the whooping crane will ever become abundant (CWS and USFWS 2007). Nevertheless, as nesting pairs gain experience they become more successful in rearing chicks, and since the species' is long-lived, if adult mortality is low and habitat conditions are favorable, continued population growth is likely (T. Stehn, USFWS, personal communication). Protection is needed for additional public and private land to accommodate an expanding crane population (CWS and USFWS 2007).

The sustained long-term growth of the whooping crane population, even at a relatively low level, has allowed the species to make a notable comeback. However, the current size of the AWBP at only 247 birds is still far from the targeted potential downlisting threshold of 1,000 individuals. Until this target is reached, the population will continue to lose genetic material with each generation, a critical factor for a species that already has lost two thirds of all genetic material during the 1941 population bottleneck. Substantial genetic variation is essential for population vitality and persistence. Thus, to increase chances for recovery, it is essential that the current rate of population growth be maintained.

Status of reintroduced populations

Recovery objectives call for the establishment of two additional self-sustaining populations of 100 individuals each in size within other parts of the historic range (CWS and USFWS 2007). Reintroductions began in 1975 and continue to the present. One of three reintroductions attempted, the Rocky Mountain population, has failed with all birds extirpated. The introduction of the non-migratory flock in Florida started in 1993 and the population is declining; mortality is too high and productivity too low for this population to have much of a chance of ever becoming self-sustaining (CWS and USFWS 2007). The eastern migratory population started in 2001 (which moves between Wisconsin and Florida) shows some promise, but early productivity has been disappointing and mortality is considerable (T. Stehn, USFWS, personal communication). Thus, it is imperative that all efforts continue to promote growth of the AWBP by reducing mortality, increasing productivity, and reducing threats to the population.

Effects of increased mortality on whooping crane recovery

According to the most recent population viability analysis done for the AWBP, the population would show a significant drop in probability of persistence (i.e. probability of species survival) if a 3% increase in absolute mortality were to occur (Reed 2004). At the current flock size of 247, 3% mortality equates to less than 8 birds annually. An annual loss of 8 birds added to the current mortality rate from existing sources would cause the AWBP to become a nonviable population with a probability of persistence (200 years into the future) predicted to be 86% (Reed 2004). A viable population is defined as having a ≥95% probability of persisting 200 years (Reed 2004). It should be noted that mortality of any birds in such a small population also represents a loss of genetic material and a setback for recovery efforts. For the species to survive, any increased mortality due to collisions with new obstructions in the migration corridor, including wind turbines, towers and new power lines, must be kept extremely low.

BIOLOGY OF WHOOPING CRANES IN MIGRATION

Location of the migration corridor

The AWBP whooping cranes migrate more than 2,400 miles twice annually between wintering and breeding grounds. Fall and spring migrations for the AWBP follow the same general path each year (Howe 1989, Kuyt 1992). The migration corridor basically follows a straight line, with the cranes traveling through Alberta, Saskatchewan, extreme eastern Montana, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma and Texas (Figure 1). The primary migration corridor can be over 200 miles wide as cranes are pushed east or west by unfavorable winds, and occasionally cranes have been documented in Minnesota, Iowa, and Illinois.

Migratory behavior

As spring approaches, “dancing” behavior (running, leaping and bowing, unison calling, and flying) increases in frequency, and is indicative of pre-migratory restlessness (Allen 1952, Blankinship 1976, Stehn 1992a). Whooping cranes depart Aransas NWR generally between

March 25 and April 15, with the last birds usually leaving by May 1. Occasional stragglers may linger and not depart until mid-May. The spring migration is usually completed in 2-4 weeks, more rapidly than the reverse trip in the fall, as there is no known spring staging area.

Autumn migration normally begins in mid-September, with most birds arriving on the wintering grounds between late October and mid-November. Occasional stragglers may not arrive until late December. Whooping cranes are diurnal migrants and make regular stops to feed and rest. They generally migrate in groups of 1-5 birds (Johns 1992). Large groups of up to 30 sometimes use the same stopover location and may start a migration flight together. Figure 2 delineates the migration corridor as determined by confirmed sightings (Stephen 1979, Johnson and Temple 1980, Austin and Richert 2001, Tacha et al., USFWS, unpublished data) and radio-tracking whooping cranes during the period 1981-1984 (Kuyt 1992). The crane's first stop often occurs in northeast Alberta or northwest Saskatchewan, about 500 km southeast of their departure area in WBNP. Local weather conditions influence distance and direction of travel, but whooping cranes generally are capable of reaching the autumn staging grounds in the north-central portion of the Saskatchewan agricultural area on the second day of migration. Most of the cranes remain for 2 to 4 weeks in the large triangle between Regina, Swift Current, and Meadow Lake, where they feed on waste grain in barley and wheat stubble fields and roost in the many wetlands (Johns 1992). The remainder of the migration from Saskatchewan to the wintering grounds is usually rapid, probably weather-induced, and may be completed in as little as a week (Kuyt 1992).

Daily flights, timing, and distance covered

Whooping cranes spend approximately 3 months annually in migration. They can travel between 200-400 miles a day, attain an altitude of 6,200 feet, and can glide downward at up to 62 mph. Whooping cranes migrate primarily during daylight hours between about 0930 and 1700 hours, making soaring and gliding flights while taking advantage of favorable tailwinds and thermal currents to aid their flight. When conditions become unfavorable due to cessation of thermals late in the day or a wind shift, the cranes may start flap-flying for a short period, but soon tire and will look for suitable wetland habitat nearby. Although whooping cranes usually migrate during daylight hours, they will occasionally fly during periods of darkness. They stop nightly to roost in shallow wetlands and may fly out from wetlands during the day to feed in agricultural fields. If weather is unfavorable for migration, the cranes will stay in place for multiple days until conditions improve.

Whooping cranes in migration are most vulnerable to collisions with structures early in the morning or late in the day when light levels are diminished as they fly at low altitudes between roost and foraging sites. Although whooping crane migration flights are generally at altitudes of between 1,000 and 6,000 feet above the ground, whooping cranes fly at low altitudes when starting or ending a migration flight, especially when thermal currents are minimal or for brief periods during mid-day to drink and/or feed.

Habitats used in migration

Whooping cranes use a variety of habitats during migration (Howe 1987, 1989, Lingle 1987, Lingle et al. 1991, Johns et al. 1997), primarily croplands, and wetlands, including palustrine (marshy) wetlands. In the U. S., 75% of roost wetlands were less than 10 acres in size with 40% less than 1.24 acres. Roosting wetlands were generally located within 0.62 mile of feeding sites

(Howe 1987, 1989).

Clusters of migratory observations suggested that whooping cranes in Nebraska select roost habitat by recognizing local and larger-scale land cover composition (Richert et al. 1999, Richert and Church 2001). Habitat selection was influenced by social group, season, and landscape pattern (Richert 1999). Areas characterized by wetland mosaics appear to provide the most suitable stopover habitat (Johns et al. 1997, Richert et al. in press). In states and provinces, excluding Nebraska, whooping cranes primarily used shallow, seasonally and semi-permanently flooded palustrine wetlands for roosting, and various cropland and emergent wetlands for feeding (Johns et al. 1997, Austin and Richert 2001).

During migration, whooping cranes are often recorded in riverine habitats, especially in Nebraska. Cranes can roost on submerged sandbars in wide, unobstructed channels that are isolated from human disturbance (Armbruster 1990).

Migration Habitat Management and Research

Suitable stopover habitat is necessary for whooping cranes to complete their migration in good condition. There has been considerable alteration and destruction of natural wetlands, rivers, and streams, some of which served as potential roosting and feeding sites for migrating cranes. There may be additional areas along the migration route that need to be delineated and protected.

The availability of suitable migration stopover habitat within the AWBP migration pathway within the United States has been analyzed (Stahlecker 1988, 1992, 1997a, 1997b). National Wetland Inventory (NWI) maps, used in conjunction with aerial photo maps and suitability criteria (Armbruster 1990), are poor predictors (33% correct) of suitable roosts in Oklahoma, but good predictors (97% correct) of unsuitability (Stahlecker 1992). NWI map review in Nebraska is a good predictor of both suitability (63% correct) and unsuitability (73% correct). Wetlands suitable for overnight roost sites for migrating whooping cranes are available throughout the migration corridor in the Dakotas and Nebraska (Stahlecker 1997a, 1997b), but may be limited in Oklahoma (Stahlecker 1992). Suitable stopover habitat in the prairie pothole region of the Dakotas and eastern Montana does not appear to be limited at the present time, but as additional construction of wind power facilities, and other development activities occur in this area, this habitat, or the use of it, will be diminished. Similar sampling to evaluate roost availability in Kansas and Texas should be conducted.

Stopover Locations

Whooping cranes use migration stopover habitat opportunistically and may not use the same stopovers annually. Whooping cranes often stop wherever they happen to be late in the day when they find conditions no longer suitable for migration. This tendency can make for a very unpredictable pattern of stopover use, depending on daily weather conditions. It is not unusual to have a few cranes stopping at a small wetland or farm pond for a night at a location that they may never use again. Thus, a particular wetland pond might have whooping cranes using it just once a decade or even less. However, some areas are used by at least some whooping cranes on a regular basis, and would be considered traditional stopover sites. Some of these traditional stopover sites have been designated as critical habitat. These areas are located mostly where migration stopover habitat is in limited quantity and cranes make an effort to navigate directly to specific sites. Such areas include Salt Plains NWR in Oklahoma and Quivira NWR in Kansas.

However, in any given migration, whooping crane groups may be too far east or west of these "traditional" stopover sites, or may have favorable migration conditions when approaching such a site and not stop.

MIGRATION CORRIDOR DATABASE

Data collection - 1975 to the present

A Federal/State organized effort to report data on whooping cranes sighted in migration (Lewis 1992) was organized in 1975 and continues to the present time   Sightings are obtained opportunistically, often from public reports, with efforts made by biologists to confirm validity of all sightings. Sightings are placed into one of three categories (confirmed, probably, and not likely) based on program criteria. A confirmed sighting requires that an observation be made by a trained biologist or individual with similar bird identification skills. The data set includes 1,942 confirmed sightings made over 32+ years and incorporates data from 9 radio-telemetered whooping cranes followed in migration from 1981 to1985. These data were analyzed by Austin and Richert (2001) and then updated in 2007 and placed in GIS format (Tacha et al. USFWS, unpublished data).

Distribution of sightings in the migration corridor

The whooping crane migration corridor is essentially a straight line from west central Canada to Texas. However, the cranes are often blown east or west by strong winds that can carry them a considerable distance off the centerline of the migration corridor. This enlarges the corridor, expanding it to more than 200 miles in width. Excluding 36 outlying sightings, the percent of sightings through Spring 2007 occurring within the migration corridor are:

Location	% sightings	Comment
a) within 40 miles of centerline	75.1%	greatest chance of whooping crane stopovers
b) from 40-110 miles from centerline	19.7%	moderate chance of whooping crane stopovers
c) greater than 110 miles from center	5.2%	low chance of whooping crane stopovers
	100.0%	

Limitations and biases of the data set and what a single sighting point represents

Although the location of the migration corridor has been defined based on sighting data, it is very important to interpret this data set correctly. Movements of individuals are not completely known and are highly variable over both time and space. The migration corridor map is biased by heavy observation effort made at known migration stopovers. For example, the work of one volunteer at Salt Plains NWR accounts for 62% of all sightings reported from Oklahoma in the last 5 years. In contrast, whooping cranes stopping opportunistically in sparsely settled country may rarely be reported by a qualified individual.

Most whooping cranes complete their migration without being reported. Based on the 5 migrations between Spring, 2005 and Spring, 2007, reports were obtained for an estimated 4% of all stopovers (T. Stehn, USFWS, Austwell, TX, unpublished data). Every whooping crane makes approximately 7-9 stopovers in the U.S. during each migration (Kuyt 1992). Sometimes multiple roost sites are used at a given stopover. With current whooping crane numbers and an average group size of 3, an estimated 1,419 whooping crane group stopovers occur in the U.S. annually (T. Stehn, USFWS, unpublished data). Thus, the accumulated data set (n=1,942 through Fall 2007) represents only a small fraction of the actual stopovers and is thus vulnerable to the biases described above and to potential misinterpretation. Despite these limitations, the whooping crane migration database represents the best information currently available regarding whooping crane distribution during migration.

A low number or even lack of verified sightings at a particular location or county should not be construed as demonstration of a lack of use of that location by whooping cranes. Because so few migration stopovers are documented, one known whooping crane stopover in a county or at a particular location indicates the presence of suitable habitat, and may represent substantial use of the area by whooping cranes. It is important to understand that the lack of data from a particular location does not mean that whooping cranes do not ever stop there. It just means they have never been reported from that area by a qualified observer. Known stopovers in locations to the north and south of a given location also provide a strong indication that the site is within the whooping crane migration corridor, even if no sightings have been documented for that location. In addition, use of a location in the migration corridor by sandhill cranes can be a strong indicator of the presence of suitable habitat and potential use of the area by whooping cranes. Whooping cranes will often select a stopover site where sandhill cranes are already present.

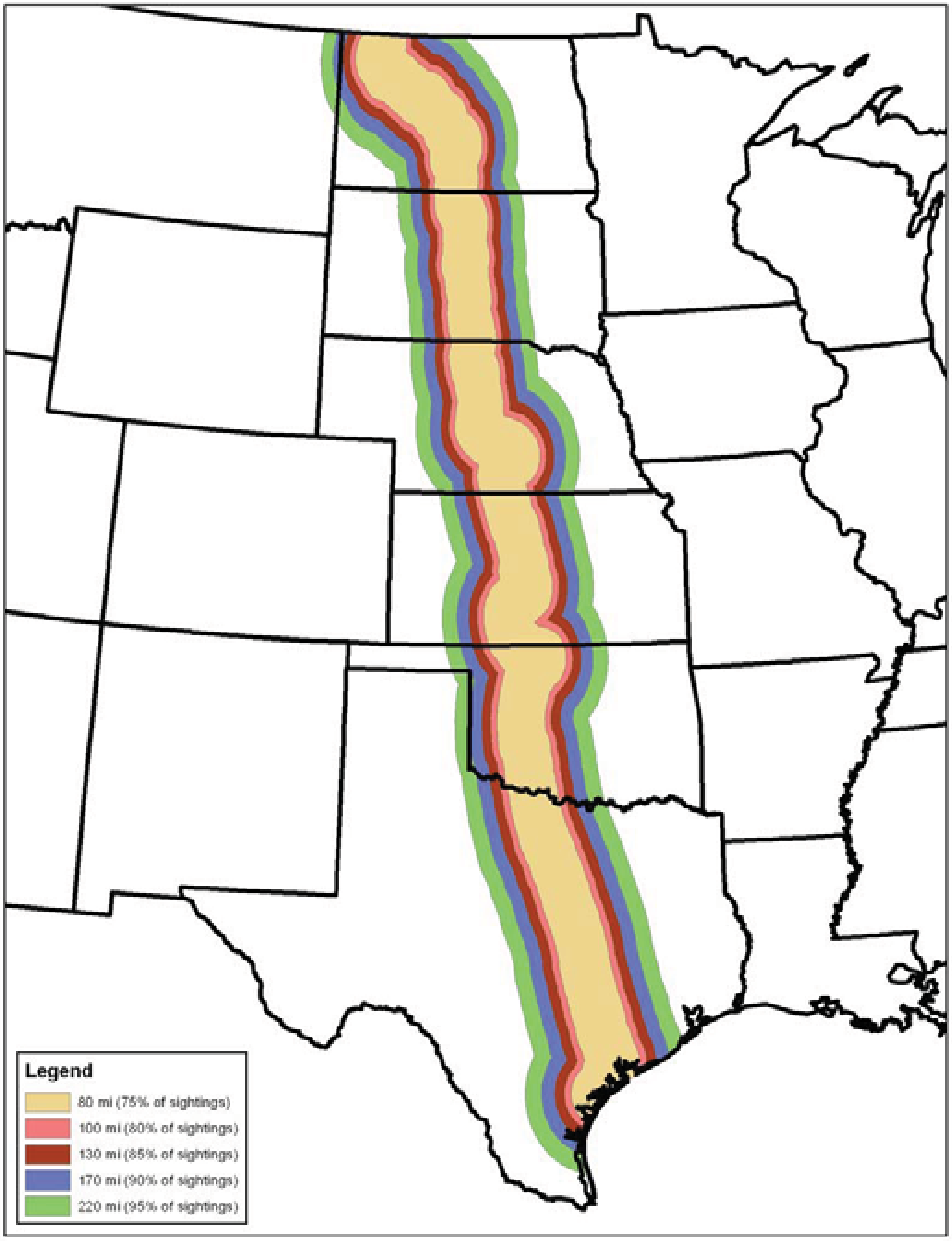

Figure 2. Ninety-five percent whooping crane migration corridor based on 1,858 confirmed sightings through Spring 2007 (Tacha et al., 2008. USFWS, unpublished data).

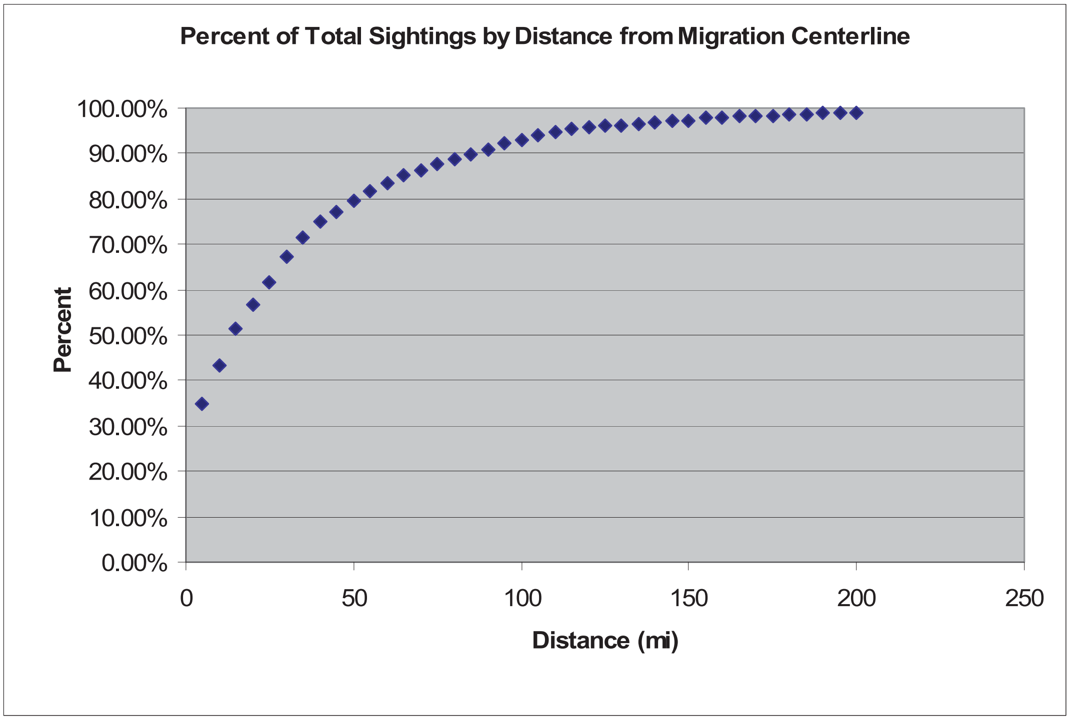

Figure 3. Distribution of points in the whooping crane migration corridor data base (Tacha et al., 2008. USFWS, unpublished data).

Whooping crane mortality in migration

Sixty to 80% of losses of fledged whooping cranes occur during migration (Lewis et al. 1992), a period comprising only about nine weeks (17%) of the bird's year, but losses are high because cranes are exposed to new hazards as they travel through unfamiliar environments (Lewis et al. 1992). Aerial surveys in WBNP indicate that summer losses are infrequent (B. Johns, CWS, personal communication). Only about 15% of the annual losses occur during the 5 to 6 months the cranes spent on the wintering grounds (Lewis et al. 1992). Mortality during April through November is five times greater than mortality during winter.

Few carcasses are ever found, thus information on causes of mortality is based on an extremely small sample size. The principal known cause of loss during migration is collision with utility lines (Lewis et al. 1992). Other known causes of mortality are shooting, other collisions or trauma, avian tuberculosis, and viral infections (Lewis et al. 1992).

Whooping crane collisions with power lines

Human settlement in the prairies brought rural electrification and the fencing of open lands. Currently, the number of power lines, communication towers, and wind turbines is increasing in the U.S. and may kill as many as 225 million birds annually (Manville 2005).

Collisions with power lines are a substantial cause of whooping crane mortality in migration (Brown et al. 1987, Lewis et al. 1992). Collisions with power lines have been responsible for the death or serious injury of at least 46 whooping cranes since 1956. In the 1980s, 2 of 9 radio-marked whooping cranes from AWBP died within the first 18 months of life as a result of power line collisions (Kuyt 1992). Of 27 documented mortalities in the Rocky Mountain experimental population, almost two thirds were due to collisions with power lines (40%) and wire fences (22%) (Brown et al. 1987). Twenty-one individuals within the Florida populations and three individuals in the migratory Wisconsin population have died from collisions with power lines (USFWS, unpublished data).

Currently, an estimated 804,500 km of bulk transmission lines and millions of km of distribution lines exist in the United States (Manville 2005). The number of miles of overhead lines in the central states of North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas as of 2007 is estimated at 77, 571 miles (Western Area Power Administration, 2007). With an increase in demand for additional transmission, many new power lines are being constructed or are proposed. Whooping cranes can collide with both types of lines (Stehn and Wassenich, 2008). Additional power line construction throughout the principal migration corridor will increase the potential for collision mortalities.

The Avian Power Line Interaction Committee (APLIC), composed of 9 investor-owned electric utilities and USFWS, was established in 1989 to address the issue of whooping crane collisions (Lewis 1997). In 1994, APLIC provided voluntary guidelines to the industry on avoiding power line strikes by migratory birds (APLIC 1994) with additional information on bird electrocutions (APLIC 2006). Tests of power line marking devices using sandhill cranes as surrogate research species have identified techniques effective in reducing collisions by up to 61% (Morkill 1990, Morkill and Anderson 1991, 1993, Brown and Drewien 1995). Techniques recommended include marking lines in areas frequently used by cranes and avoiding placement of new line corridors near wetlands or other crane use areas. Avian protection plan guidelines were put out jointly by the Edison Electric Institute's APLIC and USFWS (2005).

The American Recovery and Reinvestment Act (ARRA) of 2009 created significant provisions to benefit renewable energy. In addition to providing numerous incentives to wind energy developers and manufacturers such as tax credits, bonds, and loan programs, the ARRA also provided $11 billion for transmission activities and modernizing the electric grid. For example, the Western Area Power Administration (WAPA) was given spending authority for $3.25 billion of the ARRA funds. For the first time WAPA has the authority to construct transmission solely for the delivery of power generated from renewable energy. WAPA markets and delivers energy in a 15-state region including the upper Great Plains region which encompasses Montana, North Dakota, South Dakota, and Nebraska. The ARRA makes it highly possible that thousands to tens of thousands of new wind turbines and associated power lines and other appurtenances could be constructed in the whooping crane migration corridor in the coming years. This development and operation of facilities has the potential to cause significant additional mortality to whooping cranes. Cranes could be killed by wind turbines or power lines associated with wind farm development, and they could avoid using otherwise suitable habitat that is overlain with wind farms. Management and research are needed to reduce this new threat (CWS and USFWS 2007).

ANTICIPATED IMPACTS TO WHOOPING CRANES FROM TURBINES AND POWER LINES

Direct Impacts

Direct mortality of whooping cranes from wind energy development would reduce the size of the AWBP and could subsequently reduce the level of genetic variability within the flock. Removal of individuals from the flock would have a direct impact on the ability of the population to increase and reach downlisting targets. Whether the impact is at a level that precludes recovery depends on the number of individuals lost and the frequency at which they are lost. It should be noted, however, that mortality of any birds in such a small population as the AWBP of whooping cranes does represent a loss of genetic material and a setback for recovery efforts.

Wind farms, and the overhead transmission lines typically associated with them, represent increased structural hazards to this species. It is known that whooping crane collisions with power lines is a major threat to the species and that birds, including large birds, are killed by wind turbines. For any wind energy development project in the whooping crane migration corridor, an assessment needs to be made for potential whooping cranes use of the area to analyze risk.

Of direct concern is the potential for mortality via collision of whooping cranes with wind turbine blades. Because wind development is a fairly new, albeit rapidly increasing type of development in crane habitat, data on impacts of the wind industry to cranes has not been compiled or reported. Collision mortality with wind turbines has not been documented for whooping cranes or sandhill cranes. A research project involving observations of sandhill cranes in Wisconsin was initiated in spring 2009. Currently the study is funded for one year.The wind farms at the study site became operational in 2008. Information on sandhill cranes is relevant because they are considered a surrogate species for whooping crane behavior and habitat use in migration. This is important because with low whooping crane numbers limiting sample size, sandhill cranes can be used as an indicator of potential presence of whooping cranes.

Based on the known threat of wind turbines to other migratory birds, and to their large body size and low maneuverability, it is reasonable to expect that whooping cranes could be killed by turbine blades, given the number of existing and proposed wind turbines within the AWBP migration corridor. Whooping cranes may encounter turbines as they initiate or conclude a migration flight, a period when they sometimes fly for several miles at very low altitude due to a lack of thermal updrafts. Also, direct mortality might occur when whooping cranes occasionally fly at night or fly when visibility is limited by bad weather. Although whooping cranes generally migrate above the height of wind turbines, the cranes stop daily for food and for roosting at night. They will often make low flights of up to 2 miles from a roost site to forage late in the day or first thing in the morning. When the weather is unfavorable for migration, whooping cranes may remain at a stopover site for a few days to a few weeks. Their potential vulnerability to wind turbines is mostly associated with use at stopover locations. Crane biologists expect, except in these specific circumstances, that whooping cranes will see wind turbines and stay clear. However, cranes in close proximity to turbines may not be able to maneuver quickly enough to avoid turning blades. Thus, unless the whooping cranes recognize and steer clear of turbines, any crane use occurring within an estimated 2-5 miles of a wind turbine might result in mortality as they make local flights or start or end migration flights.

Direct mortality of whooping cranes by wind turbines is, at the present time, expected to be low, given the small number of whooping cranes in the AWBP flock migrating across the United States in spring and fall, and given that there are currently relatively few operational wind farms in the migration corridor. The Service is concerned that the risk of mortality will increase as more and more turbines are constructed.

The construction of power lines associated with wind farms is another concern for whooping crane survival during migration. As stated previously, power lines are the greatest known cause of mortality of fledged whooping cranes. Whooping cranes collide with power lines simply because they do not see them and/or can't maneuver quickly enough to avoid them. The small static wire that is usually situated above the other lines is especially hazardous to cranes, as well as other birds. The proximity of power lines to locations where birds are landing and taking off is critical (Lee 1978, Thompson 1978, Faanes 1987). No sandhill crane or waterfowl collisions were observed where distances from power lines to bird use areas exceeded 1 mile (Brown et al. 1984, 1987).

Wind farm impacts to whooping cranes should consider both the on-site power lines and any new transmission lines constructed to transport the produced electricity. USFWS recommends that all power lines on wind farms be placed underground. New transmission lines that cannot be buried and lie anywhere in the approximate 200-mile wide whooping crane migration corridor should be marked according to USFWS recommendations described in *APLIC 1994.* Although marking lines is expected to reduce collision mortality for cranes and other large birds between 53-89%, some whooping crane mortality is likely to occur on marked lines.

Indirect Impacts

Although most issues concerning wildlife and wind energy development initially focused on the direct effects of mortality from wildlife collisions with turbines and their associated infrastructure (power lines, guy wires, substation buildings, etc.), such collisions are no longer the sole focus of concern. The primary indirect effect of concern is complete avoidance by whooping cranes of stopover habitat. Also of concern are indirect effects caused by habitat fragmentation, loss of stopover habitat, and disruption of life cycles due to behavioral tendencies of many wildlife species to avoid vertical structures, including wind turbines.

Although the reaction of whooping cranes to wind turbines on the landscape is not fully known, the primary indirect effect of wind farm development may be that whooping cranes avoid wind turbines and do not use otherwise suitable stopover habitat located in wind farm areas. More research in this area is needed. A one-year funded study to be conducted in 2009-2010 at Horicon NWR in Wisconsin should provide additional information on how sandhill cranes react to turbines. Wind energy development could cause whooping cranes in the AWBP to avoid otherwise suitable habitat, forcing the birds to search for alternate stopover areas. However, any avoidance behavior is likely to be local and not alter the overall migration corridor of these birds. To measure the amount of habitat potentially removed from use by whooping cranes, it is recommended that wind energy developers calculate how many wetland acres are within the footprint of habitat overlain with turbines.

Removal of stopover habitat could result in increased mortality to the species if cranes are forced to use suboptimal habitat or fly farther to find stopover habitat away from a wind farm. This would lengthen the migration and take extra energy. Flying greater distances under low-light conditions could expose the cranes to additional dangers (hunting, power line collisions, etc.) as they search for stopover habitat. The cranes may be forced to use stopover habitat that is less suitable and thus be more subject to predation, disease, or human disturbance, all of which could increase mortality.

Loss of migration stopover habitat is a growing concern regarding the AWBP of whooping cranes (CWS and USFWS 2007). If significant loss in quality or quantity of stopover habitats were to occur, it would likely negatively affect the physical condition of migrating birds, which in turn would impact their likelihood of surviving migration, the reproductive rates on the breeding grounds, and overwinter survival. Any future population viability analyses for the whooping crane must address the importance of stopover habitat for this species (Reed 2004).

COMPLIANCE WITH THE ESA

Pursuant to section 9 of the ESA, it is unlawful for any person to take any federally-listed threatened or endangered fish or wildlife species, without special exemption. The ESA defines take as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or to attempt to engage in any such conduct. Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR 17.3). If whooping cranes avoid turbines, construction of wind farms could deny stopover habitat from the species, resulting in harm from habitat modification; such harm could result in take (defined in 50 CFR 17.3).

Take incidental to a lawful activity may be handled through formal consultation under section 7(a)(2), if a Federal agency action, funding, or permit is involved. Otherwise, an incidental take permit (ITP) pursuant to section 10(a)(1)(B) may be obtained upon completion of a satisfactory habitat conservation plan (HCP).

ESA compliance – activities with a Federal nexus

If a project has a Federal nexus (i.e. is carried out, funded, licensed or permitted by a Federal agency) and is in the whooping crane migration corridor with whooping crane stopover habitat located on or near the project, it will require consultation with the Service under section 7 of ESA. Wind energy projects on USFWS grassland or wetland easements, projects funded by the USDA, Rural Utilities Service, Department of Energy, or projects requiring Federal permits associated with construction of transmission lines and connection to the Federal power grid via interconnection agreements with the Department of Energy are examples of a Federal nexus.

ESA compliance – activities without a Federal nexus

If a project has no Federal nexus to trigger section 7 consultation under the ESA, but is in the whooping crane migration corridor and has the potential to either directly take whooping cranes or indirectly take stopover habitat, then the company still must ensure that its actions do not result in a violation of section 9 of the ESA. In the 1982 amendments to the ESA, Congress established a provision in Section 10 that allows for "incidental take" of endangered and threatened species of wildlife by non-federal entities. Incidental take is defined by the ESA as take that is "incidental to, and not the purpose of, the carrying out of otherwise lawful activity." The "incidental take permit" process was established under Section 10(a)(1)(B) of the ESA.

Section 10(a)(2)(A) of the ESA requires an applicant for an incidental take permit to submit a conservation plan that specifies, among other things, the impacts that are likely to result from the taking and the measures the permit applicant will undertake to minimize and mitigate such impacts. Conservation plans under ESA have come to be known as HCPs. As stated previously, with only 247 whooping cranes currently in the AWBP, the population cannot sustain much additional mortality from any source, including wind energy development. Therefore, for those activities that are likely to result in adverse impacts to the whooping crane, it would be necessary for project proponents to provide measures that will offset those impacts. The most effective way to deal with the provision of offsetting measures is on a programmatic basis, through programmatic HCP's where there is no federal nexus, and through programmatic NEPA and Section 7 consultations where a federal nexus exists.

RECOMMENDATIONS

Recommendations to minimize "take" of migratory birds

1. Implement USFWS's voluntary *Interim Guidance on Avoiding and Minimizing Impacts to Wildlife from Wind Turbines* available at <www.fws.gov/habitatconservation/wind.htm>, as they are intended to assist proposed wind energy projects in avoiding and minimizing impacts to wildlife and habitats. Additional information from USFWS efforts to address wind energy can be located at <http://www.fws.gov/ southwest/migratorybirds/windpower.html>.

2. If wind turbines are not already engineered to prevent perching by avian predators, anti-perching devices should be installed on each turbine. Tubular tower designs that eliminate perching sites on towers should be used. Do not use lattice towers as these attract birds to perch on the towers. Avoid use of guy wires to support towers, as birds are more likely to strike guy wires during migration. If guy wires must be used, ensure adequate high visibility marking to reduce the likelihood of collisions. Eliminate all structures on turbines and towers where birds may perch. Rounded and sloped surfaces that are too large in circumference for birds to grasp or too angled for birds to perch on are best.

3. Bury all electrical lines underground to the maximum extent possible, especially on the wind farm site. When it is not feasible to bury power lines, construct power lines in a manner consistent with guidance in the Avian Power Line Interaction Committee's (APLIC; <www.aplic.org>) *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006*. This includes increasing the visibility of overhead transmission lines by using line marking devices, including aerial marker spheres, swinging plates, spiral vibration dampers, and bird flight diverters. For guidance on markers, see APLIC (1994). Additionally, The Edison Electric Institute's APLIC and USFWS's joint publication titled, *Avian Protection Plan Guidelines*, provides another toolbox for selecting and tailoring avoidance and minimization components applicable to specific projects. A copy of this document maybe obtained from the APLIC website at <http://www.aplic.org/>.

4. Use the minimum amount of pilot warning and obstruction avoidance lighting required by the Federal Aviation Administration (FAA). The FAA typically requires lights for aviation safety on all structures over 199 feet above ground level, which includes most modern wind turbines. Unless otherwise required by the FAA, only white (preferable) or red strobe lights should be used at night, and these should be the minimum number, minimum intensity, and minimum number of flashes per minute (longest duration between flashes) allowable by the FAA. The use of solid red or pulsating red warning lights at night should be avoided. Current research indicates that solid or pulsating (beacon) red lights attract nocturnally-migrating birds at much higher rates than white strobe lights. For most wind energy facilities, the close proximity and the great number of wind turbines at a facility precludes the need for all turbines to be lighted. The FAA has been willing in the past to negotiate with wind power developers to find a sensible

compromise on the percentage of turbines that require aviation safety lighting and on the color, intensity, and pulse rate of lights required.

Recommendations to avoid and minimize "take" of whooping cranes and mitigate unavoidable impacts

Location of wind farms

Wind farms should not be built near traditional whooping crane stopover locations, and should be placed as far away from the centerline of the whooping crane migration corridor as feasible. Wind farms should not be constructed in areas within a wetland mosaic suitable for whooping cranes to use. Individual turbines should be placed as far away from wetlands as possible.

USFWS encourages wind energy companies to use the National Wetland Inventory maps in conjunction with ground truthing to identify wetlands occurring within the proposed project area at 0.5-mile and 5-mile radii from the project site. Steps should be taken in determining the final location, extent, construction, and operation of project features to avoid any wetland impacts or loss, and mitigate any unavoidable wetland impacts. USFWS's NWI provides a Wetlands Digital Data and Mapping website, <http://wetlandsfws.er.usgs.gov/>, which contains all currently available electronic versions of the NWI maps. While coverage is not complete, it is being updated as progress is made on digitizing hard copy maps (K. Frazier, USFWS, Tulsa, Oklahoma, letter to HDR Engineering, November 17, 2007).

Construction and/or maintenance activities should be stopped if whooping cranes are observed on-site and birds should be left undisturbed until they leave the area as per the *Aransas-Wood Buffalo Population Whooping Crane Contingency Plan* (U.S. Fish and Wildlife Service 2006).

Turbine shutdown

If a whooping crane were to be killed by a wind turbine, USFWS could request that the wind farm cease operations during all or portions of the spring and fall whooping crane migration periods. These migration periods are prolonged, lasting 2 months in the fall and about 6 weeks in the spring. Companies should factor in the scenario of a possible required cessation of operations when selecting a wind farm site. As a general guideline, until more is learned about crane response to turbines, the USFWS recommends that operation of turbines be temporarily ceased immediately within 2 miles of the known presence of a whooping crane. Upon learning of the presence of a whooping crane, the sighting should be immediately reported to the nearest USFWS Ecological Services Field Office and the *Aransas-Wood Buffalo Population Whooping Crane Contingency Plan* (Contingency Plan) implemented. Wind farm employees are asked to work closely with the Ecological Services Field Office, as well as the USFWS whooping crane coordinator (Tom Stehn, (361) 286-3559, ext. 221, tom_stehn@fws.gov) and/or the USFWS lead for the Contingency Plan, Martha Tacha, (308) 382-6468, ext. 19, martha_tacha@fws.gov). As per Contingency Plan guidelines for a crane in a hazardous situation, the bird should be monitored during daylight hours by wind farm personnel. Once the daily movements of the whooping cranes are determined, it may be possible to re-start some nearby turbines, especially if the local movements of the cranes avoid the wind turbines and the weather is not expected to allow for resumption of a migration flight.

USFWS believes the measures listed below are necessary and appropriate to adequately mitigate impacts to the AWBP.

1. For every acre of habitat lost to the construction of wind turbines, (*i.e.*, the actual foot print of the wind farm), USFWS recommends that provisions be made for habitat mitigation following USFWS's *Mitigation Policy* (Federal Register V.46, No. 15, January 23, 1981).

2. In addition, our current best estimate is that whooping cranes will normally not use habitat within 0.5-miles of a wind turbine. Thus, mitigation is suggested for every wetland acre within 0.5-miles of a turbine that is suitable whooping crane habitat. To Suitable whooping crane habitat is defined as shallow wetlands in open, non-wooded areas free from human disturbance such as nearby roads or buildings with at least some water area less than 18 inches deep. This also includes marshes, small ponds, lake edges, or rivers.

3. USFWS encourages the wind energy industry to collaborate with USFWS to identify appropriate and suitable mitigation measures for development projects. In many cases, providing permanent protection for suitable whooping crane wetlands more than 5 miles from the project site is be the preferred action since whooping cranes may tend to avoid turbine arrays. Areas could be protected either by acquiring fee title lands or easement rights on lands that consist of suitable whooping crane stopover habitat. Protection in perpetuity of suitable stopover habitat in the corridor will help ensure alternate, relatively safe stopover areas are available for the cranes in the future. Development on these lands should be precluded. The acquisition of any property or easement should be coordinated with USFWS to ensure adequacy. However, even with additional protected areas, the overall impact of wind energy development is still anticipated to be a net loss of stopover habitat for the cranes since no new stopover wetlands are being created. Instead, wetlands would be protected from future loss.

   It is important to analyze the availability of stopover habitat for a given locale within the migration corridor. Analysis should include an assessment of the amount of suitable stopover habitat in the general area of the wind farm. If it turns out whooping cranes mostly avoid wind farms, will there be sufficient habitat remaining in the surrounding area for the whooping cranes to find stopover habitat or does the only stopover habitat occur on the wind farm?

4. Whooping crane survival and recovery depends on mortality, including that from collisions with power lines, to not increase. USFWS recommends that all power lines at wind farm sites be placed underground. If lines cannot be placed underground, then new transmission lines anywhere in the 200-mile wide whooping crane migration corridor should be marked according to the USFWS recommendations described in APLIC 1994. Although marking lines will reduce collision mortality for cranes and other large birds between 53-89%, some whooping crane mortality is likely to occur on marked lines.

5. The increased risk posed by new structures on the landscape associated with wind energy development can be mitigated by marking existing power lines in the migration corridor of the AWBP of whooping cranes. Whooping cranes saved by this marking technique on already existing structures can hopefully mitigate potential collision mortality on new structures including turbines and power lines associated with wind energy development. To mitigate for expected collisions, construction above ground of every mile of new marked line associated with wind energy development should be matched by marking and ensuring maintenance of markers on at least one mile of existing transmission and/or distribution lines in the whooping crane migration corridor line so that the net rate of collisions on all lines will actually decrease. This practice would insure that new line construction will not result in a net increase of whooping crane mortality and could be a mitigation strategy for an HCP for the wind energy industry for whooping crane issues. To determine the amount of line that should be marked, an analysis needs to be done as part of an HCP to calculate the current number of unmarked transmission lines in the whooping crane migration corridor and an estimate of annual mortality from those lines.

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